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SYNOPSIS: Reclamation of 24 inactive uranium mill tailngs piles involves remedial work to stabilize the piles for 1000 years. Site characterization of geotechnical and groundwater conditions at each site is undertaken prior to remedial action design. This paper describes the approach to UMTRA Project site characterization. A case history, Green River, is described. Details of site characterization costs for most sites are provided.

INTRODUCTION

The Uranium Mill Tailings Remedial Action (UMTRA) Project involves the construction of remedial action to stabilize and reclaim 24 inactive uranium mill tailings piles in 10 states. An important part of the planning and design of remedial action is site characterization. This paper describes the UMTRA Project site characterization program. Details of site characterization at the Green River, Utah, site are discussed in order to provide a complete overview and a specific case history of UMTRA Project approaches and methods, as well as the end product.

Site characterization work at UMTRA Project sites, discussed in this paper, includes the following: geological investigations; field drilling and test pitting; collection of tailings, soil, rock, and surface-water and groundwater samples; laboratory testing of tailings, soils, rocks, and water; and the compilation of site characterization reports describing the site stratigraphy, groundwater regime, and the properties of the in-place and construction materials. Site characterization work performed at UMTRA Project sites, but not discussed in this paper, includes: archaeological surveys; plant and animal surveys; radiological and other waste characterization work; and climatological and surface-water characterization.

THE UMTRA PROJECT

The UMTRA Project is managed by the U.S. Department of Energy (DOE) in terms of the the Uranium Mill Tailings Remedial Control Act (UMTRCA) of 1983. Site characterization, design, and construction are performed by contractors to the DOE.

In terms of UMTRCA, the U.S. Environmental Protection Agency (EPA) sets the standards for the remedial action. The U.S. Nuclear Regulatory Commission (NRC) and affected states and tribes review and concur in the design of the remedial action works.

The EPA standards require, among other things, that the remedial action be effective for at least 1000 years, to the extent practical, and at least for 200 years. Remedial action must be designed and constructed to prevent dispersal of the tailings and other contaminated materials, and must prevent inadvertent use of tailings by man. Remedial actions should not rely for their efficacy on maintenance, although in practice, maintenance and surveillance programs are planned at all sites.

To date, construction is complete at: Canonsburg, Pennsylvania; Shiprock, New Mexico; and Salt Lake City, Utah. Construction work is in progress at: Durango, Colorado; Mexican Hat, Utah; and Lakeview, Oregon. Site characterization is complete, or significantly advanced at the remaining sites, with the exceptions of Gunnison and Naturita, Colorado, where alternate site selection studies are in progress. In terms of Federal legislation, the Project is scheduled to be complete by 1993.

THE TECHNICAL APPROACH DOCUMENT AND CONTRACTUAL PROCEDURES

Technical Approach

The technical approach to site characterization at UMTRA Project sites is described in a Technical Approach Document (TAD). The TAD, which was compiled in close discussion with the EPA, NRC, and affected states and tribes, sets out in detail the methods and approaches employed to characterize the following aspects of tailings piles and new disposal sites: geology; groundwater; site and regional seismicity; subsurface soils and rocks and their geotechnical and hydrogeochemical properties; tailings and their geotechnical and radiological properties; and the geotechnical and radon attenuation properties of potential construction materials (soils and rocks that will be used to construct and cover the reshaped or relocated tailings pile and associated contaminated materials). A later section of this paper discusses some of the technical approaches in detail.

Detailed site characterization procedures are documented in the Standard Operating Procedures of the various contractors to the DOE on the UMTRA Project.

Performance of Site Characterization Work

The UMTRA Project is managed from the DOE Albuquerque Operations Office in Albuquerque, New Mexico. The Technical Assistance Contractor (TAC) is located with the DOE. The TAC is contracted to the DOE to provide, among other services: site characterization work; conceptual designs; and the compilation of Environmental Impact Statements/Environmental Assessments (EIS/EAs) and Remedial Action Plans (RAPs). TAC staff perform geological site characterization work as well as planning, control, interpretation, and compilation of field programs and their results for geotechnical and groundwater characterization work.

Due to the fact that the 24 sites are scattered across a wide geographic area, TAC subcontractors are employed to perform site characterization work. This work involves drilling, geotechnical sampling, and in-situ testing (i.e., with a piezocone). Laboratory testing of soils, rocks, and water is done in commercial facilities subcontracted to the TAC.

Because of the technical expertise required, groundwater sampling is done by a team of TAC staff who travel from site to site with specially-equipped vehicles.

