Umetco Minerals Corporation

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June 29, 2007

Mr. Keith I. McConnell, Deputy Director
Decommissioning and Uranium Licensing Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Minerals
and Environmental Management Programs
Mail Stop T7E18
11545 Rockville Pike
Rockville, Maryland 20852-2738

Subject: **Umetco Gas Hills, Final Construction Completion Report**

Reference: **Materials License SUA-648; Docket No. 40-0299**

Dear Mr. Lukes:

Enclosed please find two copies of the report titled *Final Construction Completion Report, Gas Hills, Wyoming Site (June 2007).* This report documents the conduct and completion of reclamation construction activities performed at Umetco's former uranium mill site in Gas Hills, Wyoming. The Final Construction Completion Report has been organized into the following five volumes.

Volume I	Overview
Volume II	Heap Leach Construction Completion Report
Volume III	Above-Grade Tailings Impoundment Construction Completion Report
Volume IV	Construction Completion Report for the A-9 Repository and C-18 Pit
Volume V	GHP No. 2 Construction Completion Report

Although volumes II through V are intended to be stand-alone documents for various reclamation areas corresponding to reclamation plan areas, Volume I is necessary as it presents information related erosion protection, license termination, transfer of the site, etc., which is applicable to all project areas.

It is our understanding that the final field inspection for the Gas Hills facility is being scheduled for September 2007. Accordingly, we are awaiting advisement from NRC as to the exact dates of this inspection and have all necessary documentation available.

If you have any questions or comments concerning this submittal, please contact me at (970) 256-8889 or by e-mail at gieckte@dow.com.

Sincerely,

Thomas E. Gieck
Remediation Leader

TEG/Enclosure: As stated

cc: Michael Widdop, DOE
Mark Moxley – WDEQ-LQD

FINAL CONSTRUCTION COMPLETION REPORT INDEX
GAS HILLS, WYOMING SITE

Volume I	Overview*
Volume II	Heap Leach Construction Completion Report
Volume III	Above-Grade Tailings Impoundment Construction Completion Report
Volume IV	Construction Completion Report for the A-9 Repository and C-18 Pit
Volume V	GHP-2 Construction Completion Report

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* Although Volumes II through V are intended to be largely stand-alone reports, Volume I is necessary as it presents important information related to license termination and transfer of the site. It also documents all erosion protection quality control test results—e.g., rock durability and gradation tests—which apply to all construction areas.

For Volumes II through V, two binders are provided. The first includes the main text and appendices documenting the quality control test results. Plates are provided separately in the second binder.

Final Construction Completion Report
Gas Hills, Wyoming Site

VOLUME I

June 2007

Umetco Minerals Corporation
2754 Compass Drive, Suite 280
Grand Junction, Colorado 81506

VOLUME I TABLE OF CONTENTS

Volume I Contents

VOLUME I LIST OF TABLES

Note: In general, as indicated below, tables are provided in the body of this text. However, in cases where tables are numerous and exceed two or three pages in length—in particular, for Sections 2 and 5—these are provided at the end of that section, as indicated by an asterisk below.

Volume I Contents

VOLUME I LIST OF FIGURES (* Denotes placement at the end of section.)

Definition of Terms

Acronym / Abbreviation	Definition
11e.(2)	11e.(2) byproduct material, defined under 10 CFR 40 Appendix A
ACL	Alternate Concentration Limit
AGTI	Above-Grade Tailings Impoundment
ASTM	American Society for Testing and Materials
BLM	U.S. Bureau of Land Management
CH	Fat Clay
CL	Lean Clay
cm	centimeter
cm/s	centimeter per second
CY	cubic yards
D_{50}	Minimum median particle size
DOE	U.S. Department of Energy
F	Fahrenheit
FSSR	Final Status Survey Report
GHP	Gas Hills Pond (e.g., GHP-1)
H	Horizontal
in/y	inches per year
ISRM	International Society for Rock Mechanics
LA	License Amendment
LA abrasion	Los Angeles Abrasion
LC	License Condition
LTCB	Long-Term Care Boundary
µR/hr	microRoentgens per hour
NA	Not Applicable
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NRC	U. S. Nuclear Regulatory Commission
pcf	pounds per cubic foot
pCi/g	picoCuries per gram

Volume I Contents

Acronym / Abbreviation	Definition
pCi/m^2s	picoCuries per square meter per second
PGA	peak ground acceleration
PMP	probable maximum precipitation
psi	pounds per square inch
QA/QC	Quality Assurance/Quality Control
Ra-226	Radium-226
RMGPS	Radiological Measurement Global Positioning System
Rn-222	Radon-222
SC	Clayey sand (ASTM designation)
SF	Safety Factor
SM	Silty sand (ASTM designation)
SMI	Shepherd Miller, Inc.
STP	Staff Technical Position
TER	Technical Evaluation Report
Th-230	Thorium-230
U_3O_8	Uranium Oxide
UCC	Union Carbide Corporation
Umetco	Umetco Minerals Corporation
UMTRCA	Uranium Mill Tailings Radiation Control Act
U-nat	Natural Uranium
V	Vertical
WDEQ	Wyoming Department of Environmental Quality
WEI	Western Engineers, Inc.

Section 1

1.0 INTRODUCTION

This report documents the conduct and completion of reclamation construction activities performed by Umetco Minerals Corporation (Umetco) for the East Gas Hills, Wyoming former uranium mill site. Located in a remote area of central Wyoming (Figure 1.1), the Gas Hills site is licensed by the U.S. Nuclear Regulatory Commission (NRC) under Source Materials License SUA-648, Docket No. 40-0299 to possess byproduct material in the form of uranium tailings, as well as other radioactive wastes generated by past milling operations. Figure 1.2 (also provided as Plate 1) shows the final site plan reflecting construction completion.

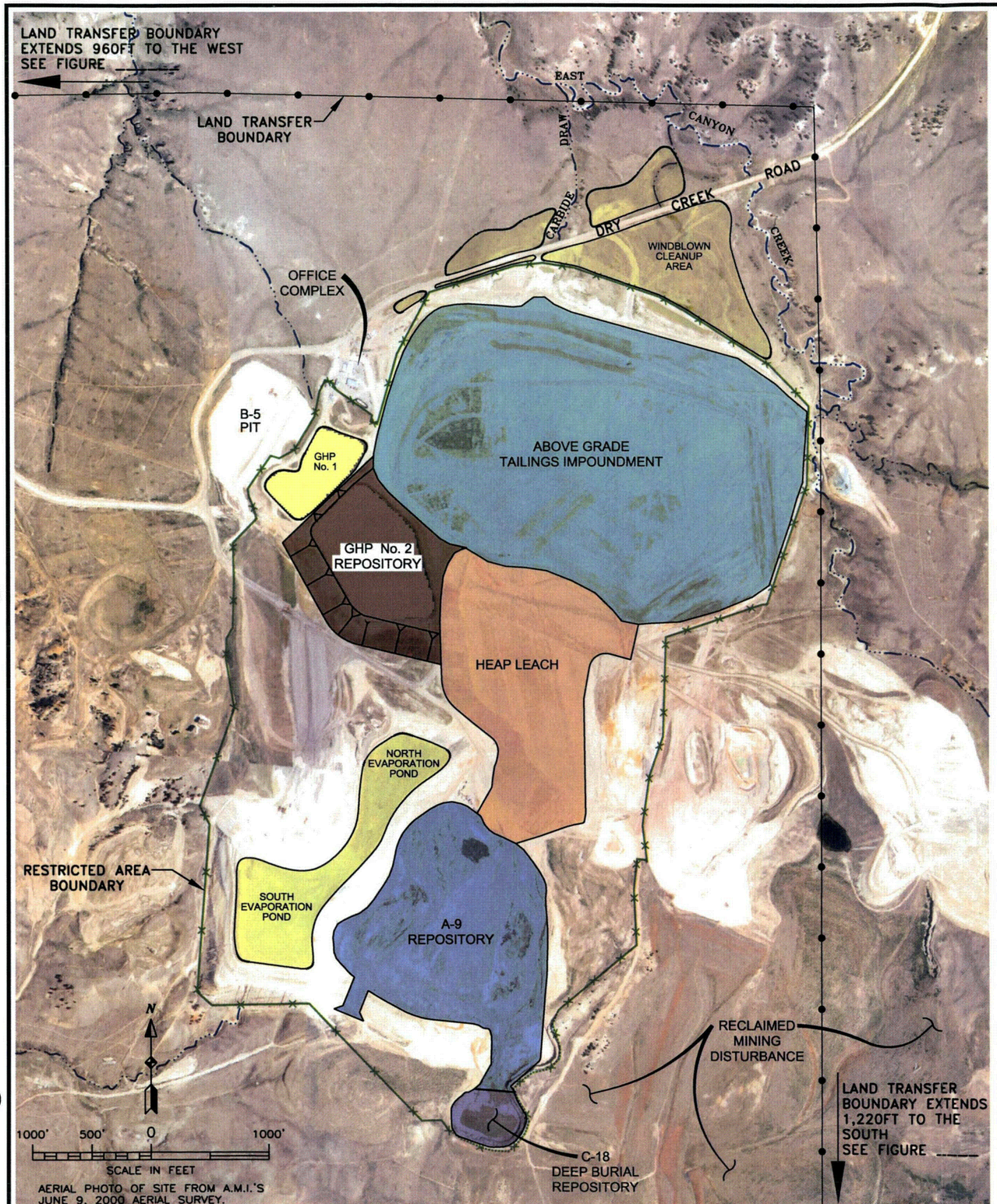
1.1 Background

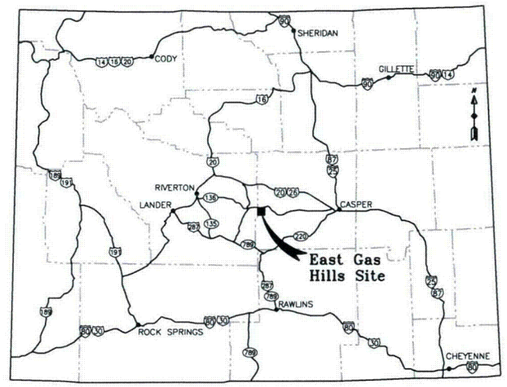
Union Carbide Corporation (UCC) and its wholly owned subsidiary Umetco conducted uranium milling operations at the site between 1960 and 1984. Mill decommissioning was initiated in 1987 and completed in 1993. Early decommissioning activities included dismantling of the mill and plant in 1991, followed by re-grading and construction of reclamation covers on the three tailings impoundments at the site: the Heap Leach, Above-Grade Tailings Impoundment (AGTI), and the A-9 Repository. By 1988, NRC-approved plans were in place for both the AGTI and the A-9 Repository, and extensive construction reclamation work had taken place at all three impoundments. An interim cover was placed on the A-9 Repository in 1988 and 1989 and in 1992 Umetco completed tailings re-grading and construction of the AGTI cover in accordance with the previously-approved reclamation plan.

However, in the early 1990s, the NRC began re-evaluating its position on previously-approved reclamation plans for Title II sites, including Gas Hills. This evaluation was formalized in the NRC's July 18, 1995 policy statement entitled *Final Position on Review of Previously Approved Reclamation Plans* (NRC 1995). This position stated that NRC approval previously granted to reclamation plans would remain a final NRC action, provided that the licensee demonstrate satisfaction of the requirements established in 10 CFR 40, Appendix A regarding slope and seismic stability and limitation of radon flux. To address these concerns, Umetco submitted enhanced design plans for the three impoundments between 1996 and 1999. These plans also addressed two related repository areas: Gas Hills Pond No. 2 (GHP-2), coinciding with the former mill, and the C-18 Pit, located south of the A-9 Repository. Upon the NRC's approval of the enhanced reclamation plans in 1998 and 1999, full-scale reclamation activities at the five repository areas began and continued until 2006. This report documents the conduct and completion of those activities.

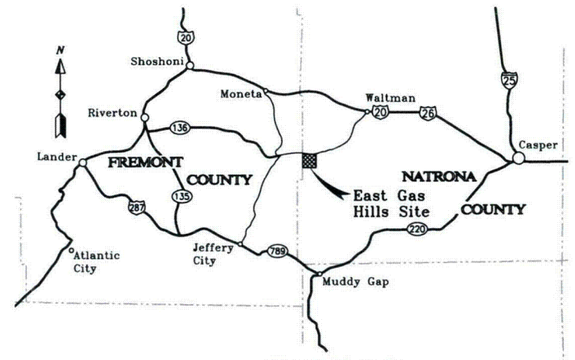
This Construction Completion Report is also the final in a series of submittals demonstrating that the Gas Hills Site meets the requirements for license termination. The other key submittals document the final radiological status for soil cleanup areas and the gamma exposure rate survey results for the five repositories. These reports, discussed in Section 6, are as follows:

- *Final Status Survey Report and Addendum 1* (Initial submittal in 2003, finalized on September 2, 2004) – Approved by the NRC on September 27, 2004, as documented in the corresponding Technical Evaluation Report (TER), duplicated in Attachment 1 herein.

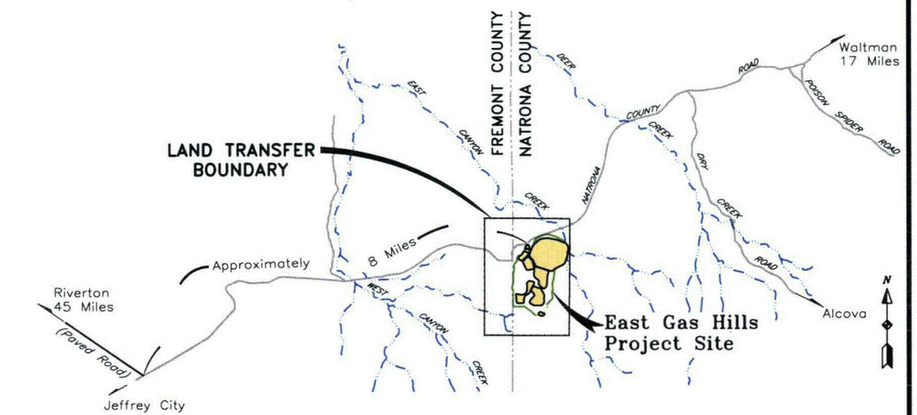




STATE OF WYOMING
NOT TO SCALE



VICINITY MAP
NOT TO SCALE



LOCATION MAP
NOT TO SCALE

LEGEND:

- ABOVE-GRADE TAILINGS IMPOUNDMENT
  RADON BARRIER LIMITS = 170.59 AC
  REPOSITORY LIMITS = 170.24 AC
- HEAP LEACH REPOSITORY
  RADON BARRIER LIMITS = 48.91 AC
  REPOSITORY LIMITS = 56.93 AC
- A-9 REPOSITORY
  RADON BARRIER LIMITS = 51.29 AC
  REPOSITORY LIMITS = 61.70 AC
- GHP No. 2 REPOSITORY
  RADON BARRIER LIMITS = 35.73 AC
  REPOSITORY LIMITS = 46.14 AC
- C-18 DEEP BURIAL REPOSITORY
  REPOSITORY LIMITS = 5.97 AC
- FINAL STATUS SURVEY AREAS
- LAND TRANSFER BOUNDARY
- RESTRICTED AREA BOUNDARY
- FEATURE BOUNDARIES
- DRAINAGEWAYS

LEGAL DESCRIPTION OF LAND TRANSFER BOUNDARY:

LAND TRANSFER BOUNDARY INCLUDES ALL OF SECTION 15, THE NORTH HALF OF SECTION 22, THE NORTHEAST QUARTER OF SECTION 21, THE EAST HALF OF SECTION 16, THE SOUTHEAST QUARTER OF SECTION 9 AND THE SOUTH HALF OF SECTION 10, ALL LOCATED IN TOWNSHIP 33 NORTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN. SAID LAND CONTAINS APPROXIMATELY 1920 ACRES.

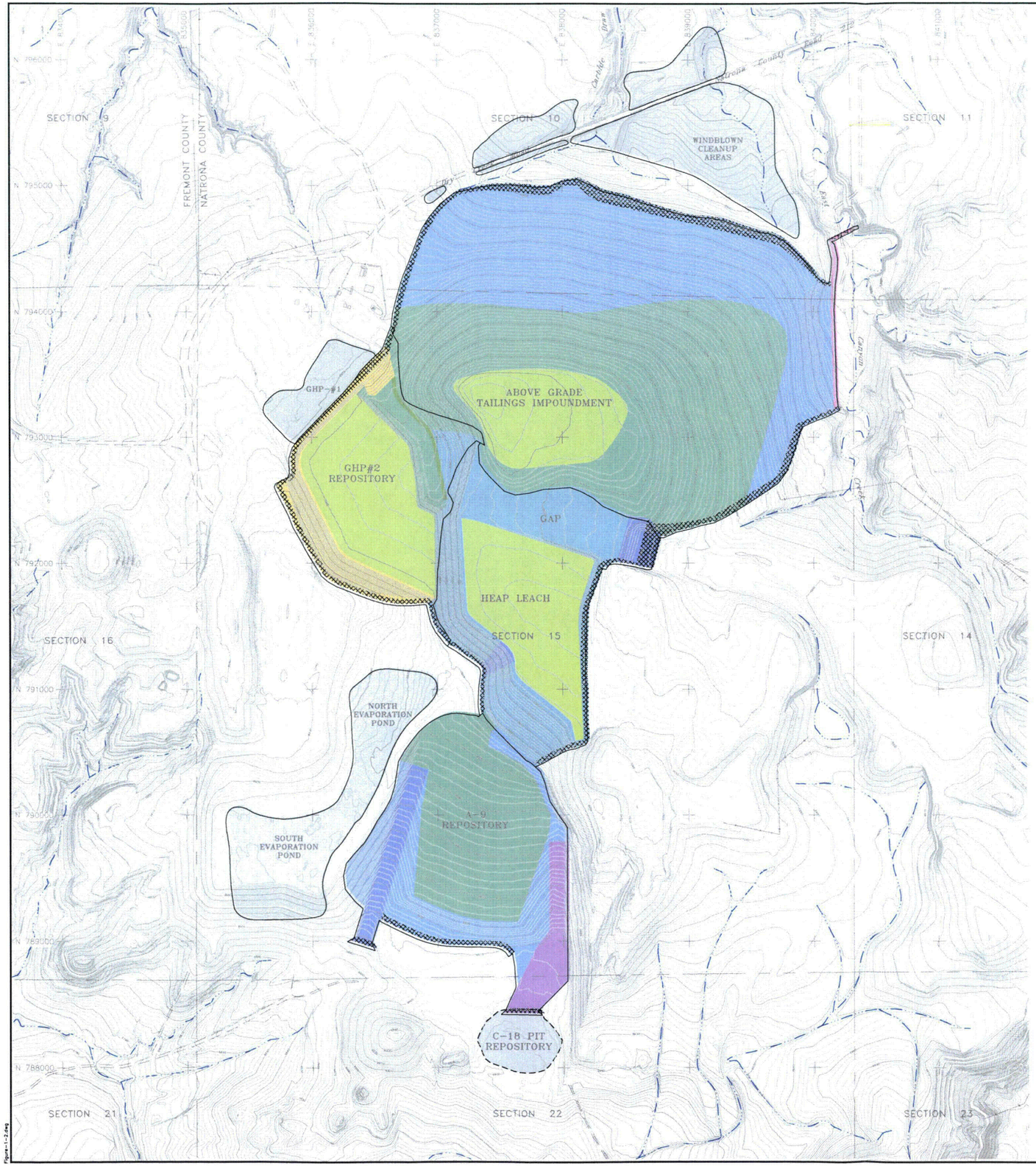
UMETCO MINERALS CORPORATION

SITE PLAN AND LOCATION MAP

GAS HILLS, WYOMING

JUNE 2007 FIGURE 1.1

GH-Loc-Map-Fig-1-1.dwg



LEGEND

- 2006 FINISHED GRADE TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6-INCHES OF RIPRAP TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH WITH 3-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 10-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH WITH 3-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 24-INCHES OF RIPRAP TYPE "D" D_{50} = 16.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- LAUNCHED STONE EMBANKMENT TYPE "E" D_{50} = 30.0 INCH
- BELOW-GRADE APRON

N

400' 0 400'

SCALE IN FEET

CONTOUR INTERVAL : 2'

Umetco Minerals Corporation
2754 COMPASS DRIVE, SUITE 280, GRAND JUNCTION, CO 81506

AS BUILT

FINAL SITE PLAN
REFLECTING
CONSTRUCTION COMPLETION

GAS HILLS, WYOMING

JUNE 2007 FIGURE 1.2

Figure-1-2.dwg

- *Final Status Survey Addendum 2* (May 11, 2005) – Approved by the NRC on September 1, 2005, as documented in the corresponding TER (see Attachment 1).

- *Final Status Survey Report, Addendum 3* (January 22, 2007) – currently undergoing NRC review.

Reclamation of the Umetco Gas Hills site is now complete and, with the exception of minor maintenance issues to be completed by the Fall of 2007, the site is ready for decommissioning and transfer to the U.S. Department of Energy (DOE) for long-term surveillance and maintenance. This report will demonstrate that the completed stabilization work for the five site repositories meets the applicable NRC requirements set forth in 10 CFR 40, Appendix A and that it was conducted and completed in accordance with the approved reclamation plans.

1.2 Facility Description

Gas Hills is located in western Natrona and eastern Fremont Counties, Wyoming, approximately 60 miles east of Riverton in a remote area of central Wyoming (Figure 1.1). The site is located within the Gas Hills Uranium Mining District of the Wind River Basin, in portions of Sections 10, 15, 16, and 22, Township 33 North, Range 89 West. The restricted area of the site, including the now reclaimed tailings disposal and heap leach areas, consists of approximately 542 acres, of which Umetco owns 280 acres and the rest is under jurisdiction of the U.S. Bureau of Land Management (BLM). The total disposal area encompassing the construction areas addressed herein is approximately 300 acres.

Figure 1.1 shows the locations of the five reclaimed repository areas addressed herein, the current restricted area, and the proposed Long-Term Care Boundary (LTCB)—the land slated for future transfer to the DOE.

1.3 Report Organization and Scope

This report consists of five volumes, organized as follows:

Volume	Area(s) Addressed	Period of Reclamation	Size (Area)*
Volume I	All – Gas Hills Site Overview & Erosion Protection Quality Control Testing Results		--
Volume II	Heap Leach	1997-1998	57 acres
Volume III	Above-Grade Tailings Impoundment	1999-2002	170 acres
Volume IV	A-9 Repository* C-18 Pit	2000-2004, 2006 2001-2005	62 acres 6 acres
Volume V	Gas Hills Pond No. 2 (GHP-2)	2005-2006	46 acres

*Acreages listed above reflect repository limits. Radon barrier limits for the Heap Leach, Above-Grade Tailings Impoundment, A-9 Repository and GHP-2 are 49 acres, 171 acres, 51 acres, and 36 acres, respectively.

This first volume (Volume I) provides an overview of all completed reclamation work and quality control test results, a summary of radon barrier and frost protection borrow material characteristics, detailed documentation of all quality control testing for erosion protection materials (rock durability and gradation testing), and summarizes all pertinent information and issues germane to license termination. The remaining volumes essentially constitute "stand-alone" Construction Completion Reports for each of the five repository areas listed above. At the outset, it is important to note that, for all repositories, this report only addresses construction completed since development of the most recently approved reclamation plans (i.e., after 1996). Any reclamation construction work performed prior to that is documented in detail in the approved plans for each of these areas.

In this initial volume, following this introduction, Section 2 presents pertinent background information, including a summary of the site operational and milling history and corresponding SUA-648 license conditions and amendments. Section 3 presents an overview of construction activities and summarizes the material documented in Volumes II through V for the Heap Leach, Above-Grade Tailings Impoundment, the A-9 Repository and related areas (C-18 Pit and North and South Evaporation Ponds), and GHP-2.

Section 4 describes the pre-placement borrow area characteristics for radon barrier and frost protection materials and summarizes the laboratory quality control test results yielded for each project area. Section 5 documents all information and testing performed for Rattlesnake Quarry erosion protection material, including volumes, rock durability and gradation test results, and in-place depth checks conducted for all Gas Hills repositories. The information in Section 5 is a key component in the demonstration of the completion of construction work for Gas Hills repositories in accordance with the approved reclamation plans and with 10 CFR 40 Appendix A criteria 4(c) and 4(d) regarding long-term stability and erosion control.

Appendix E of NUREG-1620—Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978—provides guidance regarding the license termination process (NRC 2003). In this appendix, the NRC addresses three distinct aspects of site decommissioning actions: 1) documentation of completed surface remedial actions; 2) documentation of completed site decommissioning (soil cleanup and radiation surveys); and 3) documentation of completed ground-water corrective actions. While the majority of this report focuses on the first endpoint, Section 6 summarizes the key findings and reports documenting the latter two categories. Section 7 summarizes the overall findings of this construction completion report. References are provided in Section 8.

Section 2

2.0 SITE HISTORY AND BACKGROUND INFORMATION

This section presents a brief history of Gas Hills milling and associated mining operations, summarizes the key license conditions and associated amendment history, and also summarizes decommissioning and reclamation history, as well as other site characteristics (geology, seismology) germane to this evaluation. This section concludes with a brief summary of local land use and climate. Due to their number and length, all corresponding tables and figures are provided at the end of this section.

2.1 Site History

Properties in the Gas Hills Mining District were acquired by UCC between 1956 and 1958 and the mill was constructed in 1959, at which time mining operations were initiated. Milling began in 1960, followed much later by heap leaching in 1976. The mill ceased operations in 1984, at which time it was put on standby status until 1987, when the mill was shut down. A chronological summary of key aspects of the Gas Hills site operational and reclamation history is provided in Table 2.1.

From 1960 through 1984, the mill processed approximately eight million tons of ore (approximately 900 tons per day) with an average ore grade of 0.11 percent uranium. Table 2.2 shows the amount of ore processed per year, the average uranium content, and the amount of uranium produced. From the startup of mill operations until 1979, tailings were placed in the Above-Grade Tailings Impoundment by slurry methods.

In addition to the conventional milling procedures, heap leach operations were used to recover uranium from low-grade ore in an area south of the mill between 1963 and 1967. This first pilot heap leach operation coincides with the location of GHP-2. A second heap leach was operated in an area south of the AGTI from 1973 to 1978. A third heap leach operation began in 1979 and continued until 1987.

Mill tailings were placed in two impoundment areas: the Above-Grade Tailings Impoundment and the A-9 Repository. Placement of tailings in the AGTI began in 1960 and continued until 1979, when tailings placement began in the A-9 Repository and continued until 1984. Table 2.1 summarizes these activities and associated volumes. Additional information about historical tailings placement in the AGTI and the A-9 Repository is provided in Volumes III and IV, respectively.

Figure 2.1 provides annotated aerial photographs of various stages of the Gas Hills site, from the mid-operational period in 1978 through 1997, the onset of the construction activities addressed herein. For details regarding the milling and heap leach processes, the chemical composition of the tailings, and onsite and adjacent mining activities, the reader is referred to the November 2001 Final Application for Alternate Concentration Limits (Umetco 2001).

2.2 License Conditions and Amendments

As summarized in Table 2.3, since mill operations began in 1960 and over the course of the mill decommissioning and subsequent reclamation activities, 62 license conditions were established to address various endpoints (e.g., monitoring requirements, reclamation milestones, surety). During this time frame, the license has been amended 58 times. Many of these amendments address the deletion of a license condition, reflecting either the cessation of mill operations and/or completion of a reclamation phase. Others are minor, for example, addressing insignificant language changes. However, several key amendments were added to the license addressing the reclamation construction activities documented in this report. As a prelude to the subsequent volumes, Table 2.4 summarizes the license amendments having a major impact on the conduct of construction activities and/or site decommissioning.

2.3 Soil Decommissioning and Groundwater Corrective Action History

Decommissioning activities related to soil and groundwater cleanup have been addressed extensively in other reports, and are also summarized in Sections 6 and 7, respectively. This section provides a brief overview. Planning associated with mill demolition and contaminated soil cleanup began in April 1990 when Umetco submitted a draft Decommissioning Plan to the NRC (Umetco 1990). Umetco revised the plan through subsequent submissions, culminating in the submittal of the Final Status Survey Plan, the Background Characterization report, and the East Canyon Creek risk assessment. These submittals constitute the Revised Soil Decommissioning Plan authorized under Gas Hills License Condition (LC) 30B, which was approved by the NRC in April 2001 (NRC 2001).

In accordance with this decommissioning plan, final status survey activities began in 2001 and culminated in the submittal of the Final Status Survey Report in October 2003. This report, which documented the final radiological status for most of the site, was revised and supplemented with an addendum (Addendum 1), which was approved by the NRC in September 2004. Addendum 2 to the Final Status Survey Report, documenting the A-9 Repository Exposure Survey, was approved by the NRC in September 2005. Addendum 3, which documents the exposure surveys for the C-18 Pit and GHP-2, was submitted in January 2007. As of June 1997, this report is still undergoing review by the NRC. The groundwater corrective action program was terminated in March 2002, upon the NRC's approval of Umetco's request for Alternate Concentration Limits (ACLs) (Umetco 2001). Groundwater monitoring in accordance with Umetco's Groundwater Monitoring Plan (Appendix M of the ACL report), is on-going.

2.4 Land Use

The Gas Hills site is located in a sparsely populated area in central Wyoming and the majority of the land within five miles of the site is public domain under Bureau of Land Management jurisdiction. The nearest residence, the JE Ranch, is approximately five miles northeast of the site and is only used one to two weeks per year. The nearest full-time residents are located approximately eight miles to the west-southwest at the Puddle Spring Ranch.

2.5 Climate

The Gas Hills site is located within the Wind River Basin of central Wyoming. This area has a semi-arid climate with low precipitation and wide seasonal fluctuation in temperature. Precipitation measured at the mill site from 1963 to 1991 ranged from 4.2 to 14.7 inches per year (in/y) with an average of 9.2 in/y. April and May are normally the wettest months. The annual mean lake evaporation for the site is approximately 42 inches (Umetco 2001). The prevailing wind direction is from the south to southwest with strong winds frequent throughout the year (Umetco 1996). Temperatures at the site range from winter lows near –40 degrees Fahrenheit (F) to summer highs near 100 degrees F with average temperatures of 18 degrees F in January to 68 degrees F in July (Umetco 2001).