Scopes Of Work

When subcontract work is required at a site, the usual procedure is for the TAC to call for bids from qualified subcontractors. The number of bidders varies significantly depending on the site location and the nature of the work required. Once bids have been issued, there is usually a site meeting at which salient aspects of the terrain as well as the work required are discussed with prospective subcontractors. Bids are reviewed upon receipt in Albuquerque in accordance with standard government contract procedures. Normally, the contract is awarded to the lowest bidder. (This has, unfortunately, not always led to the employment of the better, more competent contractors.)

The technical work to be performed by the subcontractor is described in the bid in the Scope of Work. This is the only part of the bid and contract compiled by the TAC technical staff. A typical Scope of Work incorporates a description of the site, a detailed listing of the work to be done,and technical specifications.

Site control

During subcontractor performance of site characterization work, technical staff from the TAC are present. A full-time site person, the Field Technical Representative (FTR), is empowered to: monitor the contractor; observe that proper work is performed; confirm that required operating procedures are observed; and request that specific work (e.g., in-situ testing) be done at appropriate times. The FTR is not empowered to control or direct the subcontractor's work. The FTR keeps a daily diary that is used as the basis for agreeing to and paying bills submitted by the subcontractor.

GEOTECHNICAL SITE CHARACTERIZATION - TECHNICAL APPROACH

Geotechnical site characterization includes geologic, geomorphic, subsurface investigations, and seismic studies.

Geologic site characterization of UMTRA Project sites is an integral part of the overall design effort. This characterization consists of a summary of the regional geologic setting, local site geology, regional and local structures, Quaternary geology of the site region, and the local distribution of surficial units. The in-depth geologic studies are presented in the Site Characterization Report section of the Remedial Action Plan (RAP).

The purpose of the geomorphic hazard assessment is to identify the geomorphic processes that affect the site, to estimate the probability of their occurrence, and to evaluate the possible magnitude of their effects during the life of the reclamation. The general approach used to accomplish these goals involves three steps: (1) identify past geomorphic processes and estimate their rates from the geomorphic and stratigraphic records (post-glacial time, roughly 10,000 years); (2) identify present geomorphic processes and estimate their rates from historic records and field observations (typically less than 80 years); and (3) predict future geomorphic processes and rates.

The purpose of subsurface characterization of UMTRA Project sites is to define the geotechnical conditions of existing tailings piles, foundation soils, and proposed borrow sources. The stratigraphy and physical properties of materials composing the stratigraphic units are characterized. Stratigraphy is determined by using information logged in boreholes and test pits. Piezocone probings or seismic field studies may also be used to define stratigraphy. Material properties are determined by laboratory and field tests.

The nature and material properties of the tailings piles must be determined in order to decide if stabilization in place can be accomplished without recompacting or otherwise consolidating the pile. In addition, the behavior and stratigraphy of the foundation soils must be determined in order to assess the stability of the pile. An initial exploratory program consisting of a series of piezocone penetration tests similar to the static cone penetration test described in the ASTM D3441 are performed at a minimum density of one per acre to cover the tailings pile. Each test penetrates the entire depth of the pile and extends into the foundation soils until stiff or dense soils are encountered. Data from these probes are used to: (1) define the stratigraphy of the pile (e.g., locate significant layers, zones, and pockets of slimes within the embankment); (2) determine the rate of dissipation of induced pore pressures (the rate of pore water pressure dissipation is used to estimate the tailings hydraulic conductivity and consolidation parameters); (3) obtain the penetration resistance of the tailings and their strength and bearing capacity; and (4) determine the groundwater level.

The stratigraphy interpreted from the piezocone data is considered in determining the location of additional boreholes conducted in the second phase of field work. These borings are performed to obtain undisturbed and disturbed samples for laboratory testing and to verify the stratigraphy defined by the piezocone data. Sufficient borings are conducted to verify the information from the piezocone. At least one of the borings is taken 20 feet into bedrock or up to 250 feet below the tailings-soil interface if foundation stratigraphy and material properties permit.

Borings with sampling are also conducted adjacent to the piles in order to identify variability of the near-pile foundation soils. Test pits are excavated on the pile to obtain representative sand, sand-slime, and slime tailings samples for laboratory testing. Test data are used to determine the geotechnical properties of the tailings when placed as fills.

For separate disposal areas, borings are required in order to determine the foundation soil and bedrock characteristics at a disposal site. The density of borings is approximately one for every three acres. A sufficient area is covered to allow repositioning of the pile within the general area of interest. These borings extend at least 20 feet below grade; at least two borings extend up to 50 feet below grade, or to a minimum of 20 feet, into bedrock. One of the borings may extend as deep as 250 feet if the soil at the site is deep.

Borrow areas are identified by performing a borrow assessment. For radon cover material, a limited number of areas are investigated by excavating eight to 12 test pits at each area. Both large and small bulk samples are obtained in order to perform classification and material properties tests.