Section 2 Tables

Table 2.1 Chronological Summary of Gas Hills Milling Operations and Reclamation Activities

Year/Period	Activities
1959	UCC acquired Globe Mining Company (uranium discovered in the area in 1953).
1960 – 1984	Period of mill operations. Milled 8.1 million tons of ore and produced 17.8 million pounds of uranium oxide (U_3O_8). In 1978, the site became a Title II remedial site under UMTRCA. Tailings from milling operations were deposited in the Above-Grade Tailings Impoundment from 1960 to 1979. The Heap Leach process began in 1976. With uranium processing at its peak in 1980, tailings were deposited in the A-9 Tailings impoundment and the Heap was extended in 1983. Operations closed down in 1984.
1979	The A-9 Repository was constructed in the previously mined A-9 Pit. The North and South Evaporation Ponds were constructed in late 1979.
1980	Umetco submitted the *Reclamation Plan for the Inactive Tailings Areas and Heap Leach Site* (prepared by D'Appolonia, submitted on December 18, 1980).
1982	Initial Above-Grade tailings reclamation plan approved by NRC.
1983	• Groundwater corrective action activities, consisting of groundwater extraction and evaporation, began at the site. • The C-18 Pit was excavated between 1983 and 1984. Ore from the C-18 Pit was processed through the mill and the tailings were deposited into the A-9 Repository.
1984	Mill operations ceased; site reclamation began.
1985	• NRC groundwater requirements imposed • Umetco began reclamation of the Above-Grade Tailings Impoundment in accordance with the previously approved reclamation plan–the latter was completed in 1992 and later revisited in the late 1990s as summarized below.
1987	• Mill decommissioning initiated • Additional NRC groundwater requirements imposed • Below-Grade (A-9) Tailings Reclamation Plan approved • Leachate from the Heap was processed during a 9-month period
1988-1989	An interim cover 1 to 5 ft thick was placed over the entire A-9 repository. Upon completion, Umetco began quarterly monitoring of settlement and pore pressure.
1990	Site decommissioning plan submitted (May 2 and June 18, 1990). This plan and the corresponding License Condition (LC 30) was amended a decade later by submittal of the Final Status Survey Plan in 2000. Groundwater corrective action plan initiated in December 1990, as required under License Condition 35.

Table 2.1 Chronological Summary of Gas Hills Milling Operations and Reclamation Activities

Year/Period	Activities
1991	• Mill building and plant dismantled and decommissioned • In a letter dated August 2, 1991, the NRC advised Umetco that previously approved reclamation plans might not meet "current" reclamation criteria and requested that Umetco review the 1980 AGTI reclamation plan to evaluate compliance with 10 CFR 40, Appendix A. NRC later formalized this position in 1995 (see below). • Heap Leach reclamation plan submitted to NRC (work initiated) • Umetco discontinued use of the North and South evaporation ponds
1992	Umetco completed tailings re-grading and construction of the Above-Grade Tailings Impoundment cover except for topsoil and seed. [*Note that a revised enhanced reclamation plan was submitted in 1997, approved by the NRC in 1999, and post-design enhancement reclamation activities were undertaken between 1999 and 2002; see below.*]
1993	Mill building decommissioning completed (above-grade mill building area soil cleanup)
1995	On July 18, 1995, the NRC published its *Final Position on Previously Approved Reclamation Plans*. Based on the latter and interim review conducted in response to NRC's request in 1991 (see above), Umetco identified the following deficiencies in the early reclamation work: • Insufficient coverage of radon barrier on the AGTI and Heap Leach • Identification of materials on site that had not previously been addressed requiring stabilization in the A-9 impoundment • Elevated radiological characteristics of cover soils • North and South Evaporation Ponds inadequately characterized Ultimately, the above findings resulted in Umetco's development of enhanced reclamation plans for all disposal areas (see below). In addition to cover design, other aspects of site reclamation (related to soil and groundwater cleanup) were also found to require further investigation and work, for example: • Windblown contamination inadequately characterized • Groundwater treatment plan ineffective License Condition 30 modified (by License Amendment 31) to allow disposal in the A-9 pit of buildings demolition and other 11e.(2) wastes within or originating from the restricted area. Umetco submitted report entitled *Seismotectonic Stability East Gas Hills Site.*
1996 – 1999	Prepared and submitted enhanced designs for surface reclamation. Aggressive reclamation activities began in 1997, starting with the Heap Leach (see below).

Table 2.1 Chronological Summary of Gas Hills Milling Operations and Reclamation Activities

Year/Period	Activities
1996	• Began evaluation of Upper and Lower Wind River aquifers, conducted background studies (soil), and characterized windblown contamination • A performance evaluation of the AGTI performed by representatives from the NRC and Umetco indicated that a vegetative cover would not provide adequate protection over the design life of the reclamation plan. This finding impacted not only the AGTI, but other repository areas as well (e.g., the A-9 repository). • Gas Hills Pond No. 2 (GHP-2), a 17-acre groundwater evaporation pond, was constructed in the former mill processing area, resulting in placement of significant volumes of 11e.(2) contaminated soils in the A-9 Repository. • The NRC approved the Gas Hills site seismic design on January 24, 1996.
1997-1998	• ACL groundwater study initiated in 1997, including assessment of background conditions. • Heap Leach/Gap enhanced reclamation began – placement of fill, radon barrier, and frost protection covers.
1999	• February 18, 1999: Umetco submitted an application requesting Alternate Concentration Limits (ACLs) and adjustments to background levels for certain groundwater constituents (this was the first of several revisions; see March 2002). • Initiated Above-Grade Enhancement
2000	• Final Status Survey Plan and Background Evaluation completed – this submitted as the Final Revised Soil Decommissioning Plan. • Cultural resource materials (archaeological findings) encountered in the East Canyon Creek area, adjacent to the toe of the Above-Grade tailings impoundment. Work on the Above-Grade was delayed due to this finding. • Continued reclamation of Heap Leach and Above-Grade; began reclamation of A-9 Repository • GHP-1 decommissioned.
2001	• The NRC approved the final revised soil decommissioning plan, including the revised background values and Final Status Survey Plan, and the No Action alternative for East Canyon Creek (License Amendment 44, April 5, 2001) • Continued reclamation of Heap Leach, Above-Grade, and A-9 Repository; began reclamation (backfilling) of the C-18 Pit
2002	• The groundwater corrective action program was terminated upon the NRC's approval of Umetco's ACL proposal on March 29, 2002. • Pumping of groundwater into GHP-2 terminated on 3/29/02. Continued reclamation of A-9 Repository and C-18 Pit; completed reclamation of Heap Leach and Above-Grade.

Table 2.1 Chronological Summary of Gas Hills Milling Operations and Reclamation Activities

Year/Period	Activities
2003	• Clean-up of windblown contaminated materials was completed in September 2003. The *Final Status Survey Report*, documenting the site's final radiological status, was submitted by letter dated October 27, 2003 (NRC comments received on December 31). This report was later augmented by three addendums. • Umetco submitted the Final Design and Reclamation Plan for GHP No. 2/Mill Area on September 11, 2003. • Continued reclamation of A-9 Repository and C-18 Pit
2004	• In response to NRC's 12/31/03 comments, *Final Status Survey Addendum 1* was submitted in April 2004. This addendum and the revised Final Status Survey Report, documenting final status survey activities for most of the site, was approved by the NRC on September 27, 2004.** • The NRC approved the reclamation plan for GHP-2 on November 10, 2000 by License Amendment 52. • Completed reclamation of the A-9 Repository; continued reclamation of the C-18 Pit.
2005	• Began reclamation of GHP-2 and completed reclamation of the C-18 Pit • Addendum 2 to the Final Status Survey Report, documenting the A-9 Repository exposure survey, was submitted on May 11, 2005 and approved by the NRC on September 1, 2005.**
2006	Completed reclamation of GHP-2. The NRC approved License Amendment 58 – allowing higher gamma exposures…
2007	Addendum 3 to the Final Status Survey Report, documenting the exposure survey results for the C-18 Pit and GHP-2, was submitted on January 22, 2007 and is currently being reviewed by the NRC.

**Denotes key NRC approval document for soil decommissioning. These documents and this Construction Completion Report support final site decommissioning and license termination.

Table 2.2 Gas Hills Site Annual Uranium Production Data

Year	Ore (Tons/Year)	Percent U_3O_8 in Ore	Mass U_3O_8 Recovered (pounds)
1960	233,825	0.15	724,026
1961	264,913	0.12	641,376
1962	266,922	0.12	647,555
1963	206,893	0.16	658,981
1964	149,666	0.17	514,169
1965	131,786	0.18	467,009
1966	147,653	0.18	489,319
1967	183,139	0.11	388,710
1968	203,896	0.10	396,945
1969	298,395	0.13	798,814
1970	416,334	0.11	867,657
1971	356,245	0.09	571,294
1972	392,542	0.11	782,069
1973	390,886	0.13	848,063
1974	393,365	0.12	845,915
1975	421,995	0.12	958,866
1976	497,351	0.12	1,062,914
1977	497,650	0.11	1,051,302
1978	515,922	0.10	1,021,027
1979	504,234	0.10	1,066,823
1980	546,250	0.11	1,152,548
1981	265,636	0.11	589,551
1982	338,381	0.09	527,201
1983	180,533	0.08	302,758
1984	258,623	0.08	397,050
Total	**8,063,035**	---	**17,771,942**
Annual Average	322,521	0.11	710,878

U_3O_8 Uranium Oxide

Table 2.3 Gas Hills Site SUA-648 License Condition Summary

LC = License Condition; LA = License Amendment. Key license conditions are shaded below.
Deleted license conditions reflect either the cessation of mill operations (and concomitant termination of associated monitoring, safety, and disposal/transfer requirements) or they are no longer applicable because the authorized work was completed.

License Condition(s)	Area/Endpoint Evaluated	Applicable Amendments	Status	Comment
Nos. 1-9	General introductory site and license information, including site name, license and docket number, etc.	22 (for LC 4 only)		LC 4 (Expiration Date), originally June 30, 1992, was revised to "until terminated" by Amendment No. 22
10	General permit, personnel, safety training, site inspection, monitoring, and organizational requirements	22, 40, 48, 50, 51, 53		There have been many amendments to this license condition, given evolving nature of reclamation.
11-12	Mill production and circuitry	22	Deleted	Mill shut down, condition deleted
13	Radioactive material posting requirements	35		
14	Radiation safety officer (RSO) qualifications	53		
15	Establishment, maintenance, review, and implementation of written procedures; requirement for documented annual review of site procedures	22, 40		
16	Requirement for annual As Low As Reasonably Achievable (ALARA) audit and environmental monitoring reports	22, 35, 40		
17	Annual ALARA audit program	32, 40	Deleted	Deleted by Amendment No. 40, addressed by LC 16
18	Mill operation safety requirements	22	Deleted	Mill shut down, condition deleted
19	Occupational exposure calculations	22, 35	Deleted	Deleted by Amendment No. 35
20	Radiation survey and air sampling equipment calibration	40		
21	Bioassay/urinalysis program	22, 32, 40	Deleted	Deleted by Amendment No. 40
22	Release of equipment or packages from the restricted area	22, 40		

Table 2.3 Gas Hills Site SUA-648 License Condition Summary

License Condition(s)	Area/Endpoint Evaluated	Applicable Amendments	Status	Comment
23	Transfer of mill tailings from the site	--		
24	On-site contaminated waste disposal	1, 3, 22	Deleted	Deleted by Amendment No. 22
25	Authorization of Umetco to possess byproduct material	43		
26	Handling of liquid effluents from the mill process building	1, 3, 22	Deleted	Deleted by Amendment No. 22
27	Documentation requirements			Specifies at least a 5 year retention period.
28	Notification requirements in the event of a release due to structure earthwork failure	22, 31		
29	Annual fire drill requirements	22	Deleted	Deleted by Amendment No. 22
30 **	Site decommissioning plan: cleanup, on-site disposal, post-reclamation surveys, and soil verification sampling	14, 16, 17, 22, 24, 31, 32, 44, 53		This is a key license condition; see in particular the two most recent amendments (LA 44 and LA 53). The original decommissioning plan for the mill facility was submitted in 1990 (May 2 and June 8 submittals) and later amended or superseded by the 9/15/00 and 11/17/00 Final Status Survey Plan submittals. The latter two reports comprise the final revised soil decommissioning plan, which was approved by the NRC on April 5, 2001 (LA 44).
31	Licensee requirements re: NRC notification; situations requiring license amendments			
32	Requirement for annual land use surveys for any properties within 5 miles of the restricted area boundary	32		
33	Cultural Resource Survey requirements	40		
34	Environmental monitoring program (e.g., air particulate sampling)	8, 22, 40, 43, 45	Deleted	Deleted by Amendment 59 dated April 5, 2007.

Table 2.3 Gas Hills Site SUA-648 License Condition Summary

License Condition(s)	Area/Endpoint Evaluated	Applicable Amendments	Status	Comment
35 **	Groundwater monitoring/corrective action; LC 35A established the post-Alternate Concentration Limits (ACL) groundwater monitoring program to be conducted at the Gas Hills site	6, 8, 11, 15, 21, 31, 32, 34, 40, 41, 43, 48, 50, 53, 56		Key license condition in the context of site decommissioning.
36	A-9 Repository: Required Umetco to manage liquids and minimize ponding on the repository prior to final grading and reclamation.	22, 40, 51, 53	Deleted	Deleted by Amendment No. 53 (February 23, 2004). This condition was deleted given the NRC's determination that "The final grading, radon barrier, and frost protection layer for the A-9 Repository have now been completed in accordance with the NRC-approved plan."
37	Required minimization of windblown transport from ore piles, tailings, and heap leach piles using water sprinkling and other suppression techniques	22	Deleted	Deleted by Amendment No. 22
38	Required lower limits of detection for environmental monitoring sampling	40	Deleted	Deleted by Amendment No. 40
39	Reporting of effluent and environmental monitoring results	32, 40, 43		
40	Leak detection system inspection requirements	32, 35	Deleted	Deleted by Amendment No. 35
41	Operation and maintenance of the uranium heap leach	22	Deleted	Deleted by Amendment No. 22
42	--	35	Deleted	Deleted by Amendment No. 35
43	--	40	Deleted	Deleted by Amendment No. 40
44	--	1	Deleted	Deleted by Amendment No. 1
45	--	40	Deleted	Deleted by Amendment No. 40
46	--	1	Deleted	Deleted by Amendment No. 1
47	--	1	Deleted	Deleted by Amendment No. 1
48	--	35	Deleted	Deleted by Amendment No. 35

License Condition(s)	Area/Endpoint Evaluated	Applicable Amendments	Status	Comment
49	Evaporation pond freeboard and monitoring requirements, originally issued for the North and South evaporation ponds, but later modified to apply to all operating evaporation ponds except GHP-2.	35, 53	Deleted	Deleted by Amendment No. 53 on 2/23/04. The North and South ponds had been removed in 2000, and GHP No. 2, the only operating evaporation pond at that time, was regulated by LC 10C. As such, LC 49 was no longer applicable.
50	--	22	Deleted	Deleted by Amendment No. 22
51	--	22	Deleted	Deleted by Amendment No. 22
52	--	22	Deleted	Deleted by Amendment No. 22
53	--	22	Deleted	Deleted by Amendment No. 22
54 **	Above-Grade Tailings Impoundment (AGTI)	4, 6, 7, 32, 38, 41, 44, 45, 53		Key license condition re: the final reclamation of the AGTI. LA 41 documents the NRC's approval of the enhanced reclamation plan. LA 44 addresses revisions to erosion protection placement.
55	Financial surety arrangement – requires annual surety updates	1, 2, 13, 19, 20, 26, 27, 28, 33, 36, 39, 44, 46, 49, 52, 54, 55		Recent surety updates reflect completion of various stages of reclamation
56	Title transfer prior to license termination			
57 **	License termination: "The NRC will not terminate the license until final reclamation has been completed and meets all applicable NRC regulations."			Demonstration of satisfaction of this requirement is the primary objective of this report.
58 **	Reclamation of the A-9 Repository, C-18 Pit, North and South Evaporation Ponds, and associated site grading	42, 53, 58*		Key license condition re: reclamation of A-9 Repository and the C-18 Pit. See following table for a description of the applicable amendments.
59	Completion of site reclamation/ milestone dates. Primarily addresses completion schedule/target dates, as they apply to cover construction for the four repository areas.	29, 30, 31, 37, 38, 40, 43, 47, 48, 50, 53		There were a number of amendments revising this license condition, reflecting either extensions to the reclamation schedule or completion of cover placement.

Table 2.3 Gas Hills Site SUA-648 License Condition Summary

License Condition(s)	Area/Endpoint Evaluated	Applicable Amendments	Status	Comment
60	NRC notification	32, 45, 58		Addresses NRC organizational changes (mailing addresses etc.)
61 **	Heap Leach and GHP-2	38 (Heap Leach), 44, 52 (GHP-2), 58 (GHP-2)		Key license condition re: these two areas. License amendment 58 is critical in that it approved modified radiological cover criteria for the C-18 Pit and GHP-2 (see Table 2.4).
62	NRC authorization for Umetco to receive and dispose non-11e.(2) by product material from the IMC site in the A-9 Repository.	46, 50	Deleted	Deleted by Amendment No. 50. This occurred in December 5, 2002 as with the closure of the on site repositories acceptance of offsite waste was suspended.

Table 2.4 Key License Amendments Addressing Gas Hills Site Reclamation Construction

License Amendment	Primary Issues/ Areas Affected	Amendment Date	Date Requested	Re: License Condition(s)	License Amendment / Revisions
No. 31 (significant for LC 30 only)	• Buildings Demolition • Milestone Extensions/Reclamation Schedule • A-9 Pit • Groundwater Corrective Action	2/29/96	11/8/95 11/27/95 1/4/96	Various; see next column	LC 28: Minor change to reporting procedures LC 30*: Allowed disposal in the A-9 Pit of buildings demolition and other 11e.(2) wastes within or originating from the restricted area in the A-9 Pit. LC 35C: Reduced frequency of groundwater monitoring LCs 42B, 42C, 42D, and 52: DELETED due to non-applicability. LC 59: Extension of 3 reclamation milestones
No. 38	Heap Leach – Enhanced Design	5/28/98	9/13/96 & subsequent supplements	LC 61	Key in that it documents the NRC's approval of the enhanced reclamation plan for the Heap Leach
No. 41	Above-Grade Inactive Tailings - Enhanced Design / Reclamation	July 16, 1999	October 6 & October 28, 1997	LC 54 (primary) LC 35C (minor)	NRC Approval of AGTI Design Enhancement EA dated May 19, 1999 (FONSI issued 5/18/99) TER dated June 21, 1999
No. 42	A-9 Reclamation Plan - Enhanced Design	December 9, 1999	10/27/98 12/10/98 3/29/99	LC 58	NRC Approval of Enhanced Reclamation Design for the A-9 Repository

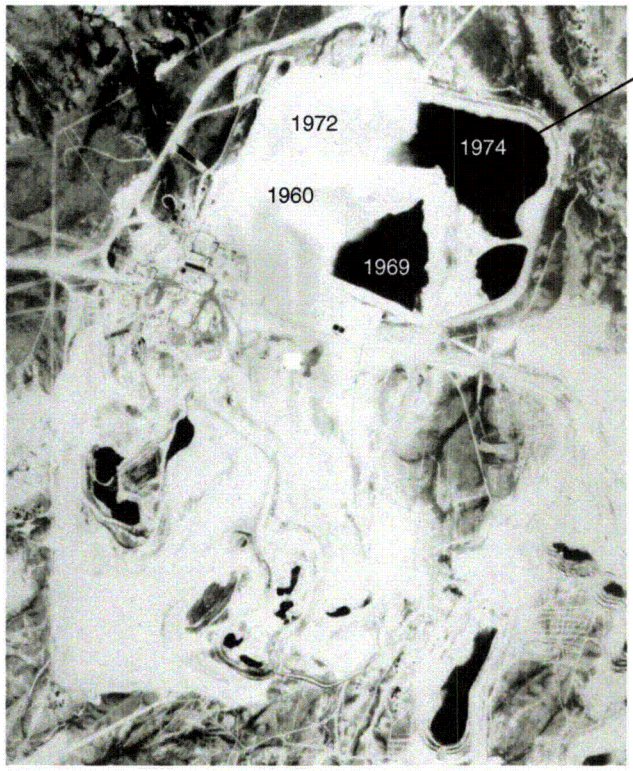
Table 2.4 Key License Amendments Addressing Gas Hills Site Reclamation Construction

License Amendment	Primary Issues/ Areas Affected	Amendment Date	Date Requested	Re: License Condition(s)	License Amendment / Revisions
No. 44	• Soil Decommissioning • Modifications to Erosion Protection Design for Heap Leach and Above-Grade Tailings Impoundment • Surety Update	4/5/01	12/20/00	LC 30B LC 54 LC 55 LC 61	The original decommissioning plan for the mill facility was submitted in 1990 (May 2 and June 8 submittals) and later amended or superseded by the 9/15/00 and 11/17/00 Final Status Survey Plan submittals. The latter two reports comprise the final revised soil decommissioning plan, which was approved by the NRC on April 5, 2001 (LA 44). This amendment documented the NRC's approval of the Umetco 2000 Final Status Survey report. Type A gradation changed for all areas – increased maximum sieve size from 1½ to 3 inches. Modifications to AGTI East Canyon Creek realignment and Heap Leach erosion protection requirements
No. 46	• Disposal of Non 11e.(2) (IMC) in the A-9 Repository • Bond/Surety Update	8/10/01		LC 62 (A-9) LC 55	Authorized Umetco to receive and dispose of approximately 2000 cubic yards of non-11e. (2) by-product material from the International Mining Company (IMC) site as described in submittals dated May 11 and July 12, 2001.
No. 48	Groundwater Corrective Action: NRC Approval of Umetco's ACL Request	3/29/02	Various (2001-2002)	Significant LC 35 Minor Changes LC 10B LC 59B2	The groundwater corrective action program was terminated upon the NRC's approval of Umetco's ACL proposal as documented in this license amendment and the supporting TER. See Section 7 for a summary of groundwater/ACL-related issues. Minor language change for LC 10B
No. 52	Final Design for GHP-2	11/10/03	5/09/03 9/11/03	LC 61 (GHP-2) LC 55 (Surety)	The primary focus of this license amendment was revision of License Condition 61 to reflect the NRC's approval of Umetco's proposed Final Design for reclamation of GHP No. 2 (September 11, 2003 submittal).

Table 2.4 Key License Amendments Addressing Gas Hills Site Reclamation Construction

License Amendment	Primary Issues/ Areas Affected	Amendment Date	Date Requested	Re: License Condition(s)	License Amendment / Revisions
No. 53	Various License Condition Changes: • LC 10C – Modification of GHP No. 2 inspection requirements • LC 35A – re: groundwater monitoring • Extension of the target completion date for a small portion of the A-9 Repository erosion protection placement • LCs 58 and 59A(3) – A-9 Repository reclamation • LC 54 – AGTI	2/23/04	1/5/04	Significant changes: LC 35A LC 59A(3) Minor changes: 10C, 14, 30C (deleted), 35A, 36 (deleted), 49 (deleted), 54, 58, 59, and 60.	Major revisions included: LC 35A: The NRC staff determined that LC 35A be revised to reflect the modified Appendix M of the ACL application (dated 1/5/04), and to require supplemental information related to tracking the contamination plume. This change in the license condition required Umetco to submit monitoring data to the NRC by 9/30 of each year and include ground water contour maps, contamination iso-concentration maps, and trend graphs. LC59A(3): NRC verification of completion of A-9 Repository radon barrier based on the final radon flux measurements submitted on 12/10/03 and supplemented 2/2/04.
No. 56	Approval of Groundwater Lead-210 ACL Adjustment	3/24/06	6/17/05	LC 35	NRC approved Umetco's request to increase the Lead-210 (Pb-210) ACL for the southwestern flow regime from 46.7 pCi/l to 189 pCi/l.
No. 58	C-18 Pit and GHP-2 and C-18 Cover Designs: Approved Changes in Radiological Criteria	11/22/06	2/7/06	LC 58 (C-18 Pit) LC 61 (GHP-2)	Critical in that it approved revised radiological requirements for the C-18 Pit and GHP No. 2: • average allowable Ra-226 content for C-18 Pit topsoil changed from 5 to 10 pCi/g (LC 58) • average allowable Ra-226 content for GHP-2 frost protection cover changed from 10 to 15 pCi/g • change in the allowable background exposure limit on the cover from 30 μR/hr to 40 μR/hr

Figure 2.1



May 26, 1978

1978: This photograph shows the Above-Grade Tailings Impoundment (AGTI), with two of the four impoundments still containing solutions.

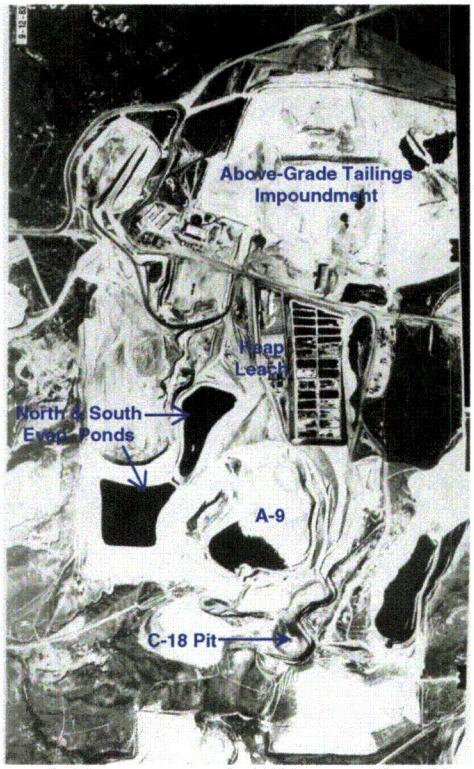
Note saturation of 1969 and 1974 impoundments

October 12, 1979

1979: A-9 Repository constructed; Heap leach operations began one year later (in 1980). Less saturation is evident in the AGTI.

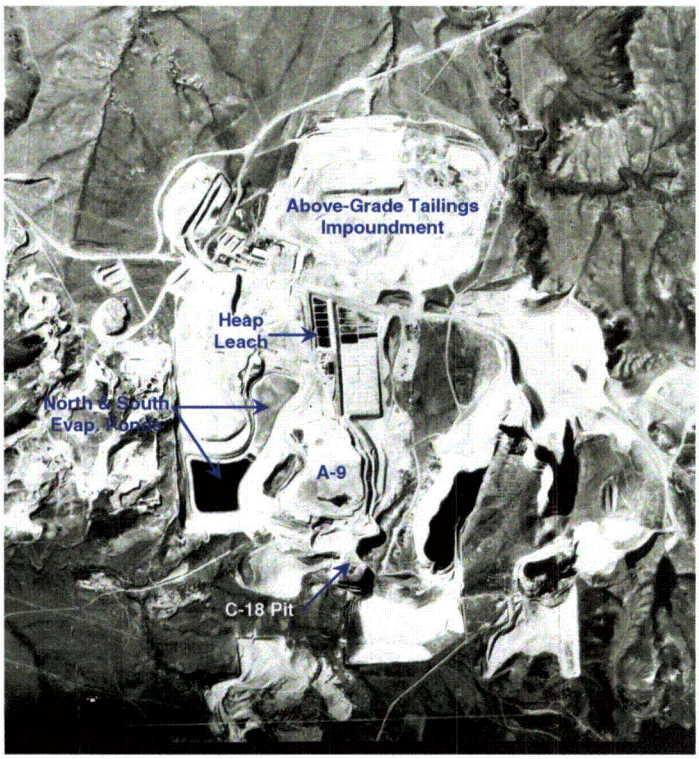
Figure 2.1

Aerial Photographs Showing Various Stages of Gas Hills Site: 1978-1997



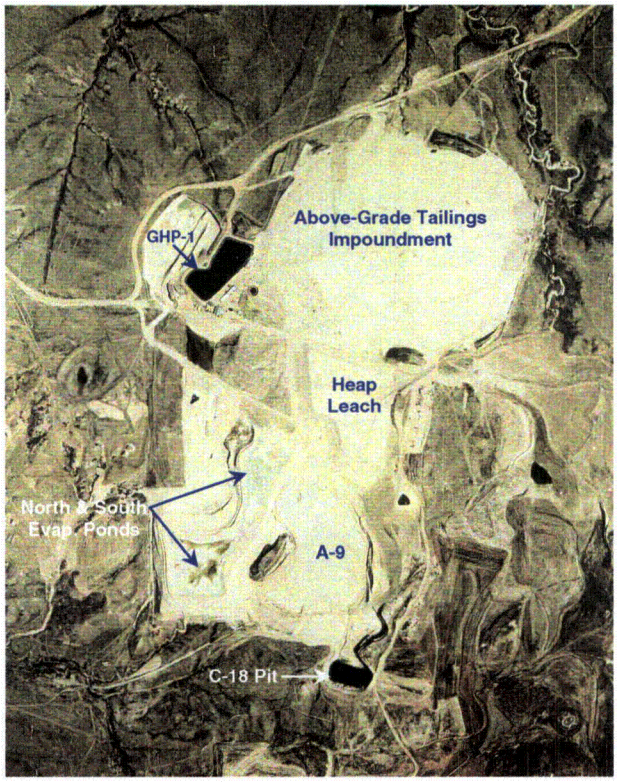
September 12, 1983

1983: Excavation of the C-18 Pit began at this time and was completed in 1984. Ore from the C-18 Pit was processed through the mill and the tailings were deposited into the A-9 Repository. The mill was shut down one year later. In this photograph, the 1982 expansions of the Heap are evident.