For rock armoring material, one or more areas are investigated in order to define the limits and quality of rock armor borrow material. For gravel sites, six to eight test pits are conducted at each area. Both large and small bulk samples are obtained. For bedrock sites, samples are obtained from rock outcrop areas.

Laboratory tests are performed on tailings, foundation, fill, and soil borrow sources in order to determine appropriate material properties needed for design. These include strength, compressibility, compaction, permeability, capillary moisture, radon diffusion coefficient, and correlative property tests. Rock samples are tested for durability using petrographic, LA abrasion, absorption, sodium sulfate soundness, and specific gravity tests. Other types of soil and rock tests are performed if needed.

As part of the design of reclamation work at UMTRA Project sites, studies are conducted to define the seismic hazard. These evaluations result in a seismotectonic characterization of each site and provide a set of earthquake design parameters. These parameters include: the design earthquake magnitude; on-site peak horizontal ground acceleration; the distances to, and lengths of, capable faults; and the types of capable fault displacement. During the seismic investigation, the potential for on-site fault rupture is analyzed.

Once the acceleration has been determined for a site using methods outlined in the previous sections of this chapter, the impact of stratigraphy upon the acceleration is evaluated. The site is classified as having shallow or deep soils. Based upon this classification, modification to the site acceleration is as follows:

- For shallow soil sites having less than 30 feet of overburden above bedrock, the site surface acceleration used in liquefaction and slope stability analyses is considered to be the same as the acceleration derived from the seismic study.
- Deep soil sites require adjustment to the on-site acceleration derived from the seismotectonic site characterization. The acceleration must be modified for attenuation to amplification through the soil in order to derive the surface acceleration used as input into liquefaction and stability analyses.

In order to assess the long-term stability of the tailings piles, the long-term static and earthquake loading conditions are determined. Natural slopes, which may affect the long-term performance of the embankment, are also analyzed for static and earthquake loading conditions. In addition, short-term static and seismic loading of the embankment and construction slopes must be analyzed to assess the suitability of the proposed designs.

Settlement of the reconstructed tailings piles at UMTRA Project sites is assessed in order to evaluate long-term stability. Settlement can occur within the reclaimed tailings embankment and in the foundation soils upon which the embankment is constructed. The absolute and differential settlement depend on the distribution of different types of materials, the compressibility of each soil type, and the stresses on specific soil layers. Settlement, especially differential settlement, can lead to surface-water runoff flow concentrations which could erode the pile cover and/or lead to cracking of the radon cover.

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In order to evaluate the long-term stability of tailings piles at UMTRA Project sites, the liquefaction potential of the pile and foundation soils under design earthquake conditions is assessed. The liquefaction potential of a site is determined by the soil properties, depositional history, depth to groundwater, and characteristics of the earthquake motion to which it is subjected.

GROUNDWATER SITE CHARACTERIZATION

Subsurface investigations are performed at each former mill processing site and potential tailings disposal site to define the presence and extent of groundwater-bearing (hydrostratigraphic) units. The ultimate objective of these investigations is to develop the appropriate remedial action plan for water resources protection and a cost-effective remedial action plan for cleanup of the inactive mill sites. Aquifer hydraulic and geochemical characteristics are defined for each hydrostratigraphic unit to aid in determining the amount and extent of present and potential contamination by the mill tailings operations.

Groundwater site characterization begins with an inventory and review of existing hydrogeologic literature and water well records in the vicinity of the site. An early assessment is made to: (1) identify water users within a two-mile radius of the site; (2) estimate the extent of contamination; (3) identify possible sources of contamination near the mill site other than mill tailings; and (4) to identify potential disposal sites. Field testing, drilling and monitor well installation, water sampling, soil sampling, and aquifer-hydraulic testing are completed in phases.

Key elements in the groundwater characterization for each site include the following:

- Definition of the contaminant source.
- Characterization of representative background water quality for each hydrostratigraphic unit of concern and for surface water.
- Definition of presence and extent of contaminant plumes, as well as discharge of plumes to surface water.

The contaminant source term is characterized by collecting and analyzing tailings solids and pore water samples. Saturated and unsaturated hydraulic conductivities of undisturbed tailings samples may be determined. To estimate the rate of movement of leachate through the tailings at the disposal site, the hydraulic conductivity of one or more remolded and compacted tailings samples is determined. Contaminant sources other than mill tailings are identified and may be characterized if it is determined that contamination from that source may affect, or in any way bias, the characterization of the tailings pile or the disposal site hydrogeology.