September 19, 1987

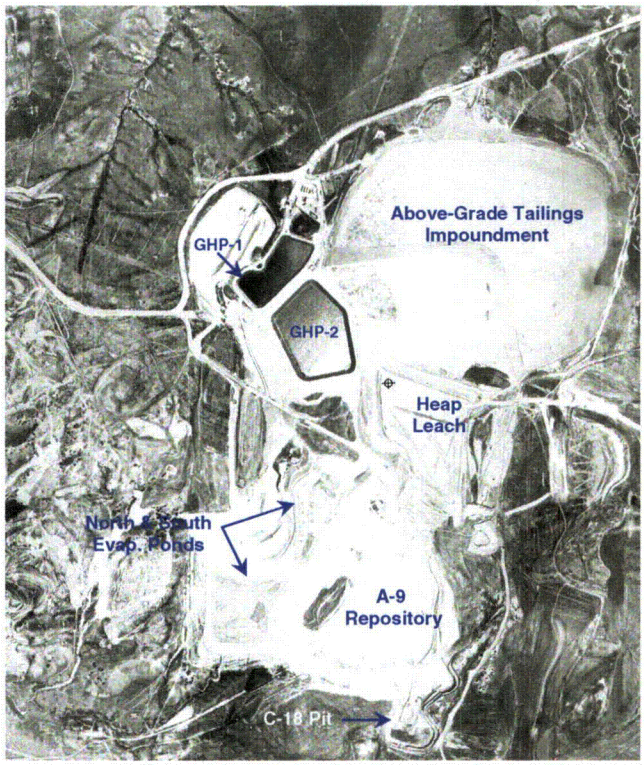
1987: Heap Leach operations ended and mill decommissioning activities began.



1995

1995: This aerial photograph shows the layout at site at the time the NRC and Umetco began reevaluating the previously-approved reclamation plans.

Note completion of the AGTI cover under the previously-approved reclamation plan; it had been completed in 1992 except for topsoil and seed. The A-9 interim cover and Heap Leach covers are also complete (no erosion protection had been placed except for a small portion of the AGTI).



June 11, 1997

1997: This aerial photograph shows the layout of the site at the beginning of the Heap Leach enhancement, when the reclamation construction activities addressed in this report began.

This photo also shows the recently constructed Gas Hills Pond No. 2 (GHP-2).

3.0 OVERVIEW OF RECLAMATION CONSTRUCTION ACTIVITIES AND ASSOCIATED QUALITY CONTROL TESTING

This section presents an overview of the reclamation plans and subsequent construction completed for the five repositories addressed in detail in Volumes II through V—the Heap Leach, Above-Grade Tailings Impoundment, the A-9 Repository, the C-18 Pit, and GHP-2. As shown in Table 3.1, between 1997 and 2006, over 3.7 million cubic yards of soil material (fill, radon barrier, and frost protection) and approximately 800,000 tons of erosion protection material were placed as part of reclamation construction activities.

3.1 Reclamation Plans

The development of reclamation plans for Gas Hills repositories was an iterative process that spanned approximately two decades. The first reclamation plan was for the Above-Grade Tailings Impoundment (D'Appolonia 1980), followed by a revised plan in 1984 (Water, Waste, and Land, Inc. 1984). In 1991, the initial plan for the Heap Leach was submitted. Because reclamation of this nature (i.e., at Title II sites) had never taken place before, the technical guidance and regulations evolved (as did the NRC's position on aspects of reclamation), and as such submittals were iteratively revised and updated over a period of nearly two decades. This section provides an overview of design plan evolution, identifies the NRC-approved reclamation plans that form the basis for the completed construction work addressed herein, and also provides a brief summary of the seismic evaluation conducted for the site.

3.1.1 Factors Underlying Development of Enhanced Design Plans

As introduced in Section 1, by 1988, NRC-approved plans were in place for both the AGTI and the A-9 Repository, and extensive construction reclamation work had taken place at all three impoundments. An interim cover was placed on the A-9 Repository in 1988 and 1989 and in 1992 Umetco completed tailings re-grading and construction of the AGTI cover in accordance with the previously-approved reclamation plan.

However, as discussed in Section 1.1, in the early 1990s, the NRC began re-evaluating its position on previously-approved reclamation plans for Title II sites. In a letter dated August 2, 1991, the NRC requested that Umetco review the reclamation plan for the AGTI to evaluate compliance with the reclamation criteria contained in 10 CFR Part 40, Appendix A. Subsequent to the NRC's issuance of the July 18, 1995 position statement (*Final Position on Review of Previously Approved Reclamation Plans*), Umetco re-examined the reclamation designs for the three repository areas and the completed work. For example, the existing vegetative cover on the Above-Grade Tailings Impoundment showed signs of erosion, after which Umetco (and the NRC) determined that it was necessary to enhance the previously approved plan and at a minimum upgrade the erosion protection component for all repository areas over a 1000-year design life. As a result, one of the major changes to the previously approved plans was the inclusion of a riprap erosion protection cover. Based on this re-evaluation, enhanced reclamation plans were developed as discussed below.

Table 3.1 Quantities of Materials Placed in Gas Hills Repositories for Gas Hills Site Reclamation Activities: 1997-2006

All quantities in cubic yards (CY).

Area/ Year	Contaminated Fill* or Backfill	Radon Barrier	Frost Protection	Toe Apron Backfill	Other (e.g., Regrade)	Rock Volumes
Heap Leach (Design Enhancement)						
1997	73,416	52,156	358,506			
1998	56,976	32,125	99,972			
2000		576	17,259			17,398
2001				10,674		57,100
2002				27,225		2,431
Subtotals:	130,392	84,857	475,737	37,899		76,929
Above-Grade Tailings Impoundment (Design Enhancement)						
1999	16,307	100,692	342,025			
2000		1,095	154,530	5,109	21,252	1,252
2001				40,299		148,715
2002				27,712	26,193	66,536
Subtotals:	16,307	101,787	496,555	73,120	47,445	216,503
A-9 Repository (Design Enhancement)						
1999	33,873					
2000	178,590					
2001	183,491	102,828	268,213			2,084
2002	177,031	23,028	91,100			44,650
2003	27,776	30,153	117,309			53,038
2004			8,064	7,728		
2006					1,967	
Subtotals:	600,761	156,009	484,686	7,728	1,967	99,771
C-18 Pit Backfill						
2001	241,476					
2002	64,922					
2003	16,773					
2004	8,694					
2005	82,173					
Subtotals:	414,038					
GHP No. 2						
2005	198,753	71,808	259,874			
2006	9,939	4,818	49,356	26,463		55,358
Subtotals:	208,692	76,626	309,230	26,463		55,358
Total All:	**1,370,190**	**419,279**	**1,766,208**	**145,210**	**49,412**	**448,561**

*In some cases—e.g., for the Above-Grade Tailings impoundment reshaping and the A-9 Repository—a portion of the contaminated fill quantities listed above reflect reshaping and compaction of the existing material.

3.1.2 Reclamation Plans for Gas Hills Repository Areas and Related Submittals

This Construction Completion Report documents the construction, material placement, quality control records, and as-built drawings conducted based on the following NRC-approved reclamation plans and related submittals:

- *Heap Leach Reclamation Plan Modifications and Reclamation Plan for GHP No. 2/Mill Area.* September 25, 1996 (Umetco 1996).

- *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment.* October 1997. Part I—Design Report—submitted on October 6, 1997. Parts II and III—Construction Plans and Specifications and Quality Plan—submitted on October 28, 1997 (SMI 1997).

- *Design for Enhancement of the Previously Approved Reclamation Plan for the A-9 Repository.* October 27, 1998 (SMI 1998).

- *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach.* December 18, 2000 (Umetco 2000c).

- *Final Design and Reclamation Plan for GHP No.2/Mill Area. Gas Hills Reclamation Project.* September 11, 2003. This plan supersedes the initial GHP-2 plan submitted in 1996 along with the Heap Leach. May 2003 (Umetco 2003a).

- *Report Amending Final Design and Reclamation Plan for GHP No. 2/Mill Area.* Gas Hills, Wyoming Site. February 2006 (Umetco 2006).

Table 3.2 summarizes these plans and the corresponding NRC approvals. In the TERs documenting the enhanced reclamation plan approvals, the NRC focused on three technical areas: 1) surface water hydrology and erosion protection; 2) geotechnical design and testing; and 3) radon attenuation. Details about the endpoints evaluated for each of these three categories—e.g., settlement, radon flux modeling, assumptions underlying the erosion protection designs—are documented extensively in the design plans and are not reiterated here.

As identified in Section 1, any reclamation construction work performed prior to the development of these plans (e.g., under the previous NRC-approved reclamation plans) is documented in detail and incorporated in the design enhancements for each of these areas. Therefore, the latter information is summarized herein, but the reader is referred to the enhanced reclamation plans for as-built drawings and supporting geotechnical data.

Table 3.2 Summary of Gas Hills Site Construction Reclamation Plans and Corresponding NRC Approvals

Reclamation Plan or Submittal	Scope of Work	Subsequent NRC Correspondence & Approval*
Heap Leach Reclamation Plan Modifications and Reclamation Plan for GHP No. 2/Mill Area. Submitted by letter dated September 25, 1996. This plan was supplemented or revised by letters/submittals dated: • June 6, 1997 • August 19, 1997 • October 15, 1997 • January 15, 1998 • February 11, 1998 • February 13, 1998 • December 20, 2000 (see Volume II for details)	• Placement of additional frost protection soils on the existing cover of the top slope. • Extension of the reclamation cover—i.e., the 18-inch radon barrier, 54-inch frost protection layer and the erosion protection layer—down the sideslopes of the heap and over the gap between the heap and above-grade tailings impoundment. • Replace the previously proposed vegetative cover surface with riprap erosion protection on both the top and sideslopes of the heap leach facility. • Incorporate the final reclamation of the new evaporation pond (GHP No. 2) in the reclamation plan for the heap leach facility. [Note: This aspect of the plan was later superseded by the September 2003 and February 2006 submittals.]	*Approved:* May 28, 1998 This approval was in the form of an amendment (License Amendment 38) to License Condition 61. The December 20, 2000 submittal, which presented an erosion protection modification, was approved by the NRC on April, 2001 (LA No. 44). *Note that aspects of this plan applying to GHP-2 were completely superseded by the revised plan submitted in September 2003, which was augmented by the February 2006 submittal.*
Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment October 1997. Part I—Design Report—submitted on October 6, 1997. Parts II and III—Construction Plans and Specifications and Quality Plan—submitted on October 28, 1997.	• Extension of the cover on the north and east sides to accommodate abandonment of the toe drain system and to provide attenuation of radon from deposits of contaminated soils that were not covered by the original barrier; • A channel modification, including installation of erosion protection, along a portion of East Canyon Creek to protect the toe of the east side of the impoundment; and • Replacement of the previously approved vegetative cover with riprap erosion protection.	*Approved:* July 16, 1999 This approval was in the form of an amendment (License Amendment 38) to License Condition 61. Approved as modified by submittals dated May 22, June 26, July 20, July 28, September 8, September 15, and November 23, 1998, and April 9 and June 7, 1999, and December 20, 2000. This approval was in the form of an amendment (License Amendment 41) to License Condition 54.

Table 3.2 Summary of Gas Hills Site Construction Reclamation Plans and Corresponding NRC Approvals

Reclamation Plan or Submittal	Scope of Work	Subsequent NRC Correspondence & Approval*
Design for Enhancement of the Previously Approved Reclamation Plan for the A-9 Repository. October 27, 1998 (SMI 1998). Supplemented by data in Umetco's responses to NRC comments on December 10, 1998 and March 29, 1999 (see Volume IV for details)	• Enlarge the A-9 repository to accommodate additional windblown or other byproduct material; • Increase the thickness of the clay radon barrier from 1 to 1.5 feet; • Reduce the thickness of the planned frost protection layer from 6.5 feet to 4.5 feet; • Replace the previously specified 6-inch topsoil/vegetative cover with 6 to 12 inches of riprap for improved long-term erosion protection; • Grade the site for proper drainage—e.g., provide diversion ditches on the east and west sides of the repository; • Reclaim the north and south evaporation ponds; and • Reclaim the C-18 Pit.	*Approved:* December 9, 1999 This approval was in the form of an amendment (License Amendment 42) to License Condition 58. The NRC staff concluded that the proposed A-9 repository enhanced reclamation design, site-wide grading plan, and reclamation plan for the north and south evaporation ponds and C-18 Pit would meet NRC requirements (e.g., regarding stability, control of the contaminated material, and limitation of radon flux).
Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach. Submitted by letter dated December 20, 2000.	This submittal proposed changes in the erosion protection designs for the Above-Grade Tailings Impoundment (LC 54) and the Heap Leach Cell (LC 61). The re-design for the AGTI included riprap armoring of the East Canyon Creek slope adjacent to the tailings embankment on the east side. The Heap Leach design change was made to better conform the outlet channel to existing topography and the adjacent designs of the WDEQ. This plan also documented Umetco's rationale for modifying the previously-approved gradation for Type A rock by increasing the maximum size rock from 1½ inches to 3 inches. The latter change applied to all areas.	*Approved:* April 5, 2001 (License Amendment 44) This approval was in the form of an amendment. Regarding the change in the Type A gradation (applied to all areas), the NRC concluded that because the layer thickness of the Type A rock is 6 inches, the proposed change would have little effect on proper rock placement and, in fact, "may actually be more stable."

Table 3.2 Summary of Gas Hills Site Construction Reclamation Plans and Corresponding NRC Approvals

Reclamation Plan or Submittal	Scope of Work	Subsequent NRC Correspondence & Approval*
Final Design and Reclamation Plan for GHP No.2/Mill Area. Gas Hills Reclamation Project. September 11, 2003. This plan supersedes the initial GHP-2 plan submitted in 1996 along with the Heap Leach. (Umetco 2003, Revision 1 of preceding May 2003 document).	Solidification of the remaining pond liquids, removal of the pond lining system, and placement of an engineered cover, consisting of a 12-inch radon barrier and 54 inches (4.5 feet) of frost protection, and erosion protection placement.	*Approved:* April 5, 2001 (License Amendment 52)
Report Amending Final Design and Reclamation Plan for GHP No. 2/Mill Area. Gas Hills, Wyoming Site. February 2006 (Umetco 2006).	This submittal provided technical data supporting Umetco's request for the following three license modifications: 1. For GHP-2 frost protection soils, an increase in the allowable average Ra-226 content to 15 pCi/g due to the depletion of available borrow soils meeting the initially established 10 pCi/g (background) criterion; 2. Concomitant with the above request, modifying the gamma exposure criteria for GHP-2 from 30μR/hr to 40μR/hr; and 3. For the C-18 Pit top cover (backfill) criterion, modifying the allowable average Ra-226 content in the top 30-centimeters of growth medium cover soils from 5 pCi/g to 10pCi/g which is consistent with site background soil conditions.	*Approved:* November 22, 2006 (License Amendment 58). TER dated October 12, 2006. This TER is provided in Volumes IV and V as Attachment 2. License Conditions 58 (C-18 Pit) and 61 (GHP-2).

Note: In all cases, NRC approval was contingent upon the staff's determination that Umetco's proposed enhanced impoundment design would meet NRC requirements regarding stability and control of the contaminated material and limitation of the radon flux from the disposal area to the atmosphere to 20 $pCi/m^2/s$. Criterion 6(7), regarding disposal to minimize further maintenance, was also acceptably demonstrated—i.e., the design would satisfy requirements of 10 CFR 40, Appendix A, Criteria 4(c), (d), and 6(1).

3.1.3 Seismic Design

The seismic evaluation and design developed for the Gas Hills site was approved by the NRC on January 24, 1996. In their evaluation, the NRC concluded that Umetco's seismic design was acceptable and that the seismic evaluation issue for the Gas Hills site was "closed." The NRC caveated this conclusion with the stipulation that if any significant changes were proposed for the geometry of the reclaimed tailings piles, Umetco would be required to reassess seismic stability. The NRC also stated that since the A-9 Repository was predominantly below-grade, it did not pose any significant seismic stability concerns. Therefore, their evaluation focused only on the above-grade and the heap leach impoundments.

Based on the information presented in Umetco's initial approved reclamation plans (pre-design enhancement) and the suggested peak ground acceleration (PGA) in the Lawrence Livermore National Laboratory (LANL) report, the NRC evaluated the seismic stability of the critical slopes for the above-grade and the heap leach impoundments and concluded that the designs were sufficient to withstand the PGA associated with the maximum credible earthquake. Based on the latter, the NRC concluded that the site appears to meet Criterion 4(e) of Appendix A to 10 CFR Part 40.

3.2 Scope of Work Addressed Herein – Summary by Area

Again, due to the large scope and supporting documentation, details of the construction completion are documented in separate volumes for each repository area. However, as a prelude, the following is a summary of the scope of work addressed in this report, by area.

3.2.1 Heap Leach (Volume II)

Overview

Heap leach operations at the site began in March 1980, under the authority of NRC License No. SUA-648, Amendment No. 11. The heap was extended in 1982 and operated until December 1984. Heap leach operations resumed in May 1987 and were finally terminated on January 1, 1988.

In February, 1991, Umetco submitted a reclamation plan for the heap leach facility to the NRC for approval. This original cover design consisted of a 12-inch radon barrier, a 12-inch filter layer, a 30-inch frost protection layer, and 6 inches of topsoil. Sideslopes were to be reclaimed by construction of a multi-gradient sacrificial fill (nominal 5:1 slope) with a 6-inch topsoil layer and subsequent vegetation to control erosion. Electing to proceed with heap leach reclamation construction prior to NRC approval, the bulk of the Heap Leach reclamation work specified in the original design was substantially completed by 1992, with the exception of topsoil placement and seeding. In 1994, the NRC provided comments on the 1991 reclamation design. Ultimately, an enhanced design plan was submitted in 1996, which incorporated the existing cover and addressed the NRC's comments (see below).

Reclamation Plan and NRC Approval

The design and specifications for the Heap Leach construction work addressed herein is entitled *Heap Leach Reclamation Plan Modifications and Reclamation Plan for GHP No. 2/Mill Area.*[1] This plan was submitted on September 25, 1996 (Umetco 1996) and was amended by submittals in response to NRC comments between 1997 and 1998. This plan was approved by the NRC on May 28, 1998 in the form of an amendment (License Amendment 38) to License Condition 61. Erosion protection aspects to this plan were later updated in December 2000, as documented in the *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach.* The latter submittal was approved by the NRC in April 2001 by Amendment 44.

Scope of Work

- Placement of additional frost protection soils on the existing cover of the top slope.
- Extension of the reclamation cover—i.e., the 18-inch radon barrier, 54-inch frost protection layer and the erosion protection layer—down the sideslopes of the heap and over the gap between the heap and above-grade tailings impoundment.
- Replace the previously proposed vegetative cover surface with riprap erosion protection on both the top and sideslopes of the heap leach facility.

Note that although this plan incorporated the final reclamation of the newly constructed evaporation pond (GHP-2), this aspect of the plan was later superseded by the September 2003 and February 2006 submittals (see GHP-2 summary below).

[1] Although GHP-2 was initially addressed in this plan (its cover design was the same as that for the Heap Leach), in response to NRC questions, Umetco determined in February 1998 that data for the pond were limited because disposal there was not complete (i.e., the groundwater corrective action was still ongoing). Umetco committed to submitting a final design for closure of Pond No. 2 when the required data were available. As such, the reclamation of GHP-2 is addressed separately in Volume V.

3.2.2 Above-Grade Tailings Impoundment Design Enhancement (Volume III)

Overview

In 1980, Umetco submitted a reclamation plan for the Above-Grade Tailings Impoundment, incorporating the experimental heap leach area.[2] Umetco completed tailings regrading and construction of the cover (except for 6 inches of topsoil and seed) in 1992. Several years after construction, erosion of the cover was evident along the east toe of the AGTI, the north toe drain, and additional contamination was found near the north edge of the AGTI. License Amendment 41 was approved to add additional radon barrier and frost protection cover on both the AGTI and the area connecting to the heap leach impoundment.

Reclamation Plan and NRC Approval

The design and specifications for the AGTI construction work addressed herein is entitled *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Impoundment.* This plan was submitted on October 6, 1997 (Part I, Design Report) and October 28, 1997 (Parts II and III, Construction Plans and Specifications and Quality Plan). The plan was approved by the NRC on July 16, 1999 by License Amendment 41. In December 2000, Umetco submitted the *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach.* The latter modifications were approved by License Amendment 44 on April 5, 2001.

Scope of Work

- Extension of the radon barrier on the north and east sides to accommodate closure of the toe drain system and cover contamination found along the downstream toe;
- Addition of erosion protection (riprap) along a portion of East Canyon Creek to protect the toe of the impoundment; and
- Replacement of the previously approved vegetative cover with riprap erosion protection.

3.2.3 A-9 Repository (Volume IV)

Overview

The A-9 repository (cell) is a former open pit uranium mine pit that was used for tailings disposal. In the NRC-approved 1987 reclamation design for the A-9 cell, the cover consisted of a 1-foot thick interim cover, a 1-foot clay radon barrier, a 1-foot filter layer, a 6.5-foot frost

[2] Note that this is distinct from the main Heap Leach disposal area addressed in Section 3.1.1 and in Volume II. The experimental heap leach area/operation involved experimental heap pads located immediately south of the Above-Grade Tailings Impoundment. Designed in 1972, construction began in 1973, and the experimental heap operated until approximately 1978, after which the heaps were incorporated into the Above-Grade Tailings Impoundment – as referred to above – in 1980.

protection/spoil layer, and a 6-inch topsoil layer. An interim cover from 1 to 5 ft thick was placed over the entire A-9 area in 1988 and 1989. The final cover (for the previously-approved reclamation plan) was not constructed because Umetco planned for additional waste and fill to be placed in the cell.

Umetco submitted the enhanced reclamation plan by letter dated October 27, 1998, and requested a license amendment to allow Umetco to modify the A-9 cover design. Additional information and revised pages to the plan were submitted December 10, 1998 and March 29, 1999.

A-9 Repository Scope of Work

- Reduce the planned frost protection soil layer to 4.5 ft and increase the clay radon barrier to 1.5 ft, for a total soil cover thickness of 7 ft for the A-9 cell (it was previously 10 ft)
- Change the vegetative cover to 6-12 inches of riprap (rock)
- Grade the site for proper drainage – include east and west diversion ditches
- Reclaim the north and south evaporation ponds
- Reclaim the C-18 pit.

3.2.4 C-18 Pit (Volume IV)

The C-18 Pit was addressed in the A-9 Repository enhanced design plan, along with the North and South evaporation ponds. Reclamation of the C-18 Pit involved placement of approximately 56 feet of backfill (excluding the 10 feet of bridge fill soil initially placed) into the pit to bring the pit material to surface level. Grading was done to promote drainage away from the pit, in accordance with the site-wide grading plan. Erosion protection beyond that associated with the site grading plan was not necessary given the depth of fill.

3.2.5 GHP-2 (Volume V)

Gas Hills Pond No. 2 (GHP-2), the former 17-acre groundwater evaporation pond, was constructed in the former mill process area at the site in 1996. While constructing GHP-2, it was necessary to remove remaining mill foundations, process facilities, and related mill utilities. Groundwater was pumped into the pond until March 2002, when the groundwater corrective action program was terminated upon the NRC's approval of Umetco's ACL proposal.

Although initially addressed in the 1996 Heap Leach plan, not enough data were available to support a design, therefore Umetco submitted a revised plan in 2003, which was approved by License Amendment 52 on November 10, 2003 (TER dated October 27, 2003. The key components of the Plan included solidification of the remaining liquids, removal of the pond lining system, and placement of an engineered cover. In this final plan, because significantly less contaminated material would be placed in the pond than that initially anticipated, the radon barrier was reduced from 18 to 12 inches. As such, more rigorous testing and verification

requirements were imposed. Also, the erosion protection layer thickness for the side slope was increased by one inch and the diameter of the rock increased in the final plan.

3.2.6 Site-Wide Grading Plan

Since reclamation of the site involved several separate and distinct plans, it was essential that all of the plans dovetail to ensure that the final topography would be continuous and uniform. As such, Umetco developed a site-wide grading plan. This was initially provided for in the 1997 Design Enhancement for the AGTI (SMI 1997), but was later updated and included in the enhanced reclamation plan for the A-9 Repository (SMI 1998). This plan consisted of the following seven elements:

1) Tie in to the contours approved with the reclamation plans for the heap leach and above-grade impoundments;

2) Divert an existing drainage channel to minimize potential erosion of the Above-Grade Tailings Impoundment cover (referred to as the East Canyon Creek realignment);

3) Raise the final elevation of the A-9 cell by approximately 10 feet to accommodate additional material;

4) Re-grade the east side of the A-9 Repository to a 3H:1V or less slope;

5) Provide diversion ditches on the east and west sides of the A-9 Repository to direct runoff away from the cover;

6) Grade the area of the North and South evaporation ponds to a 5H:1V or less slope; and

7) Provide positive drainage for other areas on the site.

3.3 Quality Assurance/Quality Control (QA/QC) and Material Testing

For each of the five repository areas addressed herein, a detailed quality assurance/quality control (QA/QC) program was implemented to ensure that the construction would be in accordance with the NRC-approved reclamation plans. As demonstrated in Volumes II through V, the field and laboratory quality control program for Gas Hills site reclamation construction activities was rigorous and conservative. For most endpoints, required tests were performed at a much higher frequency than those specified in the reclamation plans.

In addition to the quality control program, external audits on the reclamation construction activities were performed on at least an annual basis, and several were performed initially to ensure the effectiveness of the QA/QC program. During a site inspection conducted in 1997 (the onset of enhanced reclamation activities), the NRC inspectors concluded that the implementation of the quality control program was effective and that the tests and associated frequencies required were in compliance with those recommended by the NRC (*Staff Technical Position on Testing and Inspection Plans during Construction of DOE's Remedial Action Inactive Uranium Mill Tailings Sites* (NRC 1987).

Quality control requirements for test frequencies were generally as follows:

- *Field compaction (nuclear gauge) tests*: one test for every 1000 cubic yards placed (1:1000 CY) for contaminated fill, and 1:500 CY for radon barrier and frost protection layers

- *Laboratory Compaction (Proctor) Tests*: 1:5000 CY. Note that this was modified slightly for GHP No. 2, which required 1 Proctor for every 10 to 15 field tests for all cover layers.

- *Soil Classification Tests* (Gradations and Atterberg Limits): 1:1000 CY and 1:2000 CY for radon barrier and frost protection layers, respectively (not applicable for contaminated fill). GHP-2 had more stringent requirements for frost protection, requiring a frequency of 1:1000 CY for this layer.

- *Sand-Cone Correlations*: One sand-cone test for every 10 nuclear gauge tests. For some areas, the testing regime for the contaminated fill layer was much more conservative: 1 for every 5 nuclear gauge tests.

3.4 NRC Inspections

During the 1997-2006 reclamation period addressed herein, the NRC conducted annual field inspections as the reclamation work proceeded. These inspections, summarized in Table 3.3, consisted of visual observations of the completed reclamation work and a review of placement and testing records. In these reports, the NRC consistently concluded that the cell covers were intact and uniform in appearance and that the quality control test records demonstrated that cover and radon barrier materials were selected, placed, and compacted in accordance with the reclamation plans. Overall, the NRC concluded that that the reclamation activities were conducted properly and in accordance with the approved final reclamation plans and were protective of human health and the environment.

3.5 Final Radiological Conditions of Repository Areas

The major radiological criteria applying to the reclamation of repository areas are 10 CFR 40, Appendix A, Criterion 6(1) and 6(2). These criteria require placement of an earthen cover (or approved alternative) over tailings and wastes at the end of the milling operations while providing assurance of control of radiological hazards for 1,000 years, to the extent reasonably achievable (but no less than 200 years) and which limits releases of radon-222 from uranium byproduct materials to the atmosphere so as not to exceed an average rate of 20 picocuries per square meter per second (pCi/m^2-s). Also relevant is Criterion 6(5), which requires the cover (frost protection) material to be comparable to background, for which a value of 10 pCi/g was initially established.

Table 3.3 Gas Hills Site NRC Inspection Report Summary

NRC Inspection Date	NRC Inspection Report Date / No.	Inspection Scope and NRC Conclusions
May 14-15, 1997	June 13, 1997 Report No. 40/0299/97-01	The NRC concluded that site activities were being conducted in accordance with NRC license conditions and regulations.
July 29-30, 1997	August 29, 1997 Report No. 40/0299/97-02	Reclamation Construction Activities and Embankment Stability. Enhanced reclamation activities had just begun at the Heap Leach. During the inspection, the NRC examined observed and evaluated all aspects of cover construction: radon barrier placement and depth checks, frost protection placement, and implementation of QA/QC procedures. All were determined to be effective and in accordance with license conditions and the approved plan.
April 15, 1998	May 6, 1998 Report No. 40/0299/98-01	The NRC concluded that all site activities were being conducted in accordance with NRC license conditions and regulations.; no violations or deviations were identified.
August 25-26, 1999	September 14, 1999 Report No. 40/0299/99-01	Same as above.
July 18, 2000	Inspection findings documented in the TER supporting License Amendment 44 dated April 5, 2001	Post-construction inspection of the Heap Leach and AGTI. The inspection consisted of visual observations and a review of placement and testing records. In the April 5, 2001 TER, the NRC concluded that: 1) the cell covers were intact and uniform in appearance; 2) a review of test records showed that cover and radon barrier materials were selected, placed, and compacted in accordance with acceptable practice; and 3) the earthen covers for the AGTI and the Heap Leach are complete and meet the project specifications.
June 21,2001	July 10, 2001 Report No. 40-0299/01-01	Reviewed site status, decommissioning activities, radiation protection programs, environmental monitoring and groundwater corrective action programs. Inspection concluded licensee conducted above activities in accordance with reclamation plans, licensee and applicable NRC regulations.
July 11, 2001	September 10, 2001 Report No. 40/0299/01-02	Geotechnical evaluation of erosion protection placement on the completed covers for the Heap Leach and AGTI, including a review of testing and inspection records. The NRC concluded that the reclamation was accomplished in accordance with the requirements of the approved reclamation plan.

Table 3.3 Gas Hills Site NRC Inspection Report Summary

NRC Inspection Date	NRC Inspection Report Date / No.	Inspection Scope and NRC Conclusions
July 31, 2002	August 23, 2002 Report No. 40/0299/2002201	Reviewed erosion protection material production, placement and testing. Additionally windblown cleanup activities were reviewed. Inspection concluded erosion protection and windblown cleanup activities were being conducted in accordance with reclamation and decommissioning plans.
August 6, 2003	September 4, 2003 Report No. 40/0299/03-01	Reviewed site status, decommissioning activities, radiation protection programs, environmental monitoring and groundwater corrective action programs. Inspection concluded licensee conducted above activities in accordance with reclamation plans, licensee and applicable NRC regulations.
2004	No Inspection	No Inspection
July 18, 2005	August 9, 2005 Report No. 40/0299/05-001	Reviewed site status, decommissioning activities, radiation protection programs, environmental monitoring and groundwater corrective action programs. Inspection concluded licensee conducted above activities in accordance with reclamation plans, licensee and applicable NRC regulations.
August 31, 2006	September 18, 2006 Report No. 404-00299/06-001	General in Scope: At the time of the inspection, site reclamation was essentially complete, with the exception of minor quality control work (construction verification) on GHP No. 2 and radon flux testing of the C-18 Pit area. The NRC concluded that Umetco was conducting activities safely and in accordance with regulatory and license requirements. One exception was identified for GHP-2 (some Ra-226 levels > 10 pCi/g in frost protection soils), but this had already been identified by Umetco in a previous (2/7/06) license amendment request. The latter request was ultimately approved by the NRC on November 22, 2006 by License Amendment No. 58 (see Volume V, Attachment 2).

A summary of the final radiological condition of Gas Hills repositories is summarized below in Table 3.4.

Table 3.4 Final Radiological Conditions of Gas Hills Repository Areas

Area	NESHAPS Radon Flux, Rn-222 (pCi/m^2-s)	Gamma Exposure Rate (μR/hr)	Cover Ra-226 (pCi/g)
Heap Leach	1.1 pCi/m^2-s (a)	27 μR/hr (d)	0-1 ft: 3.0 pCi/g 1-2 ft: 3.1 pCi/g
AGTI	1.4 pCi/m^2-s (b)	27 μR/hr (d)	0-1 ft: 5.6 pCi/g 1-2 ft: 4.0 pCi/g
A-9 Repository	3.5 pCi/m^2-s (c, e)	28 μR/hr (e)	0-1 ft: 7.7 pCi/g 1-2 ft: 7.8 pCi/g
C-18 Pit	5.2 pCi/m^2-s (f, g)	32 μR/hr (g)	0-1 ft: 8.95 pCi/g 1-2 ft: 8.4 pCi/g
GHP-2	6.8 pCi/m^2-s (f, g)	38 μR/hr (g)	0-1 ft: 13.2 pCi/g 1-2 ft: 13.5 pCi/g

The Ra-226 cover content shown above was for frost protection material except for the C-18 Pit, which corresponded to backfill soils.

References

(a) NESHAPS Report dated November 12, 1999
(b) NESHAPS Report dated January 8, 2001, approved by the NRC on May 1, 2001
(c) NESHAPS Report dated December 10, 2003
(d) Final Status Survey Report (FSSR), Addendum 1 (April 16, 2004, revised August 2004)
(e) FSSR Addendum 2, May 11, 2005, approved by the NRC on September 1, 2005
(f) NESHAPS Report dated December 13, 2006
(g) FSSR Addendum 3, January 22, 2007

At the outset it is important to address the fact that the allowable Ra-226 cover (frost protection) content for Gas Hills repositories—initially 10 pCi/g for the Heap, AGTI, and the A-9—was ultimately increased to 15 pCi/g in 2006 for GHP-2, as approved by License Amendment 58 (November 22, 2006). This amendment also approved an increase in allowable Ra-226 in C-18 Pit backfill soils from 5 pCi/g to 10 pCi/g. A brief discussion of the factors underlying this change is provided below. Concomitant with this increase in cover radium content was a change in the background exposure rate for the C-18 Pit and GHP-2.

As shown in Table 3.1, from 1997 through 2004, close to 1.5 million cubic yards of frost protection material excavated from various borrow areas were placed on the Heap Leach, Above-Grade, and A-9 repositories between 1997 and 2004. By the time GHP-2 reclamation activities commenced in 2005, the volume of available soils meeting the 10 pCi/g criterion was diminishing. The highly variable radium content of background soils at the site has been

discussed at length in the Final Status Survey report and was corroborated by the NRC in the September 27, 2004 TER documenting the approval of the FSSR:

> *"Background Ra-226 and uranium values are difficult to quantify because the site is on land containing natural deposits of uranium, open pit uranium mines are on and adjacent to the site, and the Wyoming Abandoned Mines Program has used mine overburden (spoils) to fill some adjacent open pit mines so that surface soil contains up to 20 pCi/g Ra-226."*

On February 7, 2006, Umetco submitted a request for amendments to License Conditions 58 and 61, regarding the radiological cover criteria for the C-18 Pit (License Condition 58) and GHP-2 (License Condition 61), respectively. The first request was for a change in the average allowable Ra-226 content for the C-18 Pit topsoil from 5 to 10 picocuries per gram (pCi/g). At the same time, Umetco requested two amendment modifications for License Condition 61. The first was a change in the average allowable Ra-226 content in the frost protection cover materials of GHP-2 from 10 to 15 pCi/g. The second request was to change the allowable background exposure limit on the cover from 30 microRoentgens per hour (μR/hr) to 40 μR/hr. This amendment was approved by the NRC by License Amendment 58 on November 22, 2006. The supporting TER (October 12, 2006, provided in Attachment 2), stated the following:

> *"After reviewing site background data, the NRC determined that a Ra-226 activity of 15 pCi/g is a more realistic value than the previously approved 10 pCi/g. This complies with Appendix A, Criterion 6(5)..."*

and, regarding the allowable gamma exposure rate:

> *Evaluation of area surveys on and off the site indicates that background values vary greatly, from 16 to 97 μR/hr. Determining an accurate background for the site is subject to bias due to the great variance of the area's radiation levels. An appropriate background would be one that is conservatively estimated considering site background data and radium values in the area. NRC staff has concluded that the proposed value of 40 μR/hr does not pose a significant risk to public health, safety, and the environment. NRC staff has determined that the new average allowable exposure rate of 40 μR/hr satisfies 10 CFR Part 40, Appendix A, Criterion 6(1).*

The NRC approved the revised topsoil criteria for the C-18 Pit, stating the following:

> *"NRC staff agrees that the required value of 5 pCi/g of Ra-226 concentration in the 30-cm growth medium is overly conservative and not a realistic estimate of actual background activity on site...The elevated Ra-226 level in the topsoil does not pose a significant risk...and is a conservative estimate of Ra-226 concentration background within the site boundary."*

Finally, in support of license termination requirements, the following table summarizes the volume of material encapsulated in the Gas Hills disposal cells and the corresponding Ra-226 activities.

Table 3.5 Tailings Volumes and Associated Radium Activity for Gas Hills Repositories:

Repository	Tailing Volume Cubic Yards	Dry Density (pcf)	Tailings Volume (tons)	Ra-226 Activity (pCi/g)	Repository Activity (curies)	
Heap Leach						
Tailings	1,153,535	116	1,806,436	67	110	
Above-Grade Tailings Impoundment						
Tailings	6,400,000	88	7,603,200	311	2145	
A-9 Repository						
Umetco Tailings	*1,481,815	88	1,760,396	311	497	
Susquehanna Tailings	1,793,801	116	2,809,092	342	871	
Imported Waste	5,053	112	7,640	127	1	
Mine and Mill Debris	103,830	112	156,991	127	18	
North & South Evap	178,590	116	279,672	127	32	
GHP-1	30,000	116	46,980	127	5	
Spook Soils	800	112	1,210	127	0	
IMC Cleanup Soils	1824	112	2,758	127	0	
Subtotals:			5,064,739		1425	
C-18 Pit Backfill						
Tailings	98,185	116	153,758	40	6	
GHP No. 2						
Tailings	345,827	116	541,565	27	13	
Total All:			**15,169,698**		**3699**	

* 98,185 cubic yards of tailings in the C-18 Pit is attributable to previous sediment transport from the A-9 Tailings Repository during historical runoff events at the site.

4.0 RADON BARRIER AND FROST PROTECTION MATERIAL BORROW SOURCES AND CHARACTERISTICS

As demonstrated in the following volumes, testing of radon barrier and frost protection material to ensure that the characteristics met plan specifications was a major component of the Gas Hills Reclamation program. Between 1997 and 2006, over 419,000 cubic yards of radon barrier material and 1.8 million cubic yards of frost protection material were used to construct the reclamation covers for the Heap Leach, Above-Grade Tailings Impoundment, A-9 Repository, and GHP-2. As an overview, this section describes the sources of these materials, documents the results of preliminary (pre-construction) testing, and also summarizes the results of laboratory quality control testing conducted for all repository areas, as documented in detail in Volumes II through V.

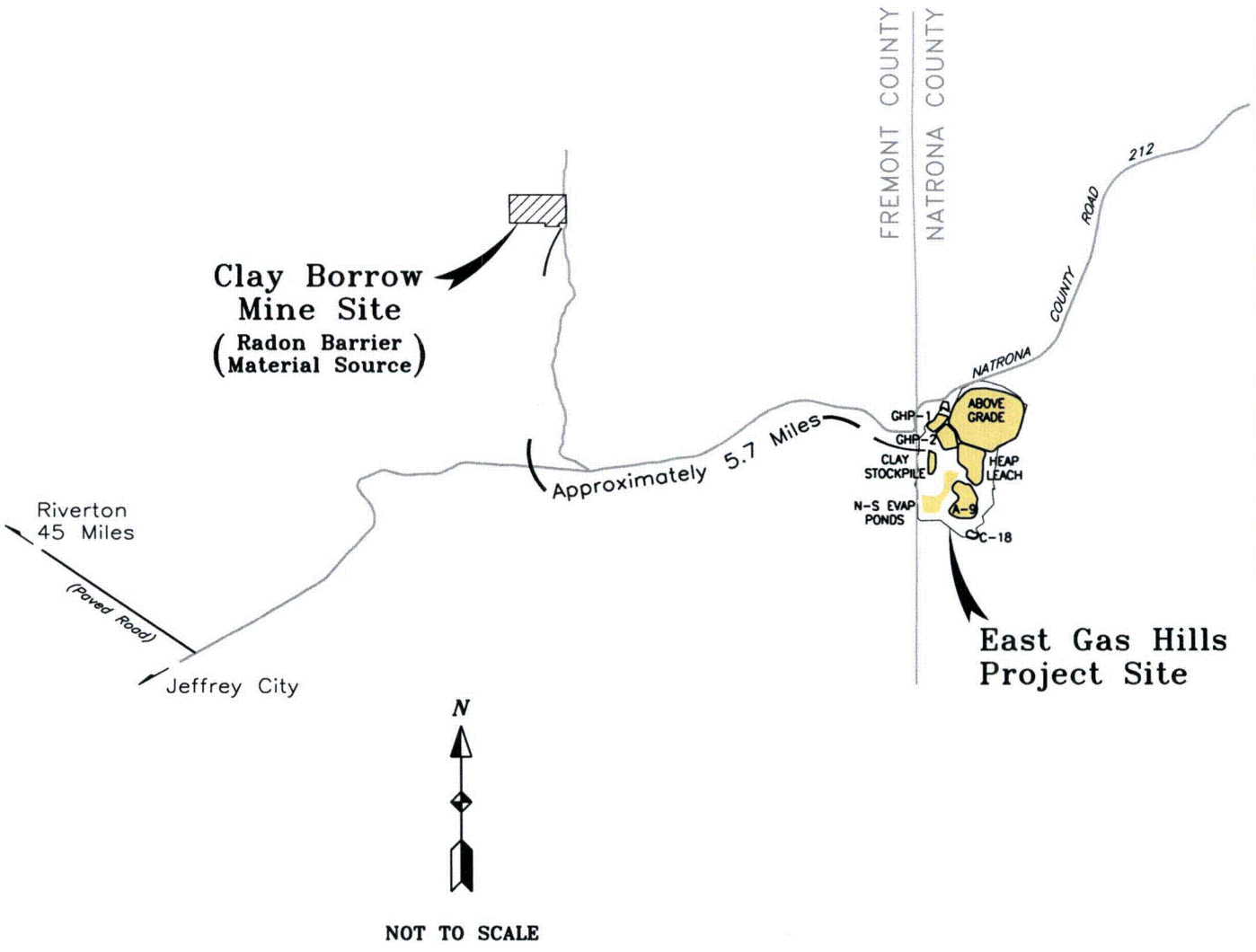
4.1 Radon Barrier Material Sources and Characteristics

4.1.1 Borrow Area Description and Associated Mining Operations

The source of material used to construct the radon barrier layers for Gas Hills site repositories was the Clay Borrow Area, located approximately 6 miles northeast of the East Gas Hills site (Figure 4.1). The soils from this area consist of claystone soils known as Cody shale. Mining in this area is/was permitted by the Wyoming Department of Environmental Quality (WDEQ) under Permit 628(s), which was first issued on April 1, 1990. Shale materials from this 39-acre area were used to construct the radon barrier layers for the Heap Leach, the Above-Grade Tailings Impoundment, the A-9 Repository, and GHP-2.

Between 1991 (when Clay Borrow mining operations began) and 2000, over 1 million tons of Cody shale material were removed from the clay borrow area and transported to the Gas Hills site for use in construction of the repository radon barriers. This clayey soil was brought to a designated area south of GHP-1 for stockpiling (see Figure 4-1) and for preparation of the soil to the proper moisture content prior to placement. Moisture was added to the clayey soil stockpile with water trucks, and a scarifier was used to mix the moisture and soil to provide a uniform moisture content. The quantities of Clay Borrow Material placed on Gas Hills repositories for radon barrier construction is summarized below.

Project Area	Quantities (cubic yards)
Heap Leach	84,857
Above-Grade	101,787
A-9 Repository	156,009
GHP-2	76,626
Total:	419,279



UMETCO MINERALS CORPORATION	
CLAY BORROW MINE SITE	
LOCATION MAP	
GAS HILLS, WYOMING	
JUNE 2007	FIGURE 4.1

Clay-Borrow-Fig-4-1.dwg

4.1.2 Radon Barrier Material (Cody Shale) Characteristics

Soils from the Clay Borrow area consist of claystone soils known as Cody shale. The material is a gray, carbonaceous, variably silty shale of the Upper Cretaceous Cody Formation (herein referred to as Cody shale). In determining suitability of the clay materials found in the Clay Borrow source area, a series of test holes were drilled and samples were collected for analysis of geotechnical properties. This initial testing, which was conducted as part of preliminary studies conducted for the Heap Leach and during development of the enhanced reclamation plan for the Above-Grade repository, yielded the following results.

Soil Classification and Gradation. The Cody Shale material generally consists of Fat Clays (CH) and some lean clays (CL), with generally greater than 95 percent passing the No. 200 sieve.

Hydraulic Conductivity and Specific Gravity. Hydraulic conductivity was measured by Inberg-Miller in early 1998 using a flexible wall permeameter (ASTM D 5084 Method C). Eleven samples were analyzed and test results ranged from 3.9E-9 to 9.0E-8 centimeters per second (cm/s), with an average of 2.9E-8 cm/s. [These results are documented in Volume II (Heap Leach), Table B.3.] All results are below the maximum 1.0E-7 cm/s requirement established for the reclamation plans. The specific gravity of the Cody Shale material ranges from 2.75 to 2.78.

Density and Moisture Content. The maximum Standard Proctor density of the Clay Borrow material ranged from 100 pcf to 110 pcf with an optimum moisture content ranging from 17 to 22 percent. The in-place density of the existing radon barrier on the heap leach ranged from 100 to 109 pcf, averaging about 106 pcf.

Long-Term Moisture Content. The long-term moisture content for radon barrier material was obtained from soil-water characteristic curves developed by Inberg-Miller in May 1998 as part of the A-9 reclamation plan design. Using a Cody Shale stockpile sample with a maximum dry density of 105.7 pcf at 19.2% optimum moisture content, the long-term water content was estimated by laboratory measurement of the 15-bar water retention value. This test yielded an average long-term moisture content of 12.4 percent for radon barrier material.

Radium Activity. An average Ra-226 content of 2 pCi/g was established for the radon barrier based on the average of 9 samples tested by Rodgers and Associates. Test results are documented in Umetco's September 25, 1996 and October 15, 1997 Heap Leach submittals (see Volume III).

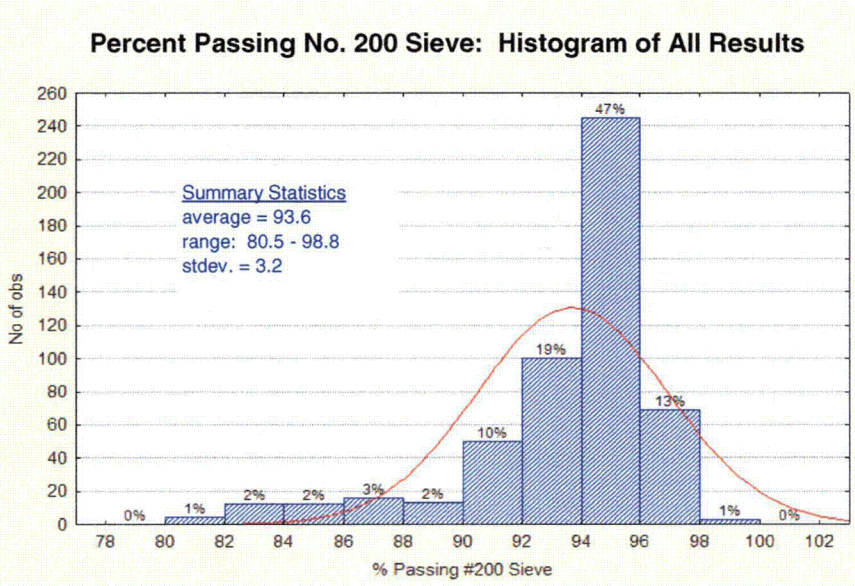
All of the above preliminary tests indicated that Cody shale soils were generally very consistent. This conclusion is corroborated by the results of laboratory tests of radon barrier materials for all repository areas, summarized below (Table 4.1). As demonstrated in this table and in the supporting exhibits, the radon barrier material soil characteristics are consistent and satisfy the reclamation design plan requirements for all repository areas. Graphical displays of the data above are provided in Figures 4.2 through 4.4.

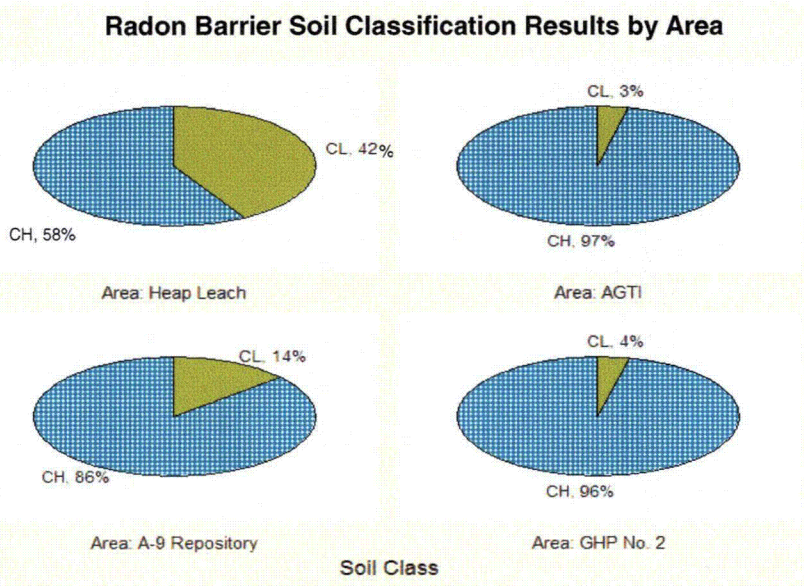
Table 4.1 Radon Barrier Soil Characteristics of Gas Hills Reclamation Areas

Note: Average values are provided in shaded rows (see table footnotes for additional information).

	Laboratory Standard Proctors		Atterberg Limits		Grain-Size and Soil Class	
Project Area	Maximum Dry Density (pcf)	Optimum Moisture (%)	Liquid Limit (%)	Plasticity Index (%)	% Passing #200 Sieve	Soil Classification
Heap Leach	104.9	19.6	50.5	32.4	94.1	
range:	102.3 – 108.6	18.2 – 21.1	43 - 60	20 – 43	86.4 – 98.4	CH: 58% CL: 42%
std. deviation:	1.9	0.9	4.0	4.1	2.5	
Above-Grade	104.7	20.1	54.7	35.8	94.6	
range:	102.8 – 107.2	17.6 – 21.4	48 - 64	28 – 44	87.9 – 97.9	CH: 97% CL: 3%
std. deviation:	1.3	0.9	3.2	3.3	1.2	
A-9 Repository	104.3	20.0	55.8	35.4	93.3	
range:	101.0 – 107.5	18.0 – 21.5	42 – 72	18 – 49	80.5 – 98.8	CH: 86% CL: 14%
std. deviation:	2.0	0.9	6.2	5.4	4.2	
GHP No. 2	104.5	20.3	55.6	38.9	92.1	
range:	101.0 – 107.9	18.5 – 22.6	44 – 72	30 – 53	82.1 – 97.5	CH: 96% CL: 4%
std. deviation:	1.6	0.9	3.8	3.8	2.9	
Global Average	**104.6**	**20.0**	**54.5**	**35.5**	**93.6**	
range:	101.0 – 108.6	17.6 – 22.6	42 – 72	18 – 53	80.5 – 98.8	CH: 86% CL: 14%
std. deviation:	1.7	0.9	5.1	4.8	3.2	

CH = Fat Clay; CL = Lean Clay
Number of Proctor tests: All areas = 98; Heap = 19; AGTI = 25; A-9 = 36; GHP No. 2 = 18
N of Atterberg Limit/Soil Classification tests: All areas = 523; Heap = 96; AGTI = 145; A-9 = 199; GHP No. 2 = 83





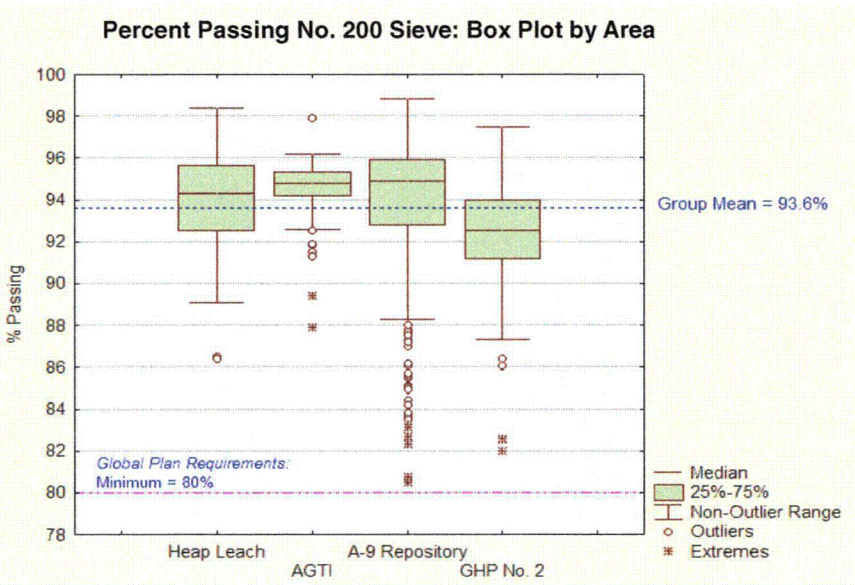
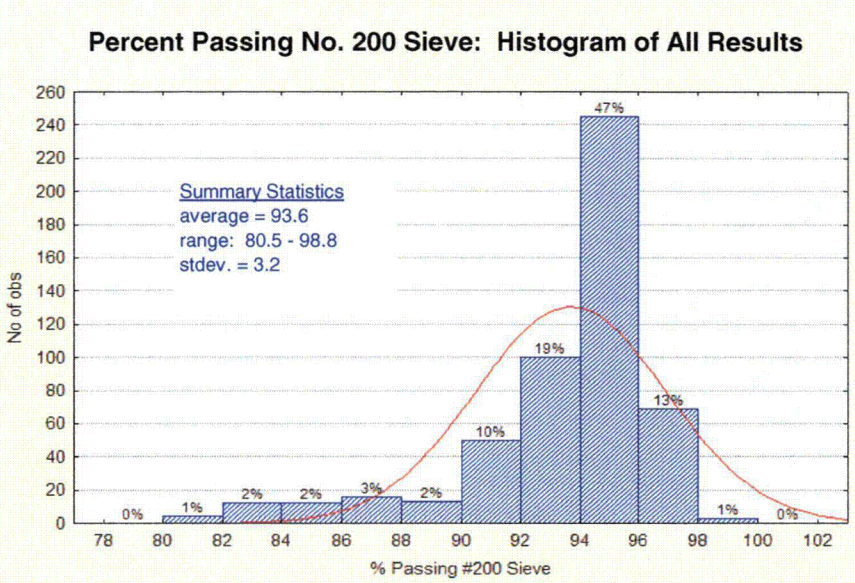
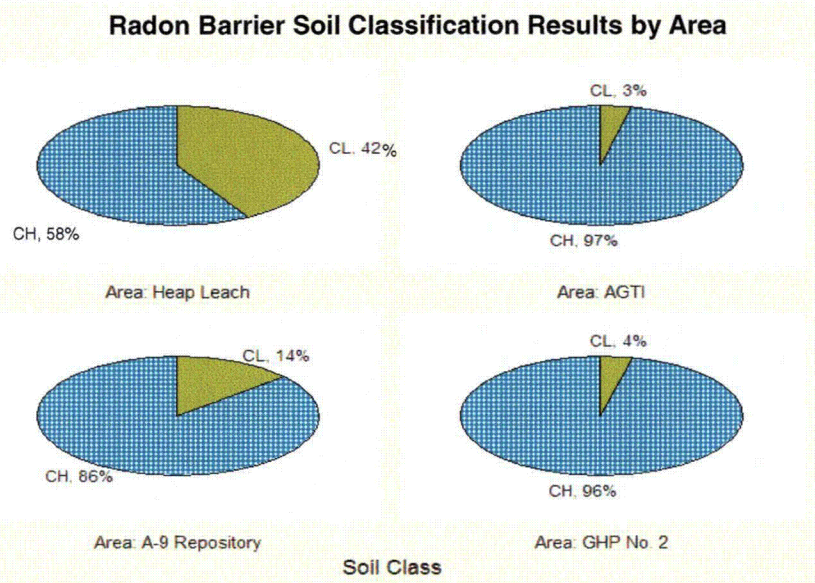


Figure 4.2
Grain Size Distribution and Soil Classification Summaries for Radon Barrier Soils
Gas Hills, Wyoming Site





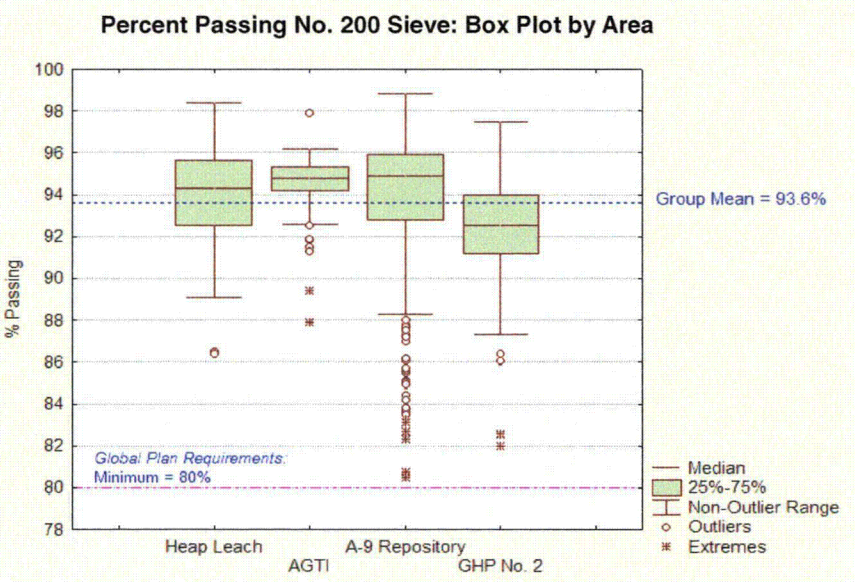


Figure 4.2
Grain Size Distribution and Soil Classification Summaries for Radon Barrier Soils
Gas Hills, Wyoming Site

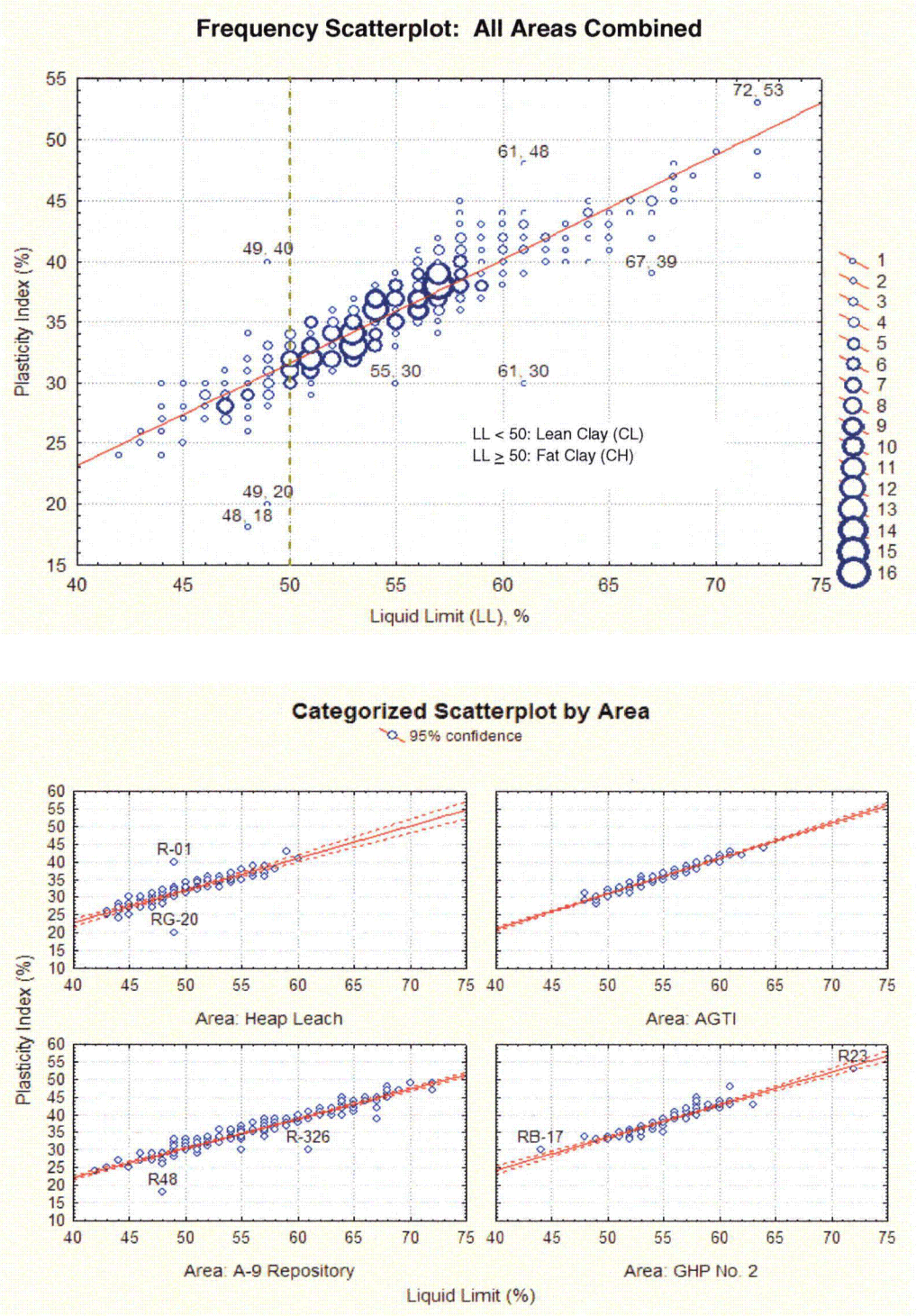


Figure 4.3
Atterberg Limit Summary and Plasticity Charts: Radon Barrier Soils
Gas Hills, Wyoming Site

Finally, the following photographs provide examples of radon barrier placement during Gas Hills construction activities.