Background groundwater quality is determined by establishing representative values for constituents from water samples obtained from wells upgradient of the tailings pile. These background wells must be sufficiently upgradient so that the groundwater is unaffected by tailings seepage. Existing springs and wells may be used, or it may be necessary to install monitor wells specifically to determine background water quality. Where six or more sample analyses are available, the background concentration range is assumed to be the arithmetic mean (or possibly the geometric mean, depending upon the distribution of the data) plus or minus two standard deviations. For less than six samples, the background concentration range is assumed to be equal to the observed range of data. Obvious outliers in the data set are eliminated and an explanation for doing so is provided for reviewers.

The vertical extent of contamination in the groundwater system is determined by installing a group or "nest" of monitor wells at specific locations on the site, and downgradient and crossgradient from the site. Each well in this nest is screened within a discrete interval which is different in depth below the surface from all other wells in the nest. The deepest well showing no impact from tailings seepage defines the lower limit of contamination. The lateral extent of contamination is determined by installing monitor wells progressively away from the contaminant source(s) until water-quality analyses from the outermost wells show that there is little or no contamination. At many of the UMTRA Project sites, the lateral extent of contamination is defined by one or more groundwater discharge points such as springs, intermittent drainages, or rivers.

As solvents and other chemicals were used at some of the UMTRA Project sites during the milling processes, an EPA Priority Pollutant scan is conducted at one or more of the monitor wells, usually on the site or immediately downgradient from the site. Then, at several of the other wells at each site, organic contamination is screened by analyzing for total organic carbon (TOC) and total organic halogens (TOX).

CASE HISTORY: GREEN RIVER

Green River, Utah, is one of the 24 UMTRA Project sites at which remedial action work will be undertaken. The following sections describe the site characterization work completed at the Green River site. Final designs have been prepared for the remedial action work; and construction is scheduled to begin in the summer of 1988.

Green River Site Description

The Green River inactive uranium mill site is in Grand County, Utah, approximately one mile southeast of the city of Green River and 0.5 mile south of U.S. Highway 6 & 50. The 48-acre site is in Sections 15 and 22, Township 21 South, Range 16 East, Salt Lake Meridian, and is bordered by the mainline track of the Denver and Rio Grande Western (D&RGW) Railroad on the north and the recently completed Interstate 70 on the south.

The 48-acre designated site consists of the tailings pile (eight acres), the mill yard and ore storage areas (23 acres), four main buildings, a water tower, and several small buildings. The buildings are all structurally sound and marginally contaminated.

Dispersion of tailings by wind and water erosion has contaminated approximately 30 acres. The total volume of contaminated materials, including the tailings and underlying soils, is estimated to be 185,000 cubic yards (cy).

In order to stabilize the tailings and meet the EPA standards, the tailings and other contaminated materials will be consolidated into a disposal cell out of Brown's Wash approximately 500 feet south and 50 feet higher in elevation than the existing mill site. The site occupies a level area that is disected by a shallow, ephemeral stream. This stream drains to the northwest around the mill site. Bedrock is exposed in the bottom of drainage near the mill site. The site surface is formed of pediment sand and gravel and is covered by sagebrush and wild forbs. A power line crosses the site area.

Geotechnical Site Characterization

The Green River site is in the northern part of the Canyon Lands section of the Colorado Plateau Physiographic Province, an area of low historic seismicity. The site region is drained by the Green River which passes 0.5 mile west of the site. The tailings pile rests on the bank of Brown's Wash, intermittent tributary with a watershed of 85 square miles. The peak horizontal acceleration at the site is 0.21g.

Subsurface Investigation

The Green River tailings pile was characterized by drilling five borings and excavating three test pits on the pile. The locations of these boreholes and test pits are presented in Figure 1.

Tailings are divided into three categories according to the size of the particles. The three designations are: sand; sand-slime; and slime. At Green River, the slimes were removed for upgrading at Rifle, Colorado, leaving only

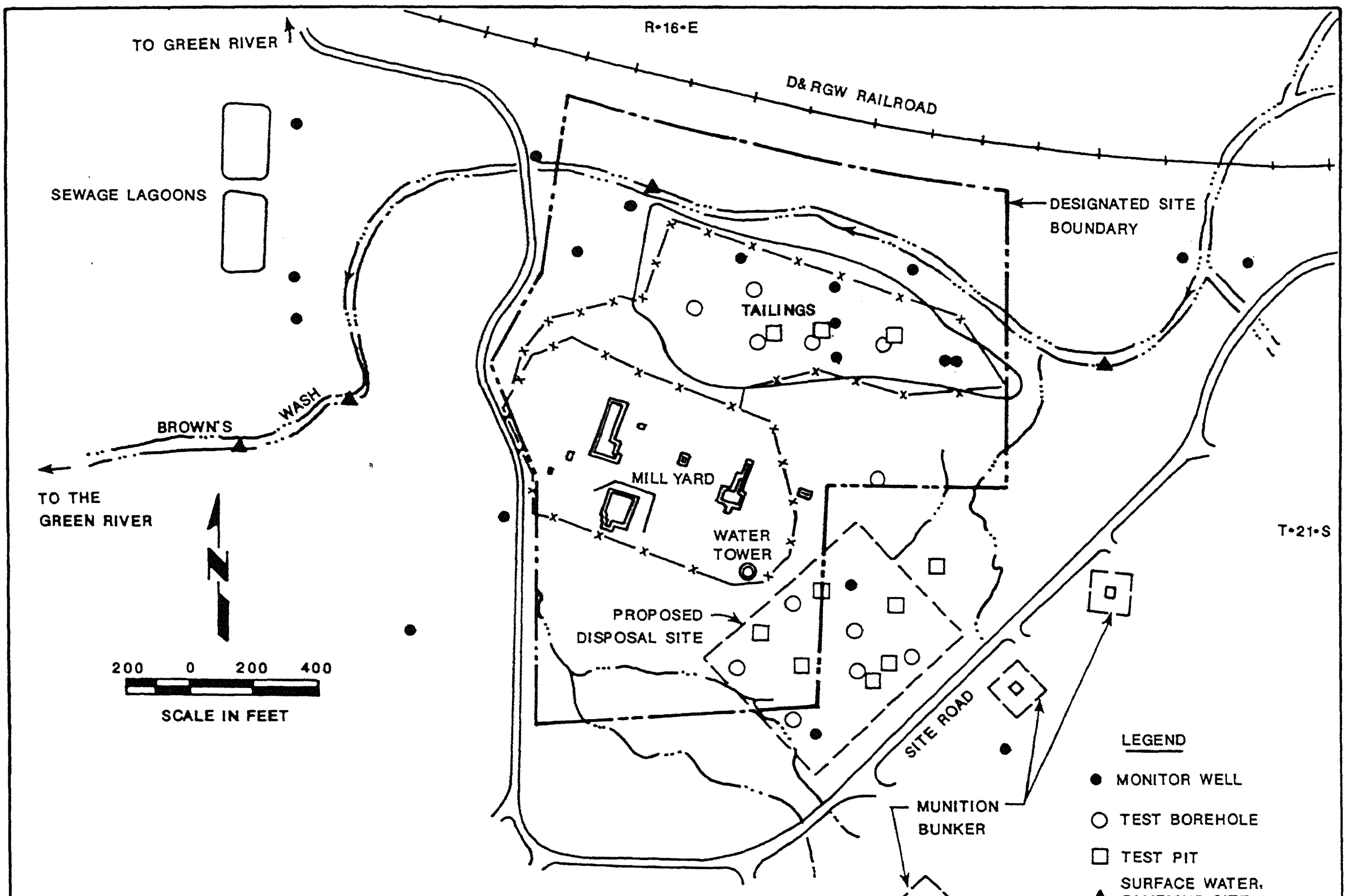

FIGURE 1 LOCATIONS OF MONITOR WELLS, ABANDONED BOREHOLES, TEST PITS, AND SURFACE-WATER SAMPLING SITES, GREEN RIVER, UTAH, TAILINGS SITE

the sand tailings. Sand tailings, as used here, refers to those tailings with up to 30 percent passing the No. 200 sieve. Most of the Green River pile contains less than 20 percent passing the No. 200 sieve. The Unified Soil Classification System (USCS) classifies the material as silty or clayey sand: SP-SM, SP-SC, SM, and SC.

Moisture contents within the tailings pile range from 1.2 to 6.4 percent. Blow counts from SPT tests range from four to 16, which correlates with a loose to medium-dense consistency. Groundwater was not encountered within the tailings.

The Green River disposal area was characterized by drilling eight borings and excavating seven test pits as shown on Figure 1. In addition, information obtained from many of the 34 monitor well drill holes was used to define subsurface stratigraphy.

The soils underlying the site consist of between five and 16 feet of loose to dense silty or clayey sand alluvium. Large lenses of clay are contained within the layer. Dense to very dense sand and gravel alluvium underlies these near-surface soils. The soils in turn overlie bedrock of coarse conglomerate sandstone of the Dakota Sandstone and shales of the Cedar Mountain Formation. These near-surface soils lie within the area of windblown contamination and are considered representative of this material. Groundwater was not encountered within the soils at the site.

Geologic cross sections were developed from outcrop and borehole information. A typical cross section is shown on Figure 2. The conditions at the site reflect the regional bedrock configuration of shallow dipping beds of Mancos Shale overlying a thin and discontinuous layer of Dakota Sandstone which in turn overlies the Cedar Mountain Formation.