Processing clay for radon barrier material in the stockpile.

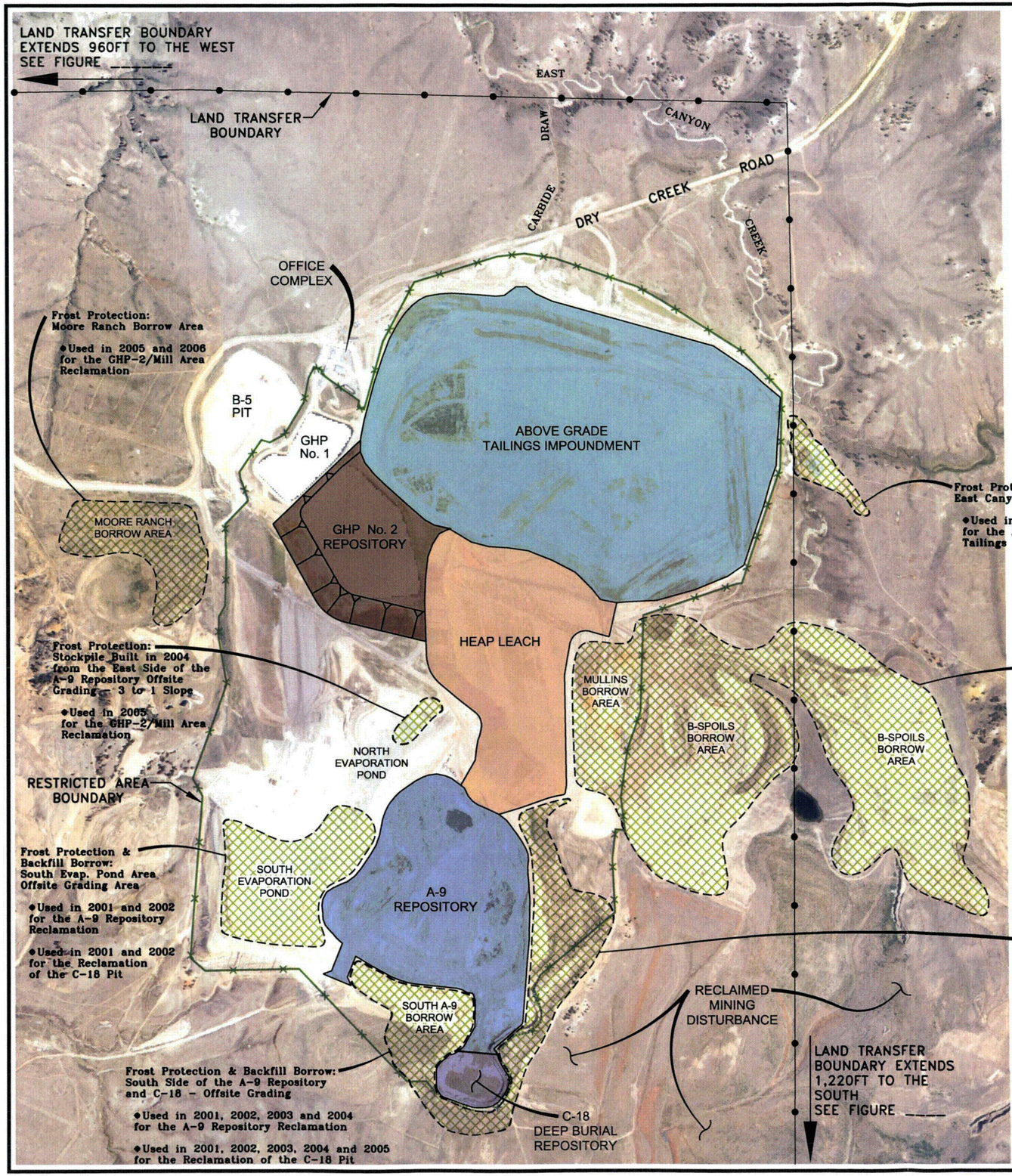
August 1998: Compacting Heap Leach Gap radon barrier soils with a sheepsfoot compactor.

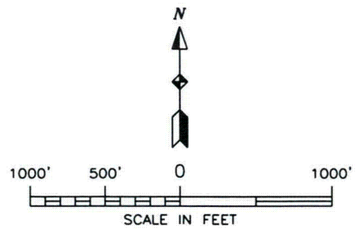
4.2 Frost Protection Material Sources and Characteristics

From 1997 until 2005, Umetco conducted mining activities in search of suitable frost protection soils for completion of the Above Grade, Heap Leach, A-9, and GHP-2 repository covers. Borrow areas used as sources of material for frost protection for Gas Hills site repositories are shown in Figure 4.5. These areas include the B-Spoils area, Moore Ranch, areas east and south of the A-9 Repository, and mine spoils from the north and south evaporation pond area. Initially, the B-Spoils area was the primary source of frost protection materials. This area is located in Natrona County on BLM land and is permitted by the WDEQ. However, as construction activities proceeded, it was necessary to find other sources of suitable material. Between 1997 and 2006, nearly 1.8 million cubic yards of frost protection material excavated from these borrow areas were placed as cover materials at the Gas Hills site repositories. The following photograph shows frost protection material being placed on the A-9 Repository in 2003.

Placing the first lift of frost protection material on top of the radon barrier on the A-9 Repository, June 2003.

Based on preliminary testing conducted in support of the reclamation plans, the borrow area soils used for constructing the frost protection layers for the various covers consisted of clayey sand and/or silty-clayey sand that classify as SC, SM, or SC-SM. The maximum standard Proctor density ranged from 109 pcf to 121 pcf with optimum moisture content ranging from 11 to 14 percent. These measurements formed the basis for the reclamation plan requirements which, as shown in Table 4.2 (following page), were generally satisfied for all repository areas. In some cases, a small percentage was classified as clay, but this material was considered acceptable, because the main criterion for suitability of frost protection materials was the radium content.





AERIAL PHOTO OF SITE FROM A.M.I.'S JUNE 9, 2000 AERIAL SURVEY.

NOTE:

COLOR SHADED AREAS DENOTE THOSE AREAS FOR WHICH RECLAMATION CONSTRUCTION ACTIVITIES ARE DOCUMENTED HEREIN. (SEE LEGEND BELOW)

LEGEND:

- ABOVE-GRADE TAILINGS IMPOUNDMENT
- HEAP LEACH REPOSITORY
- A-9 REPOSITORY
- GHP No. 2 REPOSITORY
- C-18 DEEP BURIAL REPOSITORY
- FROST PROTECTION AND BACKFILL BORROW AREAS
- LAND TRANSFER BOUNDARY
- RESTRICTED AREA BOUNDARY
- FEATURE BOUNDARIES

LEGAL DESCRIPTION OF LAND TRANSFER BOUNDARY:

LAND TRANSFER BOUNDARY INCLUDES ALL OF SECTION 15, THE NORTH HALF OF SECTION 22, THE NORTHEAST QUARTER OF SECTION 21, THE EAST HALF OF SECTION 16, THE SOUTHEAST QUARTER OF SECTION 9 AND THE SOUTH HALF OF SECTION 10, ALL LOCATED IN TOWNSHIP 33 NORTH, RANGE 89 WEST OF THE SIXTH PRINCIPAL MERIDIAN. SAID LAND CONTAINS APPROXIMATELY 1920 ACRES.

UMETCO MINERALS CORPORATION

FROST PROTECTION AND BACKFILL SOURCES

GAS HILLS, WYOMING

JUNE 2007 FIGURE 4.5

Frost-Borrow-Fig-4-5.dwg

Table 4.2 Frost Protection Material Characteristics of Gas Hills Reclamation Areas

Note: Average values are provided in shaded rows (see table footnotes for additional information).

	Laboratory Standard Proctors		Soil Classification
Project Area	Maximum Dry Density (pcf)	Optimum Moisture (%)	
Heap Leach	114.3	14.4	SC: 76% CL: 14% SM: 9% SC-SM: 1%
range:	100.1 – 122.6	10.1 – 21.8	
std. deviation:	3.7	1.9	
Above-Grade	116.3	13.3	SC: 93% CL: 6% SC-SM: 1%
range:	107.5 – 121.9	10.6 – 17.9	
std. deviation:	3.2	1.5	
A-9 Repository	118.0	12.4	SC: 58% SM: 37% SC-SM: 3% CL: 1%
range:	114.0 – 121.8	10.4 – 14.0	
std. deviation:	1.7	0.7	
GHP No. 2	118.1	12.7	SC: 79% SM: 18% CL: 2%
range:	109.4 - 121.9	10.2 – 16.6	
std. deviation:	3.0	1.4	
Global Average	116.4	13.3	SC: 77% SM: 16% CL: 6% SC-SM: 1%
range:	100.1 - 122.6	10.1 – 21.8	
std. deviation:	3.4	1.7	

For each area, only the most prevalent soil classifications are noted (those with percentages ≥ 1%). These include, in descending order of overall prevalence: SC (Clayey Sand); SM (Silty Sand); CL (Lean Clay); and SC-SM (Silty, Clayey Sand). Other classifications were noted, but these occurred at very low frequencies; see Figures __ and area-specific volumes for elaboration.

Number of Proctor tests: All areas = 403; Heap = 125; AGTI = 106; A-9 = 104; GHP No. 2 = 68

All corresponding geotechnical results are documented in the repository-specific volumes (Volumes II through V).

This section concludes with two additional photographs demonstrating placement of frost protection materials at GHP-2. The first shows the first lift of frost protection material being placed on the GHP-2 radon barrier in August 2005. The second provides a broader view.

5.0 EROSION PROTECTION MATERIAL SOURCES AND QUALITY CONTROL TEST RESULTS

A critical aspect of the Gas Hills reclamation project was the design and proper placement of erosion protection to ensure long-term stability of the tailings impoundments. As required by 10 CFR Part 40, Appendix A, stabilization designs must provide reasonable assurance of control of radiological hazards for a 1,000-year period, to the extent practicable, but in any case, for a minimum 200-year period.

The source of erosion protection materials for the Gas Hills site was the Rattlesnake Quarry (the location of the quarry is shown on Figure 5.1). Mining operations at the quarry began in 2000 and were completed in 2003. This section describes the quarry material and mining operations and documents the results of all quality control testing performed to demonstrate the suitability of the material for erosion protection placement.

5.1 Rattlesnake Quarry Description

The Rattlesnake Quarry site is located in central Wyoming at the northern end of the northwest-southeast trending Rattlesnake Hills, approximately 5 miles east of the Gas Hills Site (Figure 5.1). This site was selected because it is characterized by a steeply sloping rock outcrop containing hard, durable Tensleep quartzite that meets NRC requirements for Gas Hills Site reclamation activities. Under Mine Permit No. 682 issued by the Wyoming Department of Environmental Quality – Land Quality Division, the Rattlesnake permitted area encompasses a total of 144.68 acres, but only 41.6 acres of this total area were disturbed; with the quarry area comprising approximately 12.8 acres. Permit No. 682 was issued on March 24, 2000.[3]

5.2 Mining Operations and Quantities

Mining operations at the Rattlesnake Quarry began in 2000 and were completed in 2003. During that period, approximately 448,000 cubic yards of rock/riprap weighing approximately 855,000 tons were excavated from the quarry area and ultimately used as riprap for Gas Hills site areas.

Mining activities at the Rattlesnake Quarry consisted of drilling, blasting, and excavating the quarry material, processing and storage of the rock, and loading and transportation of the processed rock. The mining method used was open-faced quarrying of the Tensleep quartzite. Mining was conducted entirely from the steeply inclined strata exposed on the rock outcrop. Cross benches were excavated beginning at the top of the quarry area and blasting was conducted in a manner allowing loosening of the material and excavation with dozers. After processing, the sized material was placed in stockpiles according to the required gradation specifications for subsequent loading and hauling to Umetco's Gas Hills facilities.

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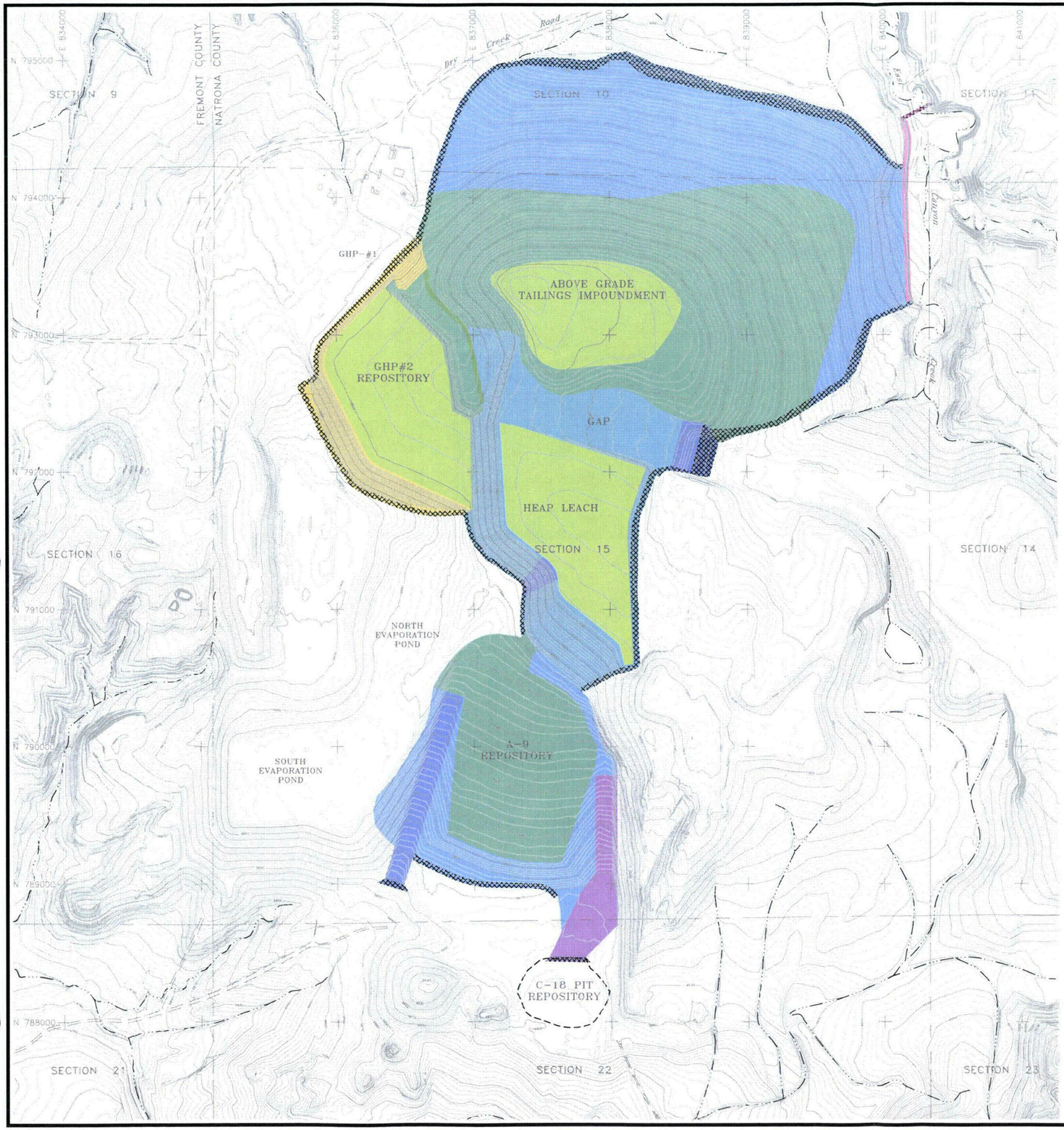
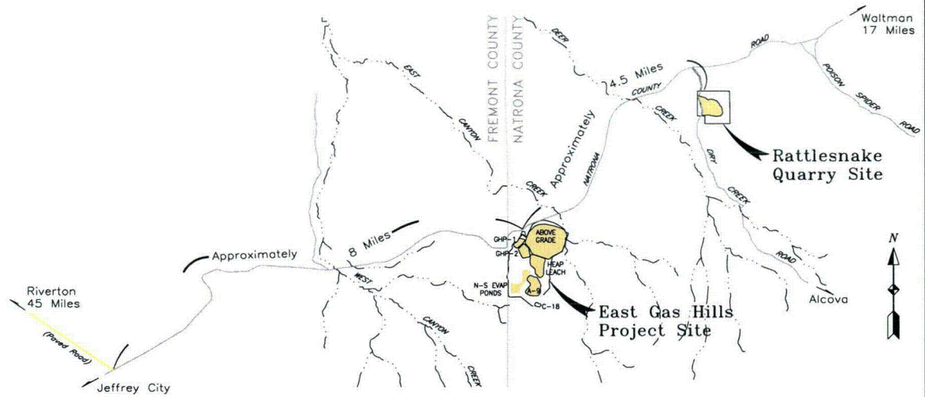
[3] Permit Amendment, Change No. 1, was approved on April 20, 2000. Permit Amendment, Change No. 2, was approved on January 31, 2005.





LOCATION MAP

NOT TO SCALE

LEGEND

- 7900 — 2006 FINISHED GRADE TOPOGRAPHY
- DRAINAGE PATH/PONDED WATER
- UN-PAVED ROADS
- N 794,000 — UMETCO 1000' SITE GRID
- 6-INCHES OF RIPRAP TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH WITH 3-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 10-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH WITH 3-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 24-INCHES OF RIPRAP TYPE "D" D_{50} = 16.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- LAUNCHED STONE EMBANKMENT TYPE "E" D_{50} = 30.0 INCH
- BELOW-GRADE APRON

N

400' 0 400'

SCALE IN FEET

CONTOUR INTERVAL : 2'

UMETCO MINERALS CORPORATION

EROSION PROTECTION PLACEMENT AT GAS HILLS REPOSITORY AREAS

MAY, 2007

FIGURE 5.1

Erosion-fig-5-1.dwg

Table 5.1 summarizes volumes by rock type and locations where the rock was placed. The rock placement locations are shown on Figure 5.1.

Table 5.1 Quantities Placed on Gas Hills Repositories, Summarized by Rock Type

Reclamation Area	Type A	Type B	Type C	Type D	Type E	Totals
Heap Leach	46,613	24,999	5,317	--	--	76,929 CY
Above-Grade	16,826	63,302	117,736	--	18,639	216,503CY
A-9 Repository	11,306	26,882	36,702	24,881	--	99,771 CY
GHP-2	29,950	9,920	15,448	--	--	55,358 CY
Total:	**104,695**	**125,103**	**175,242**	**24,881**	**18,639**	**448,181 CY**

Rock was placed between 2000 and 2003 for the Heap Leach, Above-Grade and A-9 Repositories, and in 2006 for GHP-2. Tons to CY conversion factors: Type A = 2.008; Type B = 2.158; Type C =1.752; Types D and E = 1.55

5.3 Testing, Inspection, and Quality Control Procedures

Quality control testing and inspection was performed by Umetco using the quality control procedures for the erosion protection material which included rock durability testing, gradation testing, and verification of rock and filter layer thickness. Umetco's quality control program was rigorous and in general the erosion protection material was tested at a much higher frequency than required by the reclamation plans (1 test for every 10,000 cubic yards). Erosion protection testing methods are summarized in Table 5.2 (see following page).

5.4 Petrographic Examination

An initial petrographic examination was performed to determine if smectites or expanding lattice clay minerals were present, in which case the rock would not be suitable for erosion control measures. This examination was performed by Dr. Jack Roadifer in May 1997, as documented in the June 1997 report by Western Engineers, Inc. (WEI) entitled *Rock Materials Laboratory Testing Report, RS-97-2*. This report is duplicated here in Attachment 1. In this report, Dr. Roadifer concluded the following: "All of the rock samples examined are rated as "good" for riprap. The predominantly silica cement makes them very hard and durable. The fractures observed are filled with silica for the most part, with one being filled with calcite, and they all appear to be well-healed and not easily opened."

Table 5.2 Rock Durability and Gradation Test Methods

Test Name	Test Method	Full Test Name and Reference
Specific Gravity	ASTM C127	Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate (R1993), C127-88
Absorption	ASTM C127	" "
Sodium Sulfate Soundness	ASTM C88 (5 cycles)	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate (ASTM C88-90)
LA (Los Angeles) Abrasion	ASTM C131 (100 & 500 revolutions)	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine (C131-89)
Schmidt Rebound Hardness (Schmidt Hammer)	ISRM Method	Suggested Method for Determination of the Schmidt Rebound Hardness, pp. 101-102
Splitting Tensile Strength	ISRM Method	Suggested Method for Determining Indirect Tensile Strength by the Brazil Test, pp. 120-121
Petrographic Examination	ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete (C295-90)
Gradation	ASTM C117, ASTM C136	Standard Test Method for Materials Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing (C117-95); Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates (C136-93)

ASTM – American Society for Testing and Materials
ISRM – International Society for Rock Mechanics (ISRM), 1981, Rock Characterization Testing and Monitoring, ISRM Suggested Methods, E. T. Brown, Editor, Pergamon Press, New York.

5.5 Rock Durability Testing

NRC regulations require that control of residual radioactive materials be effective for up to 1000 years, to the extent reasonably achievable, and in any case, for at least 200 years. Rock durability testing to evaluate rock quality was performed during material processing in accordance with NRC requirements and associated scoring criteria, as specified in Appendix D of the document entitled *Final Staff Technical Position (STP) – Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites* (NRC, August 1990). This guidance ultimately evolved into what is now NUREG-1623, entitled *Design of Erosion Protection for Long-Term Stabilization* (NRC Final Report, August 2002).

Table 5.3 summarizes the results of the rock durability testing conducted for the Gas Hills site. Ninety-five tests were conducted, corresponding to a testing frequency of approximately 1:3,800 CY, well above the 1:10,000 CY requirement. The individual durability results and rock quality scores are given in Table 5.4 (provided at the end of this section). Scores ranged from 73.8 to 88.9 and the average score was 82.5. The majority (84%) of scores are greater than or equal to 80, the score considered by the NRC to represent rock of "Good" quality, requiring no oversizing. Lower scores were generally yielded early in the rock processing phase (mostly in 2000), due primarily to specific gravity and/or absorption, but in some cases influenced by slightly lower LA Abrasion loss scores (given its higher weighting factor). These results indicate that, overall, the rock produced was of sufficient quality for use as erosion protection and in most cases did not require oversizing.

Table 5.3 Summary of Gas Hills Rock Durability Test Results

Test Name	Testing Results	Score
Specific Gravity	average: 2.52	average: 5.3
Absorption, percent	average: 0.8	average: 6.4
Sodium Sulfate Soundness, percent loss	average: 0.35	average: 10.0
LA Abrasion - 100 revolutions, percent loss	average: 4.7	average: 8.1
Schmidt Hammer	average: 67.3	average: 9.5
Splitting Tensile Strength, average pounds per square inch (psi)	average: 2373	average: 10.0
Rock Quality Score		average: 82.5

The scores and weighting factors used to calculate the scores are from Appendix D, Table D-1 of the STP (NUREG-1623), as summarized in Table 5.2. Individual test endpoints included specific gravity, absorption, sodium sulfate soundness, Los Angeles (LA) abrasion, Schmidt rebound harness, and tensile strength. [Note: Table 5.4 is provided at the end of this section along with detailed gradation results.]

5.6 Rock Gradation Test Results

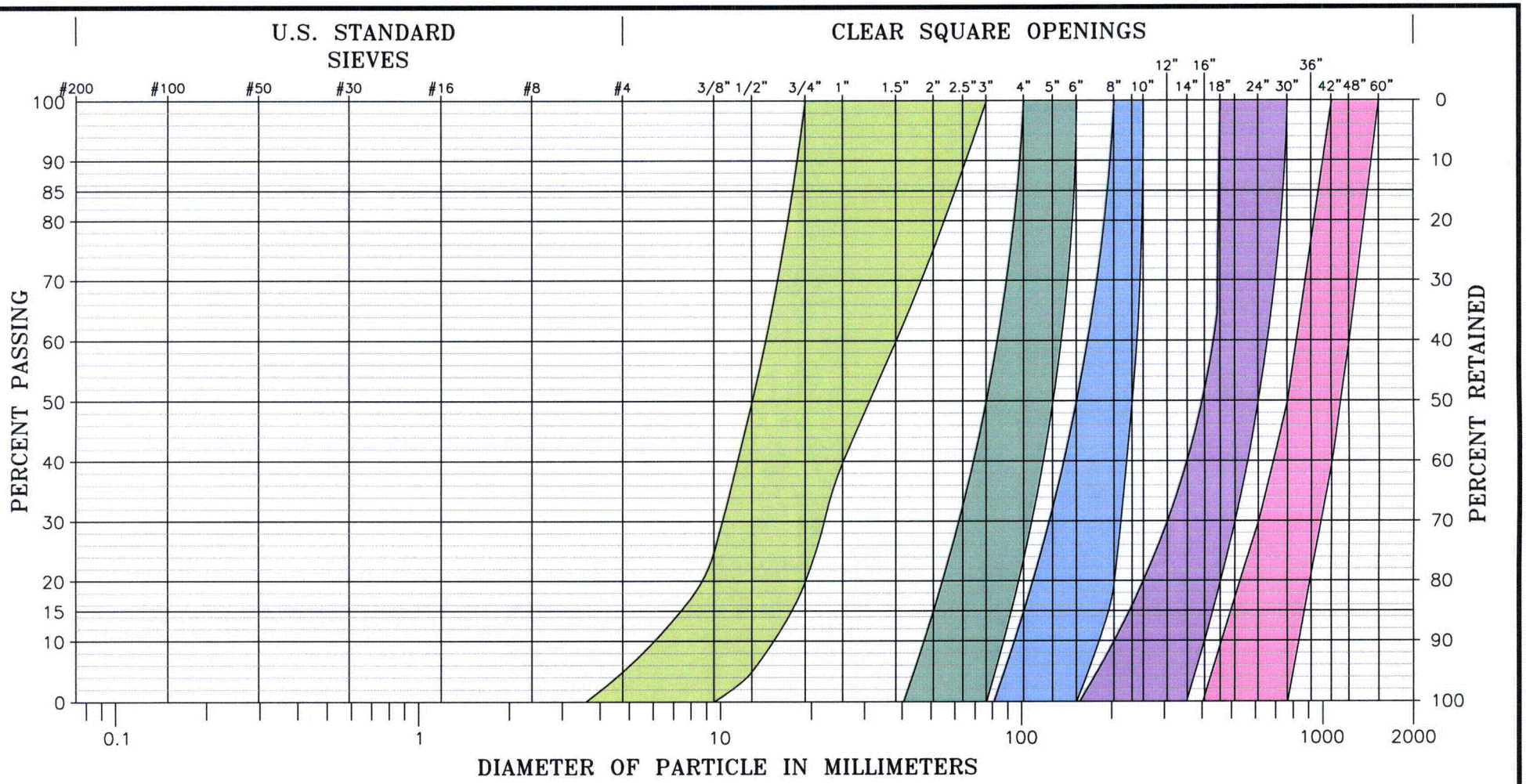
Riprap was processed as necessary to produce the gradations specified in Table 5.6 and shown on Figure 5.2. As a preface to the subsequent volumes, it is important to note that during the early stages of processing, several modifications were made to the gradation requirements initially specified in the reclamation plans. For example, most gradation tests performed in the early phases of rock processing did not meet the initially specified maximum 1.5-inch size requirement. After initial experimentation in September 2000, Umetco determined that a more feasible gradation could be produced and therefore proposed to modify the previously-approved gradation for Type A rock by increasing the maximum size rock from 1½ inches to 3 inches. This proposal was submitted formally as a license amendment request on December 20, 2000, which was approved by the NRC on April 5, 2001 by Amendment No. 44. In the supporting TER, the NRC (T.L. Johnson) concluded that, because the layer thickness of the Type A rock is 6 inches, the proposed change would have little effect on proper rock placement and, in fact, "may actually be more stable."

Tables 5.7 through 5.13 document the results of the gradation testing performed on quarry and in-place samples collected at the repositories for all rock types (all provided at the end of this section). For in-place gradation samples, one test section, approximately 30 feet by 50 feet, was constructed for each type of riprap material placed. Riprap material fully meeting the specified gradations was placed in the test sections by the same methods used for production placement. The finished test sections were used as visual samples for comparison of the production work.

5.6 In-Place Depth Checks

In accordance with the recommendations in NUREG/CR-1623 and the reclamation plan specifications, rock layer thicknesses were a minimum of 1.5 times the design minimum median particle size (D_{50}) for each rock type. Table 5.14 (provided at the end of this section) summarizes the results of in-place depth checks for all repository areas and demonstrates that the latter requirements were met. Figure 5.3 shows the visual depth check locations.

GHRIPRAP-REV2002.DWG



Type A Specification (D_{50} = 0.5")

SIEVE	PERCENT PASSING
3"	100
1.5"	60 – 100
1"	40 – 100
3/4"	20 – 100
1/2"	5 – 50
3/8"	0 – 25
#4	0 – 5

Type B Specification (D_{50} = 3")

SIEVE	PERCENT PASSING
6"	100
5"	50 – 100
4"	30 – 100
3"	0 – 50
2"	0 – 15

Type C Specification (D_{50} = 6")

SIEVE	PERCENT PASSING
10"	100
9"	50 – 100
8"	20 – 100
6"	0 – 50
4"	0 – 15

Type D Specification (D_{50} = 16")

SIEVE	PERCENT PASSING
30"	100
24"	50 – 100
18"	20 – 100
12"	0 – 30
8"	0 – 10

Type E Specification ($D_{50\ MIN}$ = 30")

SIEVE	PERCENT PASSING
60"	100
48"	60 – 100
42"	40 – 100
30"	0 – 50
24"	0 – 30

LEGEND:

- TYPE A RIPRAP
- TYPE B RIPRAP
- TYPE C RIPRAP
- TYPE D RIPRAP
- TYPE E RIPRAP

FIGURE 5.2
RIPRAP GRADATIONS
UMETCO GAS HILLS SITE
JUNE, 2002

IN-PLACE-GRAD-ALL.DWG

N

500' 0 500'

SCALE IN FEET

ABOVE GRADE TAILINGS IMPOUNDMENT

GAP

GHP#2 REPOSITORY

HEAP LEACH

A-9 REPOSITORY

C-18 PIT REPOSITORY

LEGEND

- 6-INCHES OF RIPRAP TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 6-INCHES OF RIPRAP TYPE "B" D_{50} = 3.0 INCH WITH 3-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH
- 12-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 10-INCHES OF RIPRAP TYPE "C" D_{50} = 6.0 INCH WITH 3-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- 24-INCHES OF RIPRAP TYPE "D" D_{50} = 16.0 INCH WITH 6-INCHES OF FILTER TYPE "A" D_{50} = 0.5 INCH
- LAUNCHED STONE EMBANKMENT TYPE "E" D_{50} = 30.0 INCH
- BELOW-GRADE APRON

IN-PLACE VISUAL DEPTH CHECK AND GRADATION SAMPLE LOCATIONS FOR THE ABOVE-GRADE TAILINGS IMPOUNDMENT, HEAP LEACH/GAP, AND THE A-9 REPOSITORY

- C-6 1.40 — IN-PLACE VISUAL DEPTH CHECK AND IN-PLACE GRADATION SAMPLE. C-6 = FIELD IDENTIFICATION NUMBER. 1.40 = DEPTH MEASURED IN FEET
- A-64 ▼ 0.78 — IN-PLACE VISUAL DEPTH CHECK. A-64 = FIELD IDENTIFICATION NUMBER. 0.78 = DEPTH MEASURED IN FEET
- E-1 ■ — IN-PLACE GRADATION SAMPLE. E-1 = FIELD IDENTIFICATION NUMBER

IN-PLACE VISUAL DEPTH CHECK AND GRADATION SAMPLE LOCATIONS FOR THE GHP-2 REPOSITORY

- A-6 0.61 GHP2 A-4 ● — IN-PLACE VISUAL DEPTH CHECK AND IN-PLACE GRADATION SAMPLE. A-6 = VISUAL DEPTH CHECK FIELD IDENTIFICATION NUMBER. GHP2 A-4 = IN-PLACE GRADATION SAMPLE FIELD IDENTIFICATION NUMBER. 0.61 = DEPTH MEASURED IN FEET
- A-11 ▼ 0.53 — IN-PLACE VISUAL DEPTH CHECK. A-11 = VISUAL DEPTH CHECK FIELD IDENTIFICATION NUMBER. 0.53 = DEPTH MEASURED IN FEET
- GHP2 A-1 ■ — IN-PLACE GRADATION SAMPLE. GHP2 A-1 = IN-PLACE GRADATION SAMPLE FIELD IDENTIFICATION NUMBER

UMETCO MINERALS CORPORATION

IN-PLACE VISUAL DEPTH CHECK AND GRADATION SAMPLE LOCATIONS

GAS HILLS, WYOMING

JUNE 2007 FIGURE 5.3

5.7 Summary

The Tensleep quartzite rock obtained from the Rattlesnake Quarry for stabilization of the Gas Hills repositories was of exceptionally high quality considering the sparse sources of suitable erosion protection materials in this region. Essential in the riprap source selection was the hard durable nature of the predominantly silica cemented quartzite and massive structure of the Tensleep Formation.

Riprap production consisted of blasting, primary and secondary crushing, followed by screening to produce the required erosion protection gradations. The high durability of the quartzite produced riprap consisting of angular, blocky, fragments with no internal fracturing. This was further verified by L.A. Abrasion testing results which demonstrated a lower percent loss for the produced material than for rock collected during the initial investigation.

The quarry also produced very large unfractured stones for use in larger riprap gradations (24-inch to 60-inch sizes in the Types D and E). The consistency of the source rock produced high quality, durable riprap for all particle sizes ranging from #4 to 60 inches. The use of this source also resulted in a finished erosion protection that containing no (or negligible) unsuitable rock, not typical of other sources in the region—i.e., other rock sources in the region are limited to size and volume because of unsuitable (friable) particles.

The combination of the high quality erosion protection source and comprehensive quality control program used during production and placement has resulted in a finished product which satisfies the erosion protection requirements of 10 CFR 40, Appendix A.

Table 5.4 Rock Quality Scoring Criteria

	Weighting Factor			Score										
	Limestone	Sandstone†	Igneous	10	9	8	7	6	5	4	3	2	1	0
				Good					Fair				Poor	
Specific Gravity	12	6	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.30	<2.3
Absorption (%)	13	5	2	0.10	0.30	0.50	0.67	0.83	1.0	1.5	2.0	2.5	3.0	>3.0
Sodium Sulfate (%)*	4	3	11	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	>25
L/A Abrasion (%)**	1	8	1	1.0	3.0	5.0	6.7	8.3	10.0	12.5	15.0	20.0	25.0	>25
Schmidt Rebound Hardness	11	13	3	70	65	60	54	47	40	32	24	16	8	<8
Tensile Strength (psi)	5	4	10	1400	1200	1000	833	666	500	400	300	200	100	<100

† Although technically the rock is a quartzite, the sandstone weighting factor was used as it is the most relevant of the three weighting factor options.

* 5 cycles

** 100 revolutions (LA abrasion test was continued to 500 revolutions, but only the 100-revolution result was scored).

Source: *Final Staff Technical Position (STP) – Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites* (NRC, August 1990). This guidance ultimately evolved into what is now NUREG-1623, entitled *Design of Erosion Protection for Long-Term Stabilization* (NRC Final Report, August 2002).

Scores and weighting factors were derived from Appendix D, Table D-1 of the above reference (Scoring Criteria for Determining Rock Quality). The scoring criteria cited in the final (2002) version of NUREG-1623 are the same as those specified in the original 1990 STP, with one exception: NUREG-1623 no longer includes tensile strength as a rock score endpoint. However, because the erosion protection designs in the approved reclamation plans were based on the 1990 STP (the only guidance available at the time), tensile strength was tested and used to assess rock quality and to derive the final rock scores documented in Table 5.5.

As stated in Table D-1 of the STP/NUREG-1623, the NRC based the above scoring method on Tables 6.2, 6.5, and 6.7 of NUREG/CR-2642 (1982) - "Long-Term Survivability of Riprap for Armoring Uranium Mill Tailings and Covers: A Literature Review." Weighting factors were based on the work of G.W. DuPuy, Table 7 of "Petrographic Investigations of Rock Durability and Comparisons of Various Test Procedures," Engineering Geology, July 1965.

Table 5.5 Rattlesnake Quarry Rock Durability Test Results and Scores

Preface: The following tests were performed using the methods listed in Table 5.3. Scores were derived as indicated in Table 5.4, in accordance with NRC guidance (NRC 1990, NRC 2002), based on which a "good" rock score is 80 or higher. For critical areas, a score between 65 and 80 is considered acceptable, but oversizing is required. Weighting factors (WF) used here are for sandstone. Test results with rock scores less than 80 are denoted by shaded rows. Individual tests scores less than 5 are shown in red. **See Notes on page 4.

Sample ID	Sample Date	Specific Gravity	SG Score WF=6	Absorption (%)	Abs% Score WF=5	Sodium Sulfate Soundness (% loss)	SSS Score WF=3	LA Abrasion Loss @ 100 rev	LA Ab Score WF=8	LA Abrasion Loss @ 500 rev	Schmidt Hammer	SH Score WF=13	Tensile Strength (average psi)	TS Score WF=4	Rock Quality Score
GHQ1	9/13/00	2.45	4.0	1.3	4.4	0.38	10.0	8.0	6.2	37.2	67.0	9.4	2105	10.0	74
GHQ2	9/14/00	2.48	4.6	0.8	6.2	0.07	10.0	7.8	6.3	38.7	65.0	9.0	2082	10.0	76
GHQ3	9/18/00	2.48	4.6	0.8	6.2	0.01	10.0	7.8	6.3	39.1	68.3	9.7	2379	10.0	78
GHQ4	9/20/00	2.52	5.4	0.6	7.4	0.08	10.0	5.7	7.6	29.8	68.5	9.7	2278	10.0	84
GHQ5	9/28/00	2.47	4.4	0.9	5.6	2.21	9.4	7.9	6.3	37.6	67.4	9.5	1979	10.0	76
GHQ6	10/5/00	2.53	5.6	0.5	8.0	0.04	10.0	7.5	6.5	34.2	68.9	9.8	2386	10.0	83
GHQ7	10/10/00	2.49	4.8	0.7	6.8	0.07	10.0	6.9	6.9	33.0	67.9	9.6	2244	10.0	80
GHQ8	10/17/00	2.47	4.4	0.8	6.2	0.52	10.0	7.0	6.8	34.7	69.0	9.8	2257	10.0	79
GHQ9	10/23/00	2.50	5.0	0.8	6.2	0.11	10.0	9.4	5.4	41.2	67.5	9.5	2288	10.0	76
GHQ10	5/11/01	2.52	5.4	0.5	8.0	0.21	10.0	3.8	8.6	14.3	68.3	9.7	2432	10.0	86
GHQ11	5/14/01	2.52	5.4	0.8	6.2	0.21	10.0	4.1	8.5	13.9	66.3	9.3	2214	10.0	82
GHQ12	5/18/01	2.53	5.6	0.6	7.4	0.07	10.0	4.0	8.5	13.1	66.4	9.3	2555	10.0	84
GHQ13	5/21/01	2.50	5.0	0.7	6.8	0.11	10.0	2.8	9.1	11.1	68.4	9.7	2332	10.0	85
GHQ14	5/29/01	2.51	5.2	0.9	5.6	0.23	10.0	3.9	8.6	13.3	67.7	9.5	2050	10.0	82
GHQ15	6/1/01	2.52	5.4	0.6	7.4	0.30	10.0	5.2	7.9	15.7	65.8	9.2	2369	10.0	82
GHQ16	6/6/01	2.50	5.0	0.9	5.6	0.16	10.0	3.8	8.6	13.8	65.4	9.1	2811	10.0	81
GHQ17	6/12/01	2.45	4.0	1.3	4.4	0.10	10.0	4.3	8.4	14.9	67.5	9.5	2398	10.0	79
GHQ18	6/18/01	2.44	3.8	1.6	3.8	0.36	10.0	4.1	8.5	15.7	64.8	9.0	2212	10.0	76
GHQ19	6/21/01	2.52	5.4	0.5	8.0	0.12	10.0	3.8	8.6	13.4	65.3	9.1	2142	10.0	84
GHQ20	6/25/01	2.51	5.2	0.7	6.8	0.20	10.0	3.3	8.9	11.7	66.7	9.3	2224	10.0	84
GHQ21	6/29/01	2.49	4.8	0.9	5.6	0.63	10.0	3.9	8.6	14.5	67.5	9.5	2702	10.0	82
GHQ22	7/2/01	2.52	5.4	0.6	7.4	0.04	10.0	3.1	9.0	11.3	66.2	9.2	2150	10.0	85
GHQ23	7/9/01	2.54	5.8	0.6	7.4	0.65	10.0	4.0	8.5	12.9	65.7	9.1	2670	10.0	84
GHQ24	7/13/01	2.51	5.2	0.8	6.2	0.41	10.0	4.4	8.3	14.1	67.8	9.6	2193	10.0	83
GHQ25	7/17/01	2.52	5.4	0.2	9.5	0.26	10.0	4.0	8.5	14.0	65.9	9.2	2371	10.0	86
GHQ26	7/19/01	2.53	5.6	0.5	8.0	0.02	10.0	4.4	8.3	16.0	65.5	9.1	2542	10.0	84
GHQ27	7/25/01	2.52	5.4	0.7	6.8	0.02	10.0	3.2	8.9	14.3	67.0	9.4	2261	10.0	85
GHQ28	7/27/01	2.52	5.4	0.6	7.4	0.20	10.0	3.5	8.8	13.2	65.1	9.0	2189	10.0	84
GHQ29	7/31/01	2.51	5.2	0.6	7.4	0.29	10.0	3.2	8.9	11.7	66.4	9.3	2357	10.0	85
GHQ30	8/3/01	2.50	5.0	0.9	5.6	0.52	10.0	4.3	8.4	14.3	65.9	9.2	1866	10.0	81
GHQ31	8/6/01	2.51	5.2	1.1	4.8	0.36	10.0	4.0	8.5	12.7	66.1	9.2	2815	10.0	80
GHQ32	8/8/01	2.53	5.6	0.7	6.8	0.42	10.0	3.5	8.8	12.9	67.3	9.5	2376	10.0	85
GHQ33	8/10/01	2.49	4.8	0.9	5.6	0.08	10.0	2.7	9.2	11.9	68.7	9.7	2565	10.0	84

Table 5.5 Rattlesnake Quarry Rock Durability Test Results and Scores

Sample ID	Sample Date	Specific Gravity	SG Score WF=6	Absorption (%)	Abs% Score WF=5	Sodium Sulfate Soundness (% loss)	SSS Score WF=3	LA Abrasion Loss @ 100 rev	LA Ab Score WF=8	LA Abrasion Loss @ 500 rev	Schmidt Hammer	SH Score WF=13	Tensile Strength (average psi)	TS Score WF=4	Rock Quality Score
GHQ34	8/15/01	2.51	5.2	0.6	7.4	0.60	10.0	4.4	8.3	14.8	66.7	9.3	2503	10.0	84
GHQ35	8/17/01	2.51	5.2	0.7	6.8	0.28	10.0	4.9	8.1	16.3	65.7	9.1	2720	10.0	82
GHQ36	8/21/01	2.55	6.0	0.5	8.0	0.21	10.0	4.6	8.2	15.5	66.5	9.3	1934	10.0	85
GHQ37	8/23/01	2.51	5.2	0.7	6.8	0.18	10.0	4.6	8.2	14.8	65.4	9.1	2211	10.0	82
GHQ38	8/27/01	2.52	5.4	0.7	6.8	0.11	10.0	5.4	7.8	18.7	67.0	9.4	1929	10.0	82
GHQ39	8/29/01	2.55	6.0	0.7	6.8	0.14	10.0	4.4	8.3	16.5	67.4	9.5	2313	10.0	85
GHQ40	8/31/01	2.52	5.4	0.6	7.4	0.19	10.0	4.9	8.1	16.8	67.3	9.5	2340	10.0	84
GHQ41	9/5/01	2.49	4.8	1.3	4.4	0.39	10.0	5.1	7.9	20.4	66.2	9.2	2193	10.0	78
GHQ42	9/10/01	2.51	5.2	0.9	5.6	0.45	10.0	4.8	8.1	17.7	65.5	9.1	2067	10.0	80
GHQ43	9/12/01	2.48	4.6	1.2	4.6	0.34	10.0	5.6	7.7	21.0	67.8	9.6	2314	10.0	78
GHQ44	9/14/01	2.50	5.0	0.9	5.6	0.34	10.0	4.8	8.1	16.3	66.7	9.3	2210	10.0	81
GHQ45	9/17/01	2.49	4.8	1.1	4.8	0.39	10.0	5.0	8.0	18.3	66.8	9.4	2878	10.0	79
GHQ46	10/3/01	2.54	5.8	0.5	8.0	0.15	10.0	4.7	8.2	15.0	69.4	9.9	2299	10.0	87
GHQ47	10/10/01	2.49	4.8	1.2	4.6	0.20	10.0	4.5	8.3	19.4	69.1	9.8	2515	10.0	81
GHQ48	10/16/01	2.50	5.0	1.1	4.8	0.25	10.0	5.3	7.8	16.2	67.7	9.5	2051	10.0	80
GHQ49	10/19/01	2.50	5.0	1.0	5.0	0.35	10.0	3.7	8.7	13.0	68.2	9.6	2665	10.0	82
GHQ50	10/24/01	2.53	5.6	0.7	6.8	0.24	10.0	4.8	8.1	14.7	67.4	9.5	2464	10.0	84
GHQ51	10/29/01	2.50	5.0	0.9	5.6	0.33	10.0	5.0	8.0	17.9	67.7	9.5	2423	10.0	81
GHQ52	11/1/01	2.53	5.6	0.8	6.2	0.23	10.0	5.6	7.7	20.5	69.9	10.0	2371	10.0	83
GHQ53	11/7/01	2.52	5.4	0.8	6.2	0.13	10.0	3.6	8.7	14.2	68.5	9.7	2416	10.0	84
GHQ54	11/12/01	2.46	4.2	1.6	3.8	0.02	10.0	6.1	7.4	18.4	68.1	9.6	2484	10.0	76
GHQ55	11/15/01	2.54	5.8	0.6	7.4	0.22	10.0	5.1	7.9	16.9	68.1	9.6	2447	10.0	85
GHQ56	4/30/02	2.51	5.2	1.1	4.8	0.02	10.0	3.9	8.6	15.2	68.4	9.7	2894	10.0	82
GHQ57	5/7/02	2.54	5.8	0.5	8.0	0.06	10.0	3.5	8.8	15.0	66.0	9.2	2558	10.0	86
GHQ58	5/10/02	2.53	5.6	0.7	6.8	0.07	10.0	3.9	8.6	21.0	65.4	9.1	2236	10.0	83
GHQ59	5/14/02	2.52	5.4	0.7	6.8	0.01	10.0	6.3	7.2	21.6	66.4	9.3	2391	10.0	81
GHQ60	5/17/02	2.52	5.4	0.8	6.2	0.09	10.0	3.0	9.0	14.2	66.2	9.2	2127	10.0	83
GHQ61	5/21/02	2.51	5.2	0.9	5.6	0.12	10.0	4.2	8.4	15.9	66.6	9.3	2113	10.0	81
GHQ62	5/30/02	2.52	5.4	0.7	6.8	0.03	10.0	4.2	8.4	13.7	66.8	9.4	2530	10.0	83
GHQ63	6/4/02	2.52	5.4	0.8	6.2	0.12	10.0	4.1	8.5	16.5	67.6	9.5	2275	10.0	83
GHQ64	6/10/02	2.54	5.8	0.6	7.4	0.00	10.0	5.4	7.8	17.7	69.7	9.9	2397	10.0	85
GHQ65	6/13/02	2.51	5.2	0.9	5.6	0.02	10.0	3.6	8.7	16.2	67.5	9.5	2115	10.0	83
GHQ66	6/18/02	2.49	4.8	1.1	4.8	0.08	10.0	4.8	8.1	22.0	70.5	10.0	2715	10.0	81
GHQ67	6/21/02	2.53	5.6	0.7	6.8	5.19	7.9	4.7	8.2	15.5	66.5	9.3	2561	10.0	81
GHQ68	6/25/02	2.55	6.0	0.4	8.5	0.01	10.0	4.4	8.3	17.5	68.1	9.6	2755	10.0	87
GHQ69	6/27/02	2.55	6.0	0.4	8.5	0.00	10.0	4.1	8.5	16.6	67.2	9.4	2241	10.0	87
GHQ70	7/1/02	2.50	5.0	0.6	7.4	0.02	10.0	3.4	8.8	13.7	65.2	9.0	2163	10.0	83
GHQ71	7/10/02	2.56	6.2	0.6	7.4	0.03	10.0	3.6	8.7	12.6	66.2	9.2	2687	10.0	86

Table 5.5 Rattlesnake Quarry Rock Durability Test Results and Scores

Sample ID	Sample Date	Specific Gravity	SG Score WF=6	Absorption (%)	Abs% Score WF=5	Sodium Sulfate Soundness (% loss)	SSS Score WF=3	LA Abrasion Loss @ 100 rev	LA Ab Score WF=8	LA Abrasion Loss @ 500 rev	Schmidt Hammer	SH Score WF=13	Tensile Strength (average psi)	TS Score WF=4	Rock Quality Score	
GHQ72	7/17/02	2.54	5.8	0.2	9.5	0.04	10.0	3.9	8.6	14.0	66.2	9.2	2848	10.0	87	
GHQ73	7/23/02	2.53	5.6	0.7	6.8	0.05	10.0	3.6	8.7	7.8	66.9	9.4	2489	10.0	84	
GHQ74	7/25/02	2.53	5.6	0.8	6.2	0.02	10.0	4.9	8.1	18.2	65.9	9.2	2789	10.0	82	
GHQ75	7/30/02	2.54	5.8	0.7	6.8	0.01	10.0	4.8	8.1	18.0	67.5	9.5	2585	10.0	84	
GHQ76	8/6/02	2.54	5.8	0.6	7.4	0.01	10.0	3.8	8.6	14.8	65.8	9.2	2607	10.0	85	
GHQ77	8/9/02	2.53	5.6	0.6	7.4	0.08	10.0	6.9	6.9	23.8	66.1	9.2	2371	10.0	81	
GHQ78	8/13/02	2.51	5.2	0.9	5.6	0.14	10.0	6.3	7.2	17.5	66.4	9.3	2254	10.0	79	
GHQ79	8/19/02	2.55	6.0	0.7	6.8	0.08	10.0	5.3	7.8	20.8	68.1	9.6	2435	10.0	84	
GHQ80	8/22/02	2.51	5.2	1.0	5.0	3.68	8.7	6.7	7.0	22.9	67.3	9.5	2425	10.0	77	
GHQ81	8/26/02	2.52	5.4	0.8	6.2	0.26	10.0	5.1	7.9	16.8	68.8	9.8	2284	10.0	83	
GHQ82	9/3/02	2.55	6.0	0.5	8.0	0.03	10.0	4.4	8.3	17.1	70.3	10.0	2849	10.0	88	
GHQ83	9/6/02	2.54	5.8	0.4	8.5	0.04	10.0	3.5	8.8	12.9	69.7	9.9	2697	10.0	89	
GHQ84	9/9/02	2.53	5.6	0.9	5.6	1.90	9.6	4.5	8.3	17.1	68.4	9.7	2472	10.0	83	
GHQ85	9/12/02	2.54	5.8	1.0	5.0	0.76	10.0	3.7	8.7	15.5	69.9	10.0	2539	10.0	84	
GHQ86	9/16/02	2.59	6.8	1.1	4.8	1.12	9.9	4.3	8.4	13.6	69.1	9.8	2333	10.0	84	
GHQ87	9/23/02	2.51	5.2	1.0	5.0	0.90	10.0	6.2	7.3	23.1	69.4	9.9	1939	10.0	80	
GHQ88	9/26/02	2.50	5.0	1.3	4.4	0.50	10.0	4.5	8.3	18.3	68.2	9.6	2048	10.0	80	
GHQ89	9/30/02	2.52	5.4	0.8	6.2	0.02	10.0	5.5	7.7	20.9	69.4	9.9	1962	10.0	83	
GHQ90	6/27/03	2.50	5.0	0.9	5.5	0.12	10.0	4.8	8.1	18.7	68.0	9.6		10.0	81	**
GHQ91	7/10/03	2.52	5.4	1.1	4.7	1.03	10.0	3.2	8.9	12.9	62.9	9.6	Not Available See NOTE	10.0	82	**
GHQ92	7/18/03	2.55	6.0	0.6	7.1	0.24	10.0	3.7	8.6	13.9	67.2	9.4		10.0	85	**
GHQ93	7/23/03	2.54	5.7	0.8	6.3	0.07	10.0	1.4	9.8	13.9	67.8	9.6		10.0	87	**
GHQ94	7/28/03	2.54	5.8	0.7	7.0	0.66	10.0	No Data	6.9	--	67.8	9.6		10.0	82	**
GHQ95	8/1/03	2.54	5.8	0.8	6.3	0.17	10.0	See NOTE	6.9	--	67.5	9.5		10.0	81	**

NOTE**

In 2003, although LA Abrasion and tensile strength tests were performed, the results were misplaced by the laboratory (two results for LA abrasion and all for tensile strength). Therefore, surrogate scores were derived using the following conservative assumptions: —>

Using these conservative assumptions, the rock quality scores for 2003 all satisfy the 80 criterion. *See summary statistics on the following page.*

8.1 surrogate LA abrasion score, equivalent to the average of all scores and the minimum score yielded in 2003. This assumption is conservative

10.0 surrogate tensile strength score (all were 10.0 historically)

Table 5.5 Rattlesnake Quarry Rock Durability Test Results and Scores

Sample ID	Sample Date	Specific Gravity	SG Score WF=6	Absorption (%)	Abs% Score WF=5	Sodium Sulfate Soundness (% loss)	SSS Score WF=3	LA Abrasion Loss @ 100 rev	LA Ab Score WF=8	Schmidt Hammer	SH Score WF=13	Tensile Strength (average psi)	TS Score WF=4	Rock Quality Score

Sumary Statistics: ALL RESULTS: Scores for individual endpoints are listed in shaded columns; this summary includes the 2003 surrogate scores (see page 3).

count (n):	95		95		95		93		95		89		95
average:	2.52	5.3	0.8	6.4	0.35	10.0	4.7	8.1	67.3	9.5	2373	10.0	**82.5**
min:	2.44	3.8	0.2	3.8	0.00	7.9	1.4	5.4	62.9	9.0	1866	10.0	73.8
max:	2.59	6.8	1.6	9.5	5.19	10.0	9.4	9.8	70.5	10.0	2894	10.0	88.9
standard deviation:	0.03	0.5	0.3	1.2	0.71	0.3	1.3	0.7	1.4	0.3	245	0.0	3.0

average total score, excluding 2003 surrogates (n = 89): 82.4

Summary:
In accordance with the above guidance, after applying the weighting factor to each individual score, the final score was calculated as the percentage of the maximum possible score (390) for all durability tests that were performed. As such, the final score = (∑ (Individual scores * weighting factor)/390)*100.

Of the 95 scores listed above, the majority (84%) are greater than or equal to 80.0, the score considered by the NRC to represent rock of "Good" quality, requiring no oversizing. Fifteen scores are less than 80.0 (considered "Good" by the NRC, but all scores are above 70 (upper bound of "Fair"/intermediate in NUREG-1623 Table D-1. These lower scores were generally yielded early in the rock processing phase (most in 2000), due primarily to specifiy gravity and/or absorption, but in some cases influenced by slightly lower LA Abrasion loss scores (given its higher weighting factor). Although this rock is still considered to be of high quality, to mitigate any potential concern about rock quality, oversizing was done in accordance with guidance provided in NUREG-1623.

Regarding the summary statistics shown above, excluding the 2003 surrogate scores (derived on page 3) decreased the total average score by only one tenth of a percentage point, indicating that this approach did not result in a biased average score.

Table 5.6 Erosion Protection Gradation Requirements for Gas Hills Site Reclamation

Rock Type	Sieve Size	Percent Passing: Final Specifications[4]	Comment
Type A D_{50} = 0.5"	3 inch	100	Type A rock specifications were modified in 2000 and approved in 2001(License Amendment 44), increasing the maximum rock size from 1½ inches to 3 inches
	1-½ inch	60-100	
	1 inch	40-100	
	¾ inch	20-100	
	½ inch	5-50	
	3/8 inch	0-25	
	#4	0-5	
Type B D_{50} = 3"	6 inch	100	Type B rock specifications were modified in 2001 (increasing the maximum rock size from 5 to 6 inches); this modification was approved by the NRC
	5 inch	50-100	
	4 inch	30-100	
	3 inch	0-50	
	2 inch	0-15	
Type C D_{50} = 6"	10 inch	100	
	9 inch	50-100	
	8 inch	20-100	
	6 inch	0-50	
	4 inch	0-15	
Type D D_{50} = 16"	30 inch	100	
	24 inch	50-100	
	18 inch	20-100	
	12 inch	0-30	
	8 inch	0-10	
Type E $D_{50\ MIN}$ = 30"	60 inch	100	Type E rock used only for East Canyon Creek realignment; see Figure 5.1.
	48 inch	60-100	
	42 inch	40-100	
	30 inch	0-50	
	24 inch	0-30	

Source: *Proposal for Erosion Protection Modification for the Above-Grade Tailings Impoundment and Heap Leach* dated December 18, 2000.

[4] Although initial erosion protection specifications differed slightly for the various repository areas, by 2000 they were all consistent as indicated above. Some of these requirements—highlighted above—were modified in September 2000 to optimize processing and were approved by the NRC in April 2001 as part of License Amendment 44.