Geotechnical testing of the site soils and tailings included standard penetration tests, moisture content and dry densities, gradation tests, Atterberg Limits, compaction tests, remolded and undisturbed consolidation, triaxial shear, permeability, and capillary moisture tests.

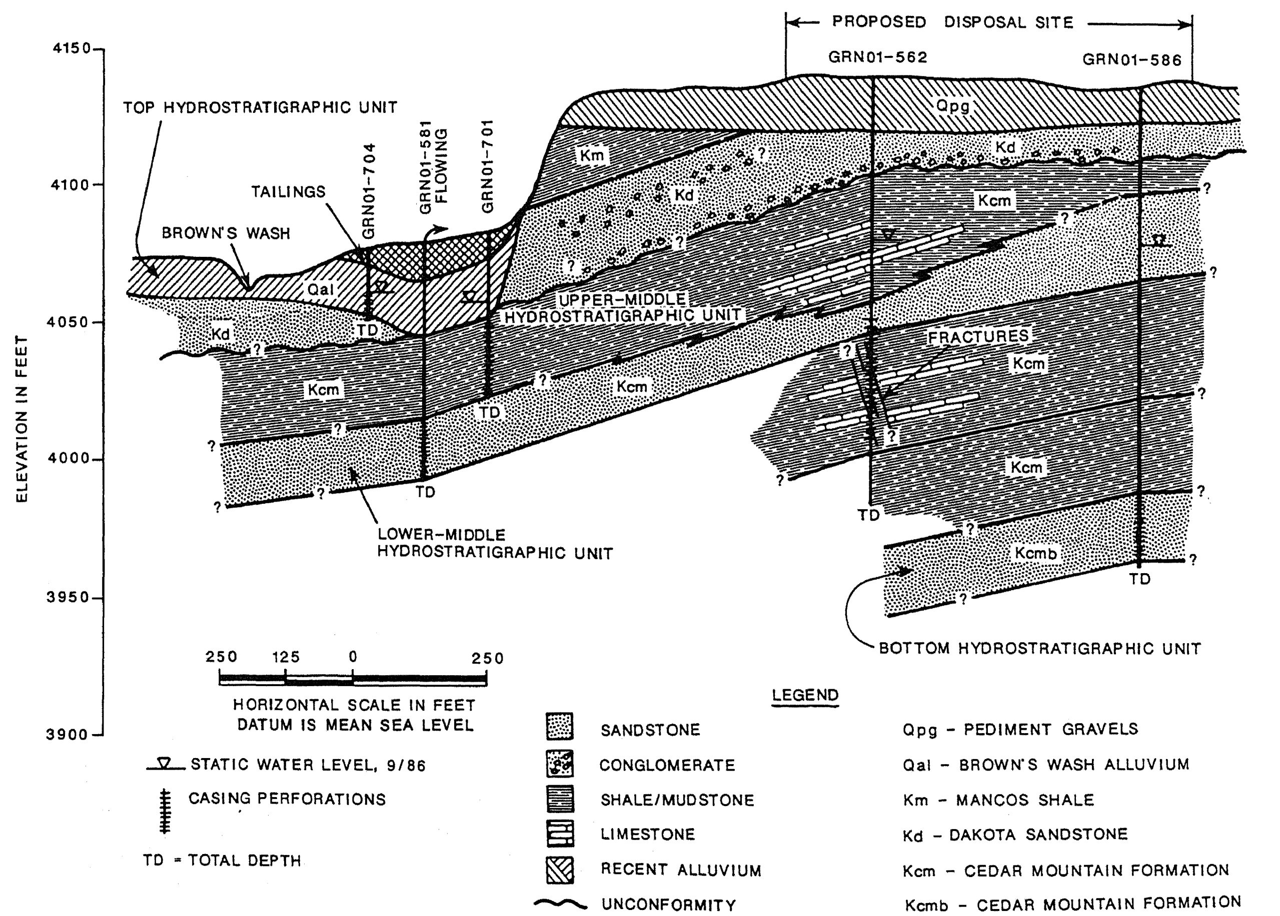

FIGURE 2 HYDROGEOLOGIC CROSS SECTION GREEN RIVER, UTAH, TAILING SITE

Groundwater Site Characterization

Thirty four monitor wells, three well points, and six surface-water sampling sites (Figure 1) were used to characterize the shallow groundwater system at the Green River site. Eight of the wells were installed by previous investigators in 1982 to characterize the tailings pile and the alluvium beneath and peripheral to the pile. The remaining wells, well points, and surface-water sites were installed by the TAC and were used to characterize three distinct Cretaceous-age bedrock units.