Table 5.7 Erosion Protection Gradation Results: Type A Rock, Rattlesnake Quarry Production Samples

Preface: As shown below, most gradation tests performed in the early phases of rock processing did not meet the initially specified maximum 1.5-inch size requirement. After initial experimentation in September 2000 (see below), Umetco determined that a more feasible gradation could be produced and therefore proposed to modify the previously-approved gradation for Type A rock by increasing the maximum size rock from 1½ inches to 3 inches. This proposal was submitted formally as a License Amendment (LA) request on December 20, 2000, which was approved by the NRC on April 5, 2001 (LA No. 44). As indicated below, there were cases when the gradation requirements were not met (even after the revised specifications were implemented)—however, in most instances the rock was just slightly oversized but still considered acceptable, in particular if subsequent gradation tests met requirements.

Test results not meeting gradation requirements are highlighted as follows:

51.8 Bold (no italic) denotes test result below lower bound gradation specification (out on course side).

23.9 *Bold italic denotes test result above upper bound gradation specification (out on fine side).*

Sample Date	Gradation Sample Location	Percent Passing Sieve Size									Comments
		3 "	2.5 "	2 "	1 1/2 "	1 "	3/4 "	1/2 "	3/8 "	#4	
		100			60 - 100	40 - 100	20 - 100	5 - 50	0 - 25	0 - 5	Revised in Sep-00; see preface note.
					100	*50 - 100*	*20 - 100*	*5 - 50*	*0 - 25*	*0 - 5*	Initial Requirements, September 2000 only
9/1/00	Quarry			100.0	**95.2**	59.1	40.2	19.0	6.9	1.8	This material–represented by the first five samples–was used on the haul roads and not used for riprap (tests not included in frequency).
9/5/00	Quarry			100.0	**90.4**	70.3	55.4	34.4	19.8	3.0	
9/6/00	Quarry				100.0	66.4	41.7	20.9	9.9	2.6	
9/7/00	Quarry				100.0	80.6	59.4	33.9	16.8	5.1	
9/12/00	Quarry				100.0	66.9	44.9	22.7	10.3	2.4	
9/13/00	Quarry			100.0	99.5	80.1	59.1	33.2	15.5	5.2	
9/14/00	Quarry				100.0	79.7	59.9	34.8	16.8	***5.6***	
9/15/00	Quarry			100.0	**88.1**	64.7	49.5	26.3	12.2	2.3	Experimental includes 2"
9/18/00	Quarry			100.0	**84.2**	52.0	38.4	19.4	8.1	1.7	" "
9/18/00	Quarry			100.0	**92.8**	64.0	44.9	23.5	11.0	2.1	
9/19/00	Quarry			100.0	**88.3**	61.2	42.8	24.0	12.0	2.7	Experimental includes 2"
9/19/00	Quarry				100.0	67.5	46.7	20.0	7.2	1.3	Experimental excludes 2"
9/20/00	Quarry			100.0	**72.5**	**33.6**	20.3	9.8	5.6	3.1	Experimental includes 2"
9/20/00	Quarry	100.0		89.4	**61.6**	**32.3**	**19.3**	8.2	3.4	1.4	" "
9/27/00	Quarry	100.0		91.1	**69.3**	**42.6**	27.9	15.2	7.7	3.4	
9/28/00	Quarry		100.0	91.4	**73.9**	53.5	40.4	20.3	9.2	2.5	
Revised Gradation Requirements Implemented:		100			60 - 100	40 - 100	20 - 100	5 - 50	0 - 25	0 - 5	Modified to optimize processing.
10/5/00	Quarry		100.0	97.9	81.0	56.7	40.3	19.7	8.7	1.5	
10/6/00	Quarry		100.0	97.2	90.5	62.8	44.9	22.5	9.1	1.4	
10/10/00	Quarry	100.0	97.4	89.7	63.7	40.8	26.2	11.7	4.6	0.9	
10/11/00	Quarry		100.0	88.7	62.4	**38.9**	24.6	10.9	4.1	1.0	
10/12/00	Quarry		100.0	91.6	63.9	**33.5**	20.3	7.8	2.8	0.8	
10/13/00	Quarry		100.0	93.3	73.3	47.8	32.1	13.9	4.7	0.7	
10/16/00	Quarry		100.0	91.3	72.9	47.4	33.8	17.5	7.0	1.9	
10/17/00	Quarry		100.0	94.8	74.9	50.0	34.3	16.2	5.8	1.0	
10/18/00	Quarry		100.0	77.2	**47.5**	**21.6**	**10.9**	**3.5**	1.2	0.5	
10/19/00	Quarry		100.0	94.5	73.6	48.0	33.9	16.0	6.1	1.3	

Table 5.7 Erosion Protection Gradation Results: Type A Rock, Rattlesnake Quarry Production Samples

Sample Date	Gradation Sample Location	Percent Passing Sieve Size									Comments
		3 "	2.5 "	2 "	1 1/2 "	1 "	3/4 "	1/2 "	3/8 "	#4	
		100			60 - 100	40 - 100	20 - 100	5 - 50	0 - 25	0 - 5	Revised in Sep-00; see preface note.
10/23/00	Quarry	100.0	98.4	86.7	62.4	40.7	28.1	14.6	7.6	2.0	
10/24/00	Quarry	100.0	99.5	92.1	73.0	54.4	39.0	19.8	8.8	1.8	
10/26/00	Quarry		100.0	88.5	60.4	37.9	25.9	12.6	5.6	1.3	
10/30/00	Quarry		100.0	88.0	65.1	40.0	25.5	11.5	4.6	0.7	
10/31/00	Quarry		100.0	96.8	87.8	55.2	35.3	16.4	6.5	0.8	
4/25/01	Quarry	100.0			77.8	53.4	39.0	21.6	10.8	2.8	
5/7/01	Quarry		100.0	82.3	56.6	31.0	17.3	4.0	2.0	1.4	Gradation out on the course side, but rock accepted; see subsequent results.
5/10/01	Quarry	100.0			71.5	42.4	27.9	11.7	5.0	1.6	
5/14/01	Quarry	100.0			59.6	33.2	17.7	10.1	5.8	2.9	Gradation out on course side (3/4" and 1")
5/23/01	Quarry		100.0	95.9	77.6	42.9	27.6	12.4	5.9	2.4	
5/30/01	Quarry	100.0		84.7	58.7	34.4	21.7	9.5	4.8	2.1	
6/6/01	Quarry		100.0	86.5	60.8	37.2	24.3	10.8	5.4	2.0	
6/12/01	Quarry		100.0	85.0	53.0	27.0	16.1	6.2	2.6	0.5	Gradation out on the course side, but rock accepted; see 6/18/01 test.
6/18/01	Quarry		100.0	90.3	70.0	48.9	35.5	17.2	8.1	2.7	
6/25/01	Quarry		100.0	87.3	65.3	39.8	26.3	10.2	5.1	1.7	
7/2/01	Quarry		100.0	85.6	62.6	40.8	29.9	19.5	7.5	1.7	
7/11/01	Quarry	100.0			67.7	41.5	24.4	7.3	2.4	0.6	
7/17/01	Quarry		100.0	66.1	39.3	17.0	4.8	3.6	1.8	0.9	This test result was anomalous because the rock did not appear as course as the gradation indicated. Nonetheless, the QC officer did request that adjustments be made at the quarry.
7/25/01	Quarry		100.0	87.4	58.5	30.8	17.0	5.7	2.5	1.3	Results still out on course side
7/31/01	Quarry		100.0	86.1	54.5	28.3	17.1	6.7	2.3	0.3	adjustments made at quarry.
8/2/01	Quarry	100.0			77.9	53.3	39.3	18.9	7.4	0.8	
8/3/01	Quarry		100.0	93.2	75.9	52.6	36.8	16.5	6.8	0.8	
8/8/01	Quarry	100.0			62.2	31.5	18.7	8.3	3.7	1.0	
8/15/01	Quarry	100.0			97.2	79.2	54.0	39.7	10.6	2.3	
8/21/01	Quarry	100.0			66.4	37.2	24.0	10.9	5.1	1.4	
8/28/01	Quarry		100.0	97.8	79.3	63.4	37.5	17.8	6.8	0.7	
9/5/01	Quarry	100.0			75.0	40.5	25.5	5.9	3.2	0.8	
9/12/01	Quarry		100.0	98.2	79.9	54.3	38.4	19.5	7.9	1.8	
10/3/01	Quarry	100.0			76.6	50.3	36.0	16.2	5.6	0.5	
10/16/01	Quarry	100.0			87.9	60.6	39.8	20.0	9.6	1.7	
10/24/01	Quarry	100.0			83.6	52.2	35.3	16.4	6.5	0.5	
10/29/01	Quarry	100.0			80.2	47.7	30.4	14.1	6.2	1.4	
11/7/01	Quarry	100.0			80.0	47.7	31.8	14.2	5.2	0.6	

Table 5.7 Erosion Protection Gradation Results: Type A Rock, Rattlesnake Quarry Production Samples

Sample Date	Gradation Sample Location	Percent Passing Sieve Size									Comments
		3 "	2.5 "	2 "	1 1/2 "	1 "	3/4 "	1/2 "	3/8 "	#4	
		100			60 - 100	40 - 100	20 - 100	5 - 50	0 - 25	0 - 5	Revised in Sep-00; see preface note.
11/12/01	Quarry	100.0			79.5	48.6	32.9	15.8	6.8	0.9	
5/3/02	Quarry	100.0			80.3	52.5	33.5	17.4	9.1	1.5	
5/13/02	Quarry	100.0			81.8	54.5	38.8	21.2	10.4	2.3	
5/23/02	Quarry	100.0			82.0	44.3	28.7	13.9	6.6	1.6	
5/29/02	Quarry	100.0			84.2	55.0	38.3	19.1	9.1	3.3	
6/4/02	Quarry	100.0			90.1	56.6	39.5	19.7	9.9	2.6	
6/11/02	Quarry	100.0			62.8	**20.6**	**10.8**	4.9	3.4	2.0	Out of gradation; see 6/12/02 test result.
6/12/02	Quarry	100.0			85.6	59.7	43.1	21.0	9.4	1.1	Verification of 6/11/02 gradation
6/18/02	Quarry	100.0			84.8	54.1	37.8	19.5	9.5	3.3	
6/25/02	Quarry	100.0			89.3	60.7	43.8	19.7	7.9	1.1	
7/10/02	Quarry	100.0			85.1	55.9	37.0	14.5	5.4	0.9	
7/17/02	Quarry	100.0			89.3	62.5	44.4	20.7	8.0	1.3	
7/23/02	Quarry	100.0			67.9	42.5	28.8	12.4	4.4	0.6	
7/30/02	Quarry	100.0			68.7	43.4	29.0	12.5	4.7	1.0	
8/6/02	Quarry	100.0			63.2	**37.0**	24.4	10.4	4.2	1.0	
8/13/02	Quarry	100.0			72.3	47.7	32.8	16.1	7.3	2.2	
8/19/02	Quarry	100.0			60.5	**35.6**	23.4	11.1	4.7	1.2	Out of gradation; see 8/20/02 test result.
8/20/02	Quarry	100.0			71.3	48.8	34.6	17.0	7.9	2.0	Verification of 8/19/02 gradation
8/26/02	Quarry	100.0			74.7	50.4	35.0	16.5	6.1	0.5	
9/3/02	Quarry	100.0			**58.6**	**31.4**	**18.8**	7.9	3.7	1.0	
9/9/02	Quarry	100.0			64.1	**38.1**	25.3	11.2	4.8	1.0	
9/16/02	Quarry	100.0			75.5	52.6	38.3	19.9	9.8	3.0	
9/23/02	Quarry	100.0			76.6	54.7	38.7	19.4	9.0	2.6	
6/27/03	Quarry	100.0			78.6	57.2	42.5	21.9	9.6	3.4	
7/16/03	Quarry	100.0			62.3	**37.7**	25.5	12.7	7.1	4.7	
7/31/03	Quarry	100.0			75.4	50.2	34.5	14.8	4.3	0.9	Last quarry production sample.

Total Number of Quarry (Production) Gradation Tests: 78
Total Number of In-Place Tests: 35 (see Table 5.8)
Total Quantity of Type A Rock Placed: 104,695 CY
Type A Gradation Testing Frequency: 1: 927 CY *(includes In-Place tests as well)*

Table 5.8 Erosion Protection Gradation Results: Type A Rock, In-Place Gradation Samples

Test results not meeting gradation requirements are highlighted as follows:

51.8 Bold (no italic) denotes test result below lower bound gradation specification (out on course side).

See text and notes at the end of this table.

23.9 *Bold italic denotes test result above upper bound gradation specification (out on fine side).*

Sample Date	Gradation Sample Location	Depth Check ID	Percent Passing Sieve Size									Comments
			3 "	2.5 "	2 "	1 1/2 "	1 "	3/4 "	1/2 "	3/8 "	#4	
	Final Gradation Requirements:		100			60 - 100	40 - 100	20 - 100	5 - 50	0 - 25	0 - 5	Revised in Sep-00; see preface note.
9/13/00	Test Pad #1, Heap Leach					100.0	90.0	76.3	***56.5***	***41.6***	***23.9***	Test pad rejected and material removed
10/2/00	Heap Leach - 10:1 slope			100.0	91.3	**51.8**	**17.7**	**6.8**	**0.8**	0.2	0.1	Out of gradation; see 10/3/00 test result.
10/3/00	Heap Leach - 10:1 slope			100.0	97.0	85.7	60.2	43.7	24.3	14.1	5.2	Retest of area that was out on 10/2/00.
10/11/00	Heap Leach - 10:1 slope	A-1		100.0	98.6	87.4	64.8	47.2	23.6	14.0	***7.0***	
10/13/00	Heap Leach - 10:1 slope	A-2		100.0	95.3	86.0	51.8	29.5	11.5	5.8	2.6	
10/14/00	Heap Leach - 10:1 slope			100.0	96.1	82.5	55.8	41.0	23.2	14.5	***7.5***	
10/18/00	Heap Leach - 10:1 slope	A-3	100.0	98.6	90.6	75.0	49.1	35.1	18.8	10.0	3.7	
10/19/00	Heap Leach, reference pad			100.0	92.5	75.1	53.8	37.5	18.6	8.6	3.6	
10/31/00	Heap Leach - 5:1 slope	A-4	100.0		93.3	69.5	41.1	27.1	13.8	6.2	1.6	
4/25/01	Heap Leach - 5:1 slope			100.0	95.2	74.7	48.5	33.9	15.9	5.7	1.1	Verification of 10/31/00 A-4 gradation
8/7/01	Heap Leach - 6:1 Slope	A-6	100.0			68.3	40.3	24.0	7.7	3.4	1.2	
9/14/01	Heap Gap - 5:1 Slope	A-11		100.0	92.8	72.0	41.6	25.6	9.6	4.0	1.6	
9/14/01	Heap Gap - 1% Slope (Top)	A-12	100.0			68.5	43.4	24.5	6.3	5.6	0.7	
9/14/01	Heap Gap - 1% Slope (Top)	A-13	100.0			69.8	40.3	21.7	7.0	3.1	1.6	
9/17/01	Heap Leach - Top, w/ fines	A-14	100.0			78.4	57.8	43.9	25.5	15.8	***7.4***	See Note.
9/17/01	Heap Leach - Top, w/o fines		100.0			76.7	54.4	39.4	19.5	9.0	-	See Note; test excluded from frequency.
10/1/01	Heap Leach - Top	A-15	100.0			68.8	41.1	24.9	10.9	5.4	2.7	
10/2/01	Heap Leach - Top	A-16	100.0			67.7	40.9	25.0	9.4	4.8	2.3	
10/2/01	Heap Leach - Top	A-17	100.0			62.5	42.1	22.0	5.6	2.1	0.8	
10/4/01	Heap Leach - Top, w/ fines	A-18	100.0			78.6	63.3	52.6	36.2	***27.4***	***18.0***	See Note.
10/4/01	Heap Leach - Top, w/o fines		100.0			74.0	55.3	42.2	22.2	11.4	-	See Note; test excluded from frequency.
10/16/01	Heap Gap - 10:1 Slope	A-36		100.0	98.5	84.2	56.6	39.4	20.7	10.3	1.7	
10/26/01	Heap Gap - 1% Slope (Top)	A-50	100.0			76.5	40.4	23.6	10.9	1.3	0.1	
8/14/02	A-9 - W. Channel	A-59	100.0			76.2	59.5	48.3	30.4	17.3	5.0	
9/5/02	Above-Grade	A-60	100.0			72.2	45.9	30.7	18.2	6.9	1.5	
9/6/02	Above-Grade	A-61	100.0			83.6	59.3	41.1	21.4	10.4	3.1	
9/6/02	Above-Grade	A-62	100.0			68.6	50.6	39.4	25.4	12.2	2.5	
6/22/04	A-9 W. Channel, w/ fines	A-67	100.0			84.9	70.6	58.9	37.5	23.0	***8.0***	See Note.
6/22/04	A-9 W. Channel, w/o fines		100.0			83.6	68.0	55.4	32.1	16.3	-	See Note; test excluded from frequency.
6/22/04	A-9 E. Channel, w/ fines	A-70	100.0			79.0	51.9	34.6	17.3	10.2	4.7	See Note.
6/22/04	A-9 E. Channel, w/o fines		100.0			77.9	49.5	31.3	13.2	5.7	-	
7/9/04	A-9 E. Channel, w/ fines	A-79	100.0			89.9	65.3	49.1	28.2	16.8	***7.5***	See Note.
7/9/04	A-9 E. Channel, w/o fines		100.0			89.1	62.5	45.0	22.3	10.1	-	
8/9/06	A-9 W. diversion channel	A-92	100.0			75.0	**39.0**	22.0	9.0	5.0	2.0	
5/26/06	GHP-2 A-1, w/ fines		100.0			78.0	57.0	42.0	23.0	14.0	***7.0***	See Note.

Table 5.8 Erosion Protection Gradation Results: Type A Rock, In-Place Gradation Samples

Sample Date	Gradation Sample Location	Depth Check ID	Percent Passing Sieve Size									Comments
			3 "	2.5 "	2 "	1 1/2 "	1 "	3/4 "	1/2 "	3/8 "	#4	
	Final Gradation Requirements:		100			60 - 100	40 - 100	20 - 100	5 - 50	0 - 25	0 - 5	Revised in Sep-00; see preface note.
5/26/06	GHP-2 A-1, w/o fines		100.0			76.0	53.0	38.0	18.0	8.0	-	
6/9/06	GHP-2 A-2, w/ fines		100.0			80.0	51.0	37.0	22.0	14.0	***7.0***	See Note.
6/9/06	GHP-2 A-2, w/o fines		100.0			79.0	48.0	32.0	16.0	8.0	-	
6/28/06	GHP-2 A-3, w/ fines		100.0			88.0	69.0	57.0	38.0	25.0	***10.0***	See Note.
6/28/06	GHP-2 A-3, w/o fines		100.0			87.0	66.0	52.0	31.0	16.0	-	
6/28/06	GHP-2 A-4, w/ fines	GHP-2-A-6	100.0			82.0	60.0	48.0	33.0	23.0	***11.5***	See Note.
6/28/06	GHP-2 A-4, w/o fines		100.0			80.0	55.0	42.0	25.0	13.0	-	
7/7/06	GHP-2 A-5	GHP-2-A-10	100.0			84.1	59.7	42.3	21.3	11.8	4.8	
7/8/06	GHP-2 A-6, w/ fines	GHP-2-A-14	100.0			82.0	55.0	38.0	18.0	11.0	***6.0***	See Note.
7/8/06	GHP-2 A-6, w/o fines		100.0			81.0	53.0	34.0	14.0	6.0	-	
7/20/06	GHP-2 A-7, w/ fines	GHP-2-A-24	100.0			83.0	60.7	48.5	33.3	24.9	***16.5***	See Note.
7/20/06	GHP-2 A-7, w/o fines		100.0			80.1	52.9	28.3	20.1	10.1	-	

Note:
While placing Type A rock on the Heap Leach, the A-9 Repository, and GHP-2, some isolated areas exhibited a greater percentage of visually apparent quarry fines than what was typical for this rock. As a conservative measure, Umetco deliberately sampled in these areas to ensure the appropriateness of the rock. In these cases, gradations were calculated for two endpoints, with and without fines (counted as one test). The gradation results with fines corroborated the visual observation—i.e., results were out on the fine side for the #4 sieve. But the corresponding calculation without fines met the gradation requirements in all cases, indicating no adverse effect on the integrity of the riprap cover. Again, note that locations selected for in-place gradation tests were essentially worst-case locations—i.e., those appearing to exhibit the greatest percentage of fines.

	Total	Heap	AGTI	A-9	GHP-2
Total In-Place Tests:	35	20	3	5	7
Quantities of Type A Rock Placed (cubic yards):	104,695	46,613	16,826	11,306	29,950
In-Place Gradation Testing Frequency*:	1: 2991	1: 2331	1: 5609	1: 2261	1: 4279

** Frequencies exclude samples that failed gradation (i.e., 9/13/00 and 10/2/00) and also the samples without fines*

Table 5.9 Erosion Protection Gradation Results: Type B Rock, Rattlesnake Quarry Production Samples

Tests not meeting gradation requirements are highlighted as follows: **51.8** Bold (no italic) denotes test result below lower bound gradation specification.

23.9 *Bold italic denotes test result above upper bound gradation specification.*

Sample Date	Gradation Sample Location	Percent Passing Sieve Size					Comments
		6 "	5 "	4 "	3 "	2 "	
Initial Gradation Requirements (9/1/00 - 8/21/01):			100	30 - 100	0 - 50	0 - 15	
	Final Gradation Requirements:	100	50 - 100	30 - 100	0 - 50	0 - 15	Changed in late August 2001 to optimize processing.
9/1/00	Quarry	100.0	**99.6**	87.6	***56.5***	***23.5***	These early tests (9/1/00 - 9/20/00) are shown to demonstrate the testing done during the very early stages of Type B rock processing. This initial rock was not placed and therefore these tests are not included in frequencies.
9/5/00	Quarry		100.0	78.8	49.6	***21.6***	
9/7/00	Quarry		100.0	86.4	***69.3***	***35.5***	
9/12/00	Quarry		100.0	88.7	***63.5***	***29.0***	
9/13/00	Quarry		100.0	92.8	***74.2***	***43.8***	
9/14/00	Quarry		100.0	91.0	***65.3***	***34.0***	
9/15/00	Quarry		100.0	93.9	***70.4***	***28.6***	Experimental, 2" removed
9/18/00	Quarry		100.0	89.2	***65.2***	***20.9***	" "
9/19/00	Quarry		100.0	85.7	***54.6***	***17.2***	" "
9/19/00	Quarry		100.0	88.2	***65.3***	***35.3***	Experimental, 2" included
9/20/00	Quarry		100.0	91.6	***59.0***	***15.4***	Experimental, 2" removed
9/20/00	Quarry		100.0	91.3	49.9	5.9	Experimental, 2" removed
9/27/00	Quarry		100.0	77.6	41.2	3.6	
9/28/00	Quarry		100.0	71.4	37.0	3.4	
10/5/00	Quarry	100.0	**98.5**	74.7	46.0	***18.5***	One rock barely oversize; 2" slightly out on fine side.
10/6/00	Quarry		100.0	71.3	39.5	12.2	
10/10/00	Quarry	100.0	**94.2**	62.1	30.9	2.2	
10/11/00	Quarry	100.0	**90.5**	57.5	26.5	1.7	
10/12/00	Quarry	100.0	**95.8**	67.9	34.8	1.5	
10/13/00	Quarry		100.0	79.5	39.1	1.3	
10/16/00	Quarry		100.0	69.3	24.7	1.5	
10/17/00	Quarry	100.0	**99.7**	75.8	34.9	3.1	
10/18/00	Quarry		100.0	78.6	37.1	0.9	
10/19/00	Quarry		100.0	76.5	37.0	1.7	
10/23/00	Quarry		100.0	75.5	30.0	1.6	
10/24/00	Quarry		100.0	77.6	38.6	2.9	
10/26/00	Quarry		100.0	70.7	34.1	2.6	
10/30/00	Quarry		100.0	76.4	36.7	2.0	
10/31/00	Quarry		100.0	82.2	***56.4***	***22.6***	2" and 3" out on fine side, rock accepted.
4/25/01	Quarry		100.0	75.1	40.7	1.7	
5/7/01	Quarry	100.0	**99.0**	71.9	31.5	2.3	One rock oversize, would pass 5 1/2' screen
5/10/01	Quarry	100.0	**98.4**	67.9	32.8	3.0	" "

Rock not placed; samples not used to derive testing frequency.

Table 5.9 Erosion Protection Gradation Results: Type B Rock, Rattlesnake Quarry Production Samples

Sample Date	Gradation Sample Location	Percent Passing Sieve Size					Comments
		6 "	5 "	4 "	3 "	2 "	
Initial Gradation Requirements (9/1/00 - 8/21/01):			100	30 - 100	0 - 50	0 - 15	
	Final Gradation Requirements:	100	50 - 100	30 - 100	0 - 50	0 - 15	Changed in late August 2001 to optimize processing.
5/14/01	Quarry	100.0	**99.3**	70.5	33.1	4.3	" "
5/23/01	Quarry	100.0	**99.3**	70.3	34.0	3.9	" "
5/30/01	Quarry		100.0	69.0	29.1	2.9	
6/6/01	Quarry	100.0	**94.0**	82.7	***50.7***	4.2	One rock oversize, would pass 5 1/2' screen; gradation just slightly out on fine side for 3" sieve
6/12/01	Quarry		100.0	82.1	41.0	3.8	
6/18/01	Quarry		100.0	83.1	***52.8***	6.5	Rock just slightly out on fine side for 3" sieve
6/25/01	Quarry		100.0	79.0	36.9	2.9	
7/2/01	Quarry		100.0	75.7	34.0	4.8	
7/11/01	Quarry		100.0	86.9	44.2	3.7	
7/17/01	Quarry		100.0	72.8	34.0	3.8	
7/25/01	Quarry		100.0	79.3	39.6	3.9	
7/31/01	Quarry		100.0	84.1	49.9	5.0	
8/2/01	Quarry	100.0	**99.1**	70.0	30.6	5.6	One rock oversize, would pass 5 1/2' screen
8/3/01	Quarry		100.0	87.6	48.8	6.1	
8/8/01	Quarry		100.0	68.4	33.7	7.1	
8/14/01	Quarry		100.0	81.4	44.1	3.7	
8/15/01	Quarry	100.0	**98.6**	81.1	48.7	10.8	One rock oversize, would pass 5 1/2' screen
8/21/01	Quarry	100.0	**96.1**	69.0	41.3	13.6	" "
Revised Gradation Requirements Implemented:		100	50 - 100	30 - 100	0 - 50	0 - 15	
8/28/01	Quarry	100.0	89.1	62.3	39.6	7.0	
9/5/01	Quarry	100.0	95.1	75.9	48.8	8.7	
9/12/01	Quarry	100.0	95.3	69.9	36.7	13.5	
10/3/01	Quarry	100.0	90.0	64.9	43.7	9.6	
10/16/01	Quarry	100.0	95.9	64.0	33.8	8.9	
10/24/01	Quarry	100.0	92.7	72.5	44.1	***15.9***	2" just slightly out on fine side.
10/29/01	Quarry	100.0	96.6	70.4	***50.6***	***16.8***	2" and 3" just slightly out on fine side.
11/7/01	Quarry	100.0	96.2	72.5	47.6	12.8	
11/12/01	Quarry	100.0	93.6	55.8	28.7	6.9	
5/3/02	Quarry	100.0	98.3	72.4	38.9	2.5	
5/13/02	Quarry	100.0	98.5	68.3	47.3	3.1	
5/23/02	Quarry	100.0	88.4	66.8	39.0	2.4	
5/29/02	Quarry	100.0	97.0	74.4	44.7	1.7	
6/4/02	Quarry	100.0	86.3	58.8	29.6	1.5	
6/11/02	Quarry	100.0	89.5	60.5	28.8	6.8	

Table 5.9 Erosion Protection Gradation Results: Type B Rock, Rattlesnake Quarry Production Samples

Sample Date	Gradation Sample Location	Percent Passing Sieve Size					Comments
		6 "	5 "	4 "	3 "	2 "	
Initial Gradation Requirements (9/1/00 - 8/21/01):			100	30 - 100	0 - 50	0 - 15	
	Final Gradation Requirements:	100	50 - 100	30 - 100	0 - 50	0 - 15	Changed in late August 2001 to optimize processing.
6/18/02	Quarry	100.0	96.6	67.9	35.6	11.7	
6/25/02	Quarry	100.0	93.5	65.1	40.4	9.4	
7/10/02	Quarry	100.0	100.0	86.2	***59.6***	***18.1***	2" and 3" just slightly out on fine side.
7/17/02	Quarry	100.0	95.8	81.6	***56.8***	***18.3***	2" and 3" just slightly out on fine side.
7/19/02	Quarry	100.0	91.1	66.1	31.8	2.8	
7/23/02	Quarry	100.0	94.9	45.0	17.8	3.0	
7/30/02	Quarry	100.0	92.9	63.1	30.7	3.1	
8/6/02	Quarry	100.0	97.7	73.8	34.7	3.0	
8/13/02	Quarry	100.0	99.3	70.5	32.6	5.2	
8/19/02	Quarry	100.0	95.8	56.7	22.9	3.2	
8/26/02	Quarry	100.0	97.6	66.9	36.5	4.7	
9/3/02	Quarry	100.0	98.8	75.9	43.8	5.0	
9/9/02	Quarry	100.0	93.7	72.3	35.6	3.9	
9/16/02	Quarry	100.0	93.9	74.2	40.6	3.5	
9/24/02	Quarry	100.0	93.2	65.9	33.8	4.5	
6/27/03	Quarry	100.0	100.0	80.5	43.9	3.1	
7/16/03	Quarry	100.0	98.5	72.6	34.9	3.4	
7/31/03	Quarry	100.0	94.5	61.5	30.0	3.4	Last quarry production sample.