Depth to groundwater in the alluvium beneath the tailings surface ranges from 11 to 16 feet; the base of the tailings is above the water table. At the proposed disposal site south of the present pile (see Figure 2), groundwater is first encountered at an approximate depth of 60 feet below the surface. The general direction of groundwater flow in the alluvium and bedrock aquifers is west toward the Green River.

Background water-quality analyses indicate that the total dissolved solids (TDS) contents of the alluvial aquifer and the two shallow-most bedrock aquifers range from 4000 milligrams per liter (mg/l) to 7000 mg/l; the bottom bedrock unit contains groundwater of significantly better quality (TDS near 1900 mg/l). The EPA and State of Utah Secondary Drinking Water Standard for TDS is 500 mg/l. Contamination from tailings seepage was detected in the alluvium beneath the pile and in the shale and siltstone bedrock unit immediately beneath the alluvium. The lateral contamination (nitrate, ammonium, uranium, and manganese) is restricted to the area beneath the pile. Downgradient from the pile, some contamination discharges from the alluvial aquifer into Browns Wash, a small intermittent tributary of the Green River. Contamination in the underlying bedrock aquifer disperses downgradient and flows preferentially in some areas through interconnected fractures visible in outcrops and core samples. The bottom sandstone unit is protected from tailings seepage by strong upward vertical hydraulic gradients. Three of the wells completed in this unit flow at the land surface during certain times of the year.

Preliminary estimates of contaminant migration and future contamination were made for the two contaminated aquifers beneath the present tailings pile. These estimates assume dispersion (non-point discharge) in the bedrock unit and discharge of contaminated water from the alluvium into Brown's Wash 400 feet west (downgradient) of the tailings. To reduce nitrate concentrations as NO_3 to 44 mg/l, the EPA primary drinking water standard for nitrate, calculations show a natural flushing time of 90 years is needed for the alluvium; 30 years is needed for the bedrock aquifer. Uranium concentrations will be reduced to the EPA health advisory level of 0.015 mg/l (10 picocuries per liter (pCi/l)) in 160 years in the alluvium, and in 260 years in the bedrock aquifer. These two contaminants represent the most mobile and one of the most retarded contaminants at the Green River site, respectively.

TABLE 1 COMPARISON OF SITE CHARACTERIZATION COSTS FOR THREE UMTRA SITES

SITE ID:	AMBROSIA LAKE			GREEN RIVER		
REMEDIAL ACTION COST:	21.2			7.1		
TOTAL SITE COST:	29.5			16.8		
ITEM	NUMBER	FOOTAGE	COST/ITEM	NUMBER	FOOTAGE	COST/ITEM
GEOTECHNICAL BOREHOLES	42	1192	28550	12	277	20955
TEST PITS	25	250	1527	24	240	1365
MONITOR WELLS,LYSIMETERS & STANDPIPES	23	4050	76942	35	1047	(W/GEOT)
GEOPHYSICAL LOGGING	23	4050	10998	35	1047	(W/GEOT)
PIEZOCONE	126	3668	33652	N/A	N/A	N/A
WATER ANALYSIS	N/A	N/A	14883	N/A	N/A	11202
SOIL ANALYSIS	N/A	N/A	23314	N/A	N/A	22482
TOTAL			189866			56004

SITE ID:	RIFLE (PROCESSING SITE)			RIFLE (DISPOSAL SITE)		
REMEDIAL ACTION COST:	48.1					
TOTAL SITE COST:	73.7					
ITEM	NUMBER	FOOTAGE	COST/ITEM	NUMBER	FOOTAGE	COST/ITEM
GEOTECHNICAL BOREHOLES	29	N/A	(OTHERS)	11	755	150777
TEST PITS	5	N/A	(OTHERS)	16	170	4061
MONITOR WELLS	85	4830	299731	10	1180	(W/GEOT)
LYSIMETERS & TENSIOMETER	N/A	N/A	N/A	12	228	(W/GEOT)
GEOPHYSICAL LOGGING	85	4830	23715	10	1180	8783
WATER ANALYSIS	N/A	N/A	8568	N/A	N/A	0
SOIL ANALYSIS	N/A	N/A	5609	N/A	N/A	18950

SITE CHARACTERIZATION COSTS

Table 1 lists details of the costs of geotechnical and groundwater site characterization work at three UMTRA Project sites. In particular, the costs of work involved in the Green River case history are provided. Table 2 gives a summary of site characterization costs at the remaining UMTRA Project sites.

Also shown on Table 1 are the remedial action costs and the total site costs. The remedial action cost is the cost of constructing remedial works at the site. It includes the costs of site preparation, decontamination, relocation, cover, erosion protection, restoration, and construction management. The total site cost includes the costs of: planning and design development; engineering; site acquisition, surveillance and maintenance; and technical and management support. The cost for the Rifle processing and disposal sites is given as a single combined cost as all tailings will be consolidated at one facility.

CONCLUSION

This paper has described the work to be performed in order to characterize geotechnical and groundwater conditions at the 24 sites that constitute the UMTRA Project. The case history of the Green River site characterization has been discussed in detail. Costs for the site characterization work have been provided.

Complete site characterization is an essential first step in preparing cost-effective remedial action plans for engineering works that must remain stable for 200 to 1000 years. As shown in both the project and site case histories decribed in this paper, complete site characterization is a multifaceted undertaking that involves skill, cost, and site-specific approaches.

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TABLE 2 SITE CHARACTERIZATION SUMMARY

SITE ID:	DUR (PROC & DISP SITE)		MEXICAN HAT		TUBA CITY		GRJ (PROC & DISP SITE)	
REMEDIAL ACTION COST:	36.5		25.0		12.1		67.5	
TOTAL SITE COST:	61.2		34.6		20.3		169.5	
ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM
GEOTECHNICAL BOREHOLES	25	38130	39	289535	17	32610	48	214533
TEST PITS	28	1425	14	930	18	2000	80	5314
MONITOR WELLS	25	(W/GEOT)	11	(W/GEOT)	19	174928	42	19770
LYSIMETERS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEOPHYSICAL LOGGING	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PIEZOCONE	N/A	N/A	40	12015	26	(W/GEOT)	N/A	N/A
WATER ANALYSIS	N/A	15347	N/A	8787	N/A	29263	N/A	1170
SOIL ANALYSIS	N/A	15449	N/A	17309	N/A	15998	N/A	24911
TOTAL		70351		328576		254799		265698

SITE ID:	BELFIELD/BOWMAN		FALLS CITY		MONUMENT VALLEY		LKV (PROC & DISP SITE)	
REMEDIAL ACTION COST:	5.4		18.6		9.8			
TOTAL SITE COST:	19.8		32.2		18.0			
ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM
GEOTECHNICAL BOREHOLES	72	(OTHERS)	138	(OTHERS)	0	N/A	36	82570
TEST PITS	30	(OTHERS)	20	2845	5	800	16	2940
MONITOR WELLS	18	36690	40	93062	23	145830	28	(W/ GEOT.
LYSIMETERS	11	(W/MON)	N/A	N/A	N/A	N/A	N/A	N/A
GEOPHYSICAL LOGGING	11	4798	40	14000	N/A	N/A	N/A	N/A
PIEZOCONE	N/A	N/A	222	26750	N/A	N/A	N/A	N/A
WATER ANALYSIS	N/A	12840	N/A	10800	N/A	30234		
SOIL ANALYSIS	N/A	15079	N/A	26750	N/A	13200		
TOTAL		69407		174207		190064		85510

SITE ID:	RIVERTON		SHIPROCK		SLICK ROCK		MAYBELL	
REMEDIAL ACTION COST:	15.8		11.8		16.0		16.1	
TOTAL SITE COST:	27.3		20.0		26.7		26.0	
ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM
GEOTECHNICAL BOREHOLES	47	80134	69	(OTHERS)	11	5985	33	9396
TEST PITS	19	3000	24	1282	23	1173	10	1050
MONITOR WELLS	32	(W/GEOT.)	34	14365	22	44172	15	107975
LYSIMETERS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GEOPHYSICAL LOGGING	N/A	N/A	N/A	N/A	5	1000	15	5900
PIEZOCONE	N/A	N/A	N/A	N/A	12	1929	40	14779
WATER ANALYSIS	N/A	5330	N/A	4882	N/A	9590	N/A	28794
SOIL ANALYSIS	N/A	3184	N/A	11590	N/A	19466	N/A	18285
TOTAL		91648		32119		83315		186179

SITE ID:	SLC (PROC & DISP SITE)		SPOOK		LOWMAN	
REMEDIAL ACTION COST:	44.9		2.8		4.4	
TOTAL SITE COST:	67.1		9.9		12.7	
ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM	NUMBER	COST/ITEM
GEOTECHNICAL BOREHOLES	97	(OTHERS)	1	890	21	26000
TEST PITS	6	600	20	2165	16	2187
MONITOR WELLS	36	97000	10	28686	12	983
LYSIMETERS	N/A	N/A	N/A	N/A	6	36598
GEOPHYSICAL LOGGING	N/A	N/A	10	10302	N/A	N/A
PIEZOCONE	N/A	N/A	N/A	N/A	N/A	N/A
WATER ANALYSIS	N/A	4882	N/A	5817	N/A	2126
SOIL ANALYSIS	N/A	11597	N/A	6945	N/A	15675
TOTAL		114079		54805		83569