Total Number of Quarry (Production) Gradation Tests:	72	
Total Number of In-Place Tests:	22	(see Table 5.10)
Total Quantity of Type B Rock Placed:	125,103	CY
Type B Gradation Testing Frequency:	1: 1331 CY	*(includes In-Place tests as well)*

Table 5.10 Erosion Protection Gradation Results: Type B Rock, In-Place Gradation Samples

Test results not meeting gradation requirements are highlighted as follows:

51.8	Bold (no italic) denotes test result below lower bound gradation specification.
23.9	*Bold italic denotes test result above upper bound gradation specification.*

Sample Date	Gradation Sample Location	Depth Check ID	Percent Passing Sieve Size					Comments
			6 "	5 "	4 "	3 "	2 "	
	Final Gradation Requirements:		100	50 - 100	30 - 100	0 - 50	0 - 15	Changed in late August 2001 to optimize processing.
8/26/02	Above-Grade	B-2	100.0	98.5	77.5	***51.5***	13.1	3" barely out on fine side; see 8-28-02 Retest
8/28/02	Above-Grade, Retest	B-2R	100.0	90.9	59.9	27.0	4.2	Retest of 8/26 Above-Grade sample.
9/3/02	Above-Grade	B-3	100.0	99.4	77.0	41.7	2.5	
9/6/02	Above-Grade	B-4	100.0	98.1	93.5	***80.6***	***36.1***	Out of gradation; see retest below.
9/6/02	Above-Grade, Retest	B-4R	100.0	89.1	47.9	16.9	1.7	Retest of Above-Grade material.
9/9/02	Above-Grade	B-5	100.0	98.7	60.9	20.2	1.6	
9/9/02	Above-Grade	B-6	100.0	95.9	70.1	29.1	1.5	
9/10/02	Above-Grade	B-7	100.0	100.0	84.3	45.7	5.3	
9/10/02	Above-Grade	B-8	100.0	87.6	52.4	21.2	1.9	
9/10/02	Above-Grade	B-9	100.0	95.7	64.7	22.5	1.8	
9/11/02	Above-Grade	B-10	100.0	90.1	51.9	23.0	4.0	
9/11/02	Above-Grade	B-11	100.0	84.3	53.1	30.8	7.6	
9/12/02	Heap Gap- 1% Slope (Top)	B-12	100.0	82.3	52.2	22.9	2.4	
9/16/02	Heap Gap- 1% Slope (Top)	B-13	100.0	89.7	55.5	22.1	1.5	
9/16/02	Heap Gap - 5:1 Slope	B-14	100.0	94.5	66.5	24.6	3.3	
9/16/02	Heap Leach - 5:1 Slope	B-15	100.0	98.1	76.4	32.3	1.2	
9/17/02	Heap Leach - 10:1 Slope	B-16	100.0	100.0	87.6	***63.7***	***24.1***	Out of gradation; see 9/20 retest below.
9/20/02	Heap Leach - 10:1 Slope, Retest	B-16R	100.0	97.6	72.5	47.8	7.4	Retest of B-16 (see above).
7/20/04	A-9 Repository - Top	B-17	100.0	95.4	78.7	48.7	4.7	
7/20/04	A-9 Repository - Top	B-18	100.0	95.8	75.8	38.5	3.6	
7/21/04	A-9 Repository - Top	B-19	100.0	94.5	72.5	43.5	13.1	
7/21/04	A-9 Repository - Top	B-20	100.0	90.5	61.1	30.3	3.1	
7/21/04	A-9 Repository - Top	B-21	100.0	93.9	77.0	47.4	12.2	
8/28/06	GHP-2 B-1	GHP-2-B-3	100.0	98.6	74.8	45.3	8.6	
8/29/06	GHP-2 B-2	GHP-2-B-4	100.0	88.1	64.1	36.0	11.4	

In a few cases above, gradation test results did not appear representative of the actual rock placed. This material was subsequently re-tested to ensure that gradation requirements were met. In these cases, only the retests are included in the total testing frequency.

	Total	Heap	AGTI	A-9	GHP-2
Total In-Place Tests:	22	5	10	5	2
Quantities of Type B Rock Placed (cubic yards):	125,103	24,999	63,302	26,882	9,920
In-Place Gradation Testing Frequency*:	1: 5687	1: 5000	1: 6330	1: 5376	1: 4960

** Frequencies exclude samples that failed gradation (i.e., 9/17/02)*

Table 5.11 Erosion Protection Gradation Results: Type C Rock, Rattlesnake Quarry Production Samples

Test results not meeting gradation requirements are highlighted as follows: **96.9** Bold (no italic) denotes test result below lower bound gradation specification (out on course

65.3 *Bold italic - denotes test result above upper bound gradation specification (out on fine side)*

Sample Date	Gradation Sample Location	Percent Passing Sieve Size						Comments
		12 "	10 "	9 "	8 "	6 "	4 "	
	Final Gradation Requirements:		100	50 - 100	20 - 100	0 - 50	0 - 15	
9/7/00	Quarry			100.0	97.8	***65.3***	10.4	Gradation out on fine side (6" sieve)
9/12/00	Quarry		100.0	92.6	85.6	46.7	0.9	
9/20/07	Quarry			100.0	98.4	***53.5***	5.0	Gradation out on fine side (6" sieve)
9/28/00	Quarry		100.0	99.4	89.7	***51.1***	3.6	Gradation out on fine side (6" sieve)
10/5/00	Quarry		100.0	98.5	87.4	35.7	2.0	
10/11/00	Quarry	100.0	**98.2**	91.6	78.0	19.7	1.2	
10/13/00	Quarry		100.0	98.9	87.2	35.2	2.1	
10/17/00	Quarry		100.0	94.4	84.5	38.3	2.4	
10/27/00	Quarry	100.0	**97.9**	87.5	75.5	29.3	2.6	
4/23/01	Quarry		100.0	95.2	83.6	34.5	2.3	
5/2/01	Quarry		100.0	98.6	85.1	44.2	5.0	
5/10/01	Quarry		100.0	96.9	89.6	42.8	3.8	
5/15/01	Quarry			100.0	95.7	39.9	3.4	
5/23/01	Quarry			100.0	95.8	***70.0***	7.9	Rock rejected; see 5/24/01 resampling.
5/24/01	Quarry	100.0	**96.9**	92.3	76.8	36.9	3.4	Retest of 5-23-01, one rock barely oversize
5/29/01	Quarry			100.0	92.3	***51.4***	5.2	Just slightly out on fine side - accepted.
6/6/01	Quarry			100.0	85.8	45.9	4.1	
6/12/01	Quarry			100.0	89.3	36.9	2.7	
6/18/01	Quarry			100.0	88.7	42.6	5.1	
6/25/01	Quarry		100.0	93.2	61.7	***51.5***	5.5	Just slightly out on fine side - accepted.
7/2/01	Quarry			100.0	91.3	41.6	4.4	
7/11/01	Quarry		100.0	97.2	84.1	37.3	4.3	
7/17/01	Quarry			100.0	89.1	32.5	3.8	
7/25/01	Quarry		100.0	93.4	72.3	25.9	3.5	
7/31/01	Quarry		100.0	89.1	89.1	***51.9***	7.1	This result was out on the fine side - the QC officer noted that this sample was not representative of what was being processed, as there were very few larger rocks in this sample.
8/8/01	Quarry			100.0	97.5	***62.2***	2.3	Rock still out on fine side, no larger rocks in sample Rock was not accepted.
8/9/01	Quarry			100.0	98.7	***65.9***	2.1	See notes above - QC officer requested that contractor make adjustments at the quarry.

Table 5.11 Erosion Protection Gradation Results: Type C Rock, Rattlesnake Quarry Production Samples

Sample Date	Gradation Sample Location	Percent Passing Sieve Size						Comments
		12 "	10 "	9 "	8 "	6 "	4 "	
	Final Gradation Requirements:		100	50 - 100	20 - 100	0 - 50	0 - 15	
8/15/01	Quarry		100.0	97.1	92.5	***53.0***	6.6	Although still out on fine side, much better than previous gradations - rock accepted.
8/21/01	Quarry			100.0	97.7	***52.0***	4.4	See note above.
8/28/01	Quarry			100.0	100.0	39.1	3.8	
9/5/01	Quarry		100.0	91.3	73.2	25.2	4.6	
9/12/01	Quarry			100.0	93.1	41.4	3.5	
10/3/01	Quarry		100.0	98.2	88.3	34.3	1.8	
10/16/01	Quarry		100.0	97.0	92.8	32.0	1.0	
10/24/01	Quarry			100.0	94.9	***58.3***	7.3	
10/29/01	Quarry			100.0	94.0	43.8	3.6	
11/7/01	Quarry		100.0	95.7	85.9	26.8	3.4	
11/12/01	Quarry			100.0	97.5	41.6	2.9	
5/3/02	Quarry	100.0	***97.4***	92.9	76.7	28.9	1.9	1 rock barely oversize
5/13/02	Quarry			100.0	100.0	***65.7***	7.7	Out See 5-14-02
5/14/02	Quarry			100.0	95.0	***52.9***	4.2	Retest 5-13-02
5/23/02	Quarry		100.0	95.8	87.6	27.4	3.4	
5/29/02	Quarry		100.0	97.9	89.8	38.8	3.6	
6/4/02	Quarry		100.0	97.3	95.4	***51.9***	6.3	
6/11/02	Quarry			100.0	85.9	37.1	5.6	
6/18/02	Quarry			100.0	88.6	35.2	6.1	
6/25/02	Quarry	100.0	***95.0***	93.2	82.6	31.4	3.9	1 rock barely oversize
7/10/02	Quarry			100.0	86.7	40.9	4.5	
7/17/02	Quarry		100.0	95.8	89.6	40.6	6.7	
7/23/02	Quarry		100.0	95.3	81.8	35.6	6.0	
7/30/02	Quarry		100.0	95.6	85.7	32.5	4.3	
8/6/02	Quarry		100.0	95.6	89.4	46.2	9.1	
8/13/02	Quarry		100.0	98.5	93.8	47.6	7.2	
8/14/02	Quarry		100.0	96.4	92.7	48.7	5.6	
8/19/02	Quarry		100.0	96.8	83.9	29.3	3.8	
8/26/02	Quarry	100.0	***97.9***	94.0	84.8	44.2	3.6	1 rock barely oversize
9/3/02	Quarry	100.0	***96.4***	92.6	78.1	35.1	6.4	
9/9/02	Quarry		100.0	94.2	85.7	43.6	4.8	
9/16/02	Quarry			100.0	93.2	45.7	5.9	
9/23/02	Quarry		100.0	97.1	89.4	43.3	9.6	
6/28/03	Quarry		100.0	98.8	88.5	46.2	8.7	
7/16/03	Quarry	100.0	***97.8***	92.6	80.4	35.8	3.6	1 rock barely oversize

Table 5.11 Erosion Protection Gradation Results: Type C Rock, Rattlesnake Quarry Production Samples

Sample Date	Gradation Sample Location	Percent Passing Sieve Size						Comments
		12 "	10 "	9 "	8 "	6 "	4 "	
	Final Gradation Requirements:		100	50 - 100	20 - 100	0 - 50	0 - 15	
7/31/03	Quarry			100.0	87.4	34.1	5.4	Last quarry production sample

Total Number of Quarry (Production) Gradation Tests:	56	
Total Number of In-Place Tests:	21	(see Table 5.12)
Total Quantity of Type C Rock Placed:	175,242	CY
Type C Gradation Testing Frequency:	1: 2276 CY	*(includes In-Place tests as well)*

Table 5.12 Erosion Protection Gradation Results: Type C Rock, In-Place Gradation Samples

Test results not meeting gradation requirements are highlighted as follows: **96.9** Bold (no italic) denotes test result below lower bound gradation specification (out on cours

65.3 *Bold italic - denotes test result above upper bound gradation specification (out on fine side*

Sample Date	Gradation Sample Location	Depth Check ID	Percent Passing Sieve Size					Comments
			10 "	9 "	8 "	6 "	4 "	
	Final Gradation Requirements:		100	50 - 100	20 - 100	0 - 50	0 - 15	
8/26/02	Above-Grade	C-1	100.0	95.7	89.7	***54.2***	5.6	6" barely out. See retest 8-28-02
8/28/02	Above-Grade, Retest #C-1R	C-1R	100.0	94.4	79.9	29.2	1.8	
8/28/02	Above-Grade	C-2		100.0	97.8	***55.4***	8.5	6" barely out. See retest 8-28-02
8/28/02	Retest #C-2R	C-2R	100.0	98.4	87.7	45.2	4.3	
8/29/02	Above-Grade	C-3	100.0	94.5	88.5	43.3	3.5	
9/3/02	Above-Grade	C-4	100.0	96.2	89.2	47.8	2.0	1 rock barely oversize
9/4/02	Above-Grade	C-5	100.0	97.7	88.5	46.7	4.6	
9/4/02	Above-Grade	C-6		100.0	94.3	40.3	3.2	
9/4/02	Above-Grade, with fines	C-7	100.0	91.9	82.0	33.2	12.3	Test sampled in an area exhibiting a higher percentage of fines - test passes
9/4/02	Above-Grade, without fines	C-7	100.0	90.9	79.7	24.6	1.0	Second test of C-7, without fines
9/5/02	Above-Grade	C-8	100.0	97.5	95.4	41.6	10.9	
9/5/02	Above-Grade	C-9	100.0	89.6	79.1	22.9	2.1	
9/5/02	Above-Grade	C-10	100.0	86.8	80.9	26.9	0.1	
9/5/02	Above-Grade	C-11	100.0	94.1	73.8	28.8	2.9	
9/5/02	Above-Grade	C-12	100.0	86.9	84.6	35.3	5.0	
9/6/02	Above-Grade	C-13	100.0	97.2	91.7	31.4	1.9	
9/6/02	Above-Grade	C-14	100.0	95.9	86.2	30.7	4.3	
9/11/02	Heap Gap	C-15	100.0	94.8	86.8	31.6	0.9	
9/20/02	Heap Leach	C-16	100.0	92.4	74.6	21.1	2.2	
6/23/04	A-9 Repository	C-19	100.0	90.5	88.2	34.0	1.6	
6/28/04	A-9 Repository	C-20		100.0	88.0	35.8	3.1	
6/28/04	A-9 Repository	C-21		100.0	87.2	49.6	2.7	
7/22/04	A-9 Repository	C-22		100.0	90.9	41.7	3.7	
7/24/04	A-9 Repository	C-23		100.0	88.7	***52.6***	9.9	6" barely out. Accepted
7/24/04	A-9 Repository	C-24		100.0	94.4	38.8	5.0	
7/24/04	A-9 Repository	C-25	100.0	97.4	73.6	39.3	5.2	
7/24/04	A-9 Repository	C-26		100.0	98.3	***56.8***	11.0	6" barely out. Accepted

Table 5.12 Erosion Protection Gradation Results: Type C Rock, In-Place Gradation Samples

Sample Date	Gradation Sample Location	Depth Check ID	Percent Passing Sieve Size					Comments
			10 "	9 "	8 "	6 "	4 "	
	Final Gradation Requirements:		100	50 - 100	20 - 100	0 - 50	0 - 15	
8/17/06	GHP-2 C-1, with fines	GHP2 C-1	100.0	97.0	87.0	***67.0***	***30.0***	
8/17/06	GHP-2 C-1, without fines	GHP2 C-1	100.0	96.0	83.0	***57.0***	8.0	
8/24/07	GHP-2 C-2	GHP2 C-2	100.0	96.0	93.0	48.0	8.0	
8/24/07	GHP-2 C-3	GHP2 C-3	100.0	100.0	98.0	***51.0***	5.0	
9/30/06	A-9 West Diversion Channel	C-28	100.0	97.3	89.8	37.4	4.9	

In a few cases above, gradation test results did not appear representative of the actual rock placed. This material was subsequently re-tested to ensure that gradation requirements were met. In these cases, only the retests are included in the total testing frequency.

	Total	Heap	AGTI	A-9	GHP-2
Total In-Place Tests:	21	2	14	9	3
Quantities of Type C Rock Placed (cubic yards):	175,242	5,317	117,736	36,702	15,488
In-Place Gradation Testing Frequency*:	1: 8345	1: 2659	1: 8410	1: 4078	1: 5163

Table 5.13 Erosion Protection Gradation Results: Type D and E Rock

Erosion Protection Gradation Results: Type D

Sample Date	Sampling Location	Percent Passing Sieve Size, inch						Comments
			30"	24"	18"	12"	8"	
	Gradation Requirements:		100	50 - 100	20 - 100	0 - 30	0 - 10	
05/03/02	Quarry		100.0	92.5	57.6	18.6	2.2	
07/29/02	Quarry	100.0	96.9	90.6	67.0	17.8	7.5	1 rock barely oversize
07/14/03	Quarry		100.0	78.9	58.4	18.1	3.1	
08/05/03	Quarry	100.0	96.1	81.6	59.7	***36.2***	***12.4***	1 rock barely oversize

	Total
Total Tests:	4
Quantities of Type D Rock Placed (cubic yards):	24,881
Gradation Testing Frequency;	1: 6220

All Type D Rock was placed on the A-9 Repository. It was not feasible to perform in-place gradation tests on this rock. However, samples were taken from delivery trucks that were placing the Type D riprap and then taken to the field laboratory to confirm that the plan gradation specifications were met.

Erosion Protection Gradation Results: Type E

Sample Date	Sampling Location	Percent Passing Sieve Size, inch					Comments
		60"	48"	42"	30"	24"	
	Gradation Requirements:	100	60 -100	20 - 100	0 - 50	0-30	
08/14/02	AGTI/East Canyon Creek	100.0	91.0	78.0	47.0	27.0	

	Total
Total Tests:	1
Quantities of Type E Rock Placed (cubic yards):	18,639
Gradation Testing Frequency:	1: 18639

All Type E Rock placed in the East Canyon Creek Realignment area for Launch Stone Embankment
No quarry production samples were tested

Table 5.14 Erosion Protection In-Place Visual Depth Check Test Locations and Results: 2000-2002, 2004, 2006

Note: Field ID prefixes denote rock type; IDs followed by an asterisk denote in-place gradation samples. Sample locations are shown on Figure 5.3. These locations are also shown in larger scale for individual construction areas in Volumes II through V.

Gradation Type A: Required Thickness = Minimum of 90% of 0.5 ft (except Type A Bedding for GHP-2 = Min. of 90% of 0.25 ft)

Field ID	Test Date	Sample Location/Area	Northing	Easting	Required Thickness	Measured Thickness (ft)	Comments
A-1 *	10/11/00	Heap Leach - 10:1 Slope	790900	837600	≥ 0.45 ft	0.72	
A-2 *	10/13/00	Heap Leach - 10:1 Slope	790705	837833	≥ 0.45 ft	0.47	
A-3 *	10/18/00	Heap Leach - 10:1 Slope	790730	837810	≥ 0.45 ft	0.62	
A-4 *	10/30/00	Heap Leach - 5:1 Slope	791701	837157	≥ 0.45 ft	0.75	
A-5	8/7/01	Heap Leach - 6:1 Slope	791846	838250	≥ 0.45 ft	0.47	
A-6 *	8/7/01	Heap Leach - 6:1 Slope	791757	838208	≥ 0.45 ft	0.56	
A-7	8/7/01	Heap Leach - 6:1 Slope	791551	838173	≥ 0.45 ft	0.59	
A-8	8/7/01	Heap Leach - 6:1 Slope	791218	838174	≥ 0.45 ft	0.85	
A-9	8/15/01	Heap Leach - 6:1 Slope	791204	838181	≥ 0.45 ft	0.74	
A-10	8/20/01	Gap - 5:1 Slope	792400	837177	≥ 0.45 ft	0.83	
A-11 *	8/20/01	Gap - 5:1 Slope	792665	837183	≥ 0.45 ft	0.90	
A-12 *	8/24/01	Gap - 1% Slope (Top)	792494	837560	≥ 0.45 ft	0.59	
A-13 *	8/24/01	Gap - 1% Slope (Top)	792494	838130	≥ 0.45 ft	0.64	
A-14 *	10/3/01	Heap Leach - Top	791034	838028	≥ 0.45 ft	0.65	
A-15 *	10/3/01	Heap Leach - Top	791355	837707	≥ 0.45 ft	0.55	
A-16 *	10/3/01	Heap Leach - Top	791865	837410	≥ 0.45 ft	0.48	
A-17 *	10/3/01	Heap Leach - Top	791907	838019	≥ 0.45 ft	0.65	
A-18 *	10/3/01	Heap Leach - Top	791249	838023	≥ 0.45 ft	0.75	
A-19	10/4/01	Heap Leach - Crest	791797	837212	≥ 0.45 ft	0.45	
A-20	10/4/01	Heap Leach - Crest	791580	837245	≥ 0.45 ft	0.55	
A-21	10/4/01	Heap Leach - Crest	792093	837194	≥ 0.45 ft	0.51	
A-22	10/8/01	Heap Leach - Crest	791430	837440	≥ 0.45 ft	0.59	
A-23	10/8/01	Heap Leach - Crest	791267	837582	≥ 0.45 ft	0.69	
A-24	10/8/01	Heap Leach - Crest	791127	837609	≥ 0.45 ft	**0.36**	Test failed - see retests below.
A-24A	10/8/01	Heap Leach - Crest	791154	837604	≥ 0.45 ft	0.68	Interim test to determine area requiring repair (one on each side of test hole); not included in frequency
A-24B	10/8/01	Heap Leach - Crest	791102	837623	≥ 0.45 ft	0.51	See above comment; not included in frequency.
A-24 Rev	10/8/01	Heap Leach - Crest	791127	837609	≥ 0.45 ft	0.61	Retest of A-24 test area after repair
A-25	10/8/01	Heap Leach - Crest	790876	837876	≥ 0.45 ft	0.77	
A-26	10/8/01	Heap Leach - Crest	790731	838045	≥ 0.45 ft	0.70	
A-27	10/8/01	Heap Leach - Crest	790624	838074	≥ 0.45 ft	0.81	
A-28	10/9/01	Heap Leach - Crest	790655	838175	≥ 0.45 ft	0.48	
A-29	10/9/01	Heap Leach - Crest	791168	838151	≥ 0.45 ft	0.45	

Table 5.14 Erosion Protection In-Place Visual Depth Check Test Locations and Results: 2000-2002, 2004, 2006

Gradation Type A, Cont.

Field ID	Date	Sample Location/Area	Northing	Easting	Required Thickness	Measured Thickness (ft)	Comments
A-30	10/9/01	Heap Leach - Crest	791600	838135	≥ 0.45 ft	0.66	
A-31	10/9/01	Heap Leach - Crest	791934	838242	≥ 0.45 ft	0.76	
A-32	10/9/01	Heap Leach - Crest	792035	838266	≥ 0.45 ft	0.70	
A-33	10/9/01	Heap Leach - Crest	792064	838192	≥ 0.45 ft	0.75	
A-34	10/9/01	Heap Leach - Crest	792251	837611	≥ 0.45 ft	0.85	
A-35	10/9/01	Heap Leach - Crest	792318	837394	≥ 0.45 ft	0.61	
A-36 *	10/16/01	Gap - 10:1 Slope	792138	838570	≥ 0.45 ft	0.73	
A-37	10/16/01	Gap - 10:1 Slope	792171	838505	≥ 0.45 ft	0.49	
A-38	10/16/01	Gap - 10:1 Slope	792044	838466	≥ 0.45 ft	**0.36**	Test failed - see post-repair retest below..
A-38 Rev	10/24/01	Gap - 10:1 Slope	792044	838466	≥ 0.45 ft	0.52	Retest of repaired A-38 test area.
A-39	10/24/01	Gap - 1% Slope (Top)	792347	837512	≥ 0.45 ft	0.74	
A-40	10/24/01	Gap - 1% Slope (Top)	792373	837255	≥ 0.45 ft	0.80	
A-41	10/24/01	Gap - 1% Slope (Top)	792562	837284	≥ 0.45 ft	0.80	
A-42	10/24/01	Gap - 1% Slope (Top)	792638	837322	≥ 0.45 ft	0.64	
A-43	10/24/01	Gap - 1% Slope (Top)	792388	837335	≥ 0.45 ft	0.75	
A-44	10/24/01	Gap - 1% Slope (Top)	792280	837803	≥ 0.45 ft	0.75	
A-45	10/25/01	Gap - 1% Slope (Top)	792209	837861	≥ 0.45 ft	0.52	
A-46	10/25/01	Gap - 1% Slope (Top)	792259	837875	≥ 0.45 ft	0.70	
A-47	10/25/01	Gap - 1% Slope (Top)	792180	837996	≥ 0.45 ft	0.54	
A-48	10/25/01	Gap - 1% Slope (Top)	792171	838138	≥ 0.45 ft	0.70	
A-49	10/26/01	Gap - 1% Slope (Top)	792077	838396	≥ 0.45 ft	0.58	
A-50 *	10/26/01	Gap - 1% Slope (Top)	792300	838435	≥ 0.45 ft	0.73	
A-51	8/6/02	A-9 - West Diversion Channel	790024	836673	≥ 0.45 ft	0.54	West Slope
A-52	8/6/02	A-9 - West Diversion Channel	790081	836692	≥ 0.45 ft	0.56	West Slope
A-53	8/6/02	A-9 - West Diversion Channel	789847	836611	≥ 0.45 ft	0.50	West Slope
A-54	8/9/02	A-9 - West Diversion Channel	790318	836767	≥ 0.45 ft	0.50	West Slope
A-55	8/9/02	A-9 - West Diversion Channel	789771	836654	≥ 0.45 ft	0.53	
A-56	8/14/02	A-9 - West Diversion Channel	790047	836744	≥ 0.45 ft	0.54	
A-57	8/14/02	A-9 - West Diversion Channel	790104	836735	≥ 0.45 ft	0.65	
A-58	8/14/02	A-9 - West Diversion Channel	790167	836778	≥ 0.45 ft	0.74	
A-59 *	8/14/02	A-9 - West Diversion Channel	790314	836859	≥ 0.45 ft	0.73	
A-60 *	9/5/02	Above Grade	793410	837313	≥ 0.45 ft	0.50	
A-61 *	9/6/02	Above Grade	793393	837954	≥ 0.45 ft	0.82	
A-62 *	9/6/02	Above Grade	792995	838141	≥ 0.45 ft	0.99	
A-63 *	9/6/02	Above Grade	793150	837945	≥ 0.45 ft	0.85	

Table 5.14 Erosion Protection In-Place Visual Depth Check Test Locations and Results: 2000-2002, 2004, 2006

Gradation Type A, Cont.

Field ID	Date	Sample Location/Area	Northing	Easting	Required Thickness	Measured Thickness (ft)	Comments
A-64	9/6/02	Above Grade	793013	837616	≥ 0.45 ft	0.78	
A-65	9/13/02	A-9 - East Diversion Channel	789788	837951	≥ 0.45 ft	0.45	
A-66	6/18/04	A-9 - West Diversion Channel	789660	836580	≥ 0.45 ft	0.53	
A-67 *	6/22/04	A-9 - West Diversion Channel	789510	836560	≥ 0.45 ft	0.60	
A-68	6/22/04	A-9 - West Diversion Channel	789315	836550	≥ 0.45 ft	0.64	
A-69	6/22/04	A-9 - East Diversion Channel	789550	837985	≥ 0.45 ft	0.50	
A-70 *	6/22/04	A-9 - East Diversion Channel	789440	837920	≥ 0.45 ft	0.62	
A-71	6/22/04	A-9 - East Diversion Channel	789300	837970	≥ 0.45 ft	0.88	
A-72	6/30/04	A-9 - East Diversion Channel	789170	837930	≥ 0.45 ft	0.47	
A-73	6/30/04	A-9 - East Diversion Channel	789055	837985	≥ 0.45 ft	0.60	
A-74	6/30/04	A-9 - East Diversion Channel	788960	837915	≥ 0.45 ft	0.55	
A-75	7/8/04	A-9 - East Diversion Channel	788910	837800	≥ 0.45 ft	0.65	
A-76	7/8/04	A-9 - East Diversion Channel	788810	837740	≥ 0.45 ft	0.68	
A-77	7/8/04	A-9 - East Diversion Channel	788705	837705	≥ 0.45 ft	0.60	
A-78	7/9/04	A-9 - East Diversion Channel	788875	837975	≥ 0.45 ft	0.48	
A-79 *	7/9/04	A-9 - East Diversion Channel	788766	837910	≥ 0.45 ft	0.51	
A-80	7/9/04	A-9 - East Diversion Channel	788694	838004	≥ 0.45 ft	0.63	
A-81	7/13/04	A-9 - East Diversion Channel	788589	837826	≥ 0.45 ft	0.53	
A-82	7/13/04	A-9 - East Diversion Channel	788626	837922	≥ 0.45 ft	0.46	
A-83	7/13/04	A-9 - East Diversion Channel	788616	837743	≥ 0.45 ft	0.67	
A-84	7/13/04	A-9 - East Diversion Channel	788765	837816	≥ 0.45 ft	0.57	
A-85	7/13/04	A-9 - East Diversion Channel	788874	837851	≥ 0.45 ft	0.56	
A-86	7/14/04	A-9 - East Diversion Channel	788538	837834	≥ 0.45 ft	0.68	
A-87	7/14/04	A-9 - East Diversion Channel	788536	837726	≥ 0.45 ft	0.55	
A-88	7/14/04	A-9 - East Diversion Channel	788501	837603	≥ 0.45 ft	0.66	
A-89	7/14/04	A-9 - East Diversion Channel	788446	837668	≥ 0.45 ft	0.61	5:1 Buried Apron
A-90	7/19/04	A-9 - West Diversion Channel	789284	836504	≥ 0.45 ft	0.47	
A-92 *	8/9/06	A-9 - West Diversion Channel	789161	836438	≥ 0.45 ft	0.71	(A-91 test ID skipped)
A-93	8/9/06	A-9 - West Diversion Channel	789016	836415	≥ 0.45 ft	0.85	

Table 5.14 Erosion Protection In-Place Visual Depth Check Test Locations and Results: 2000-2002, 2004, 2006

Gradation Type A, Cont., GHP-2 only (2006) *Note Differences in Required Thicknesses for Type A Bedding material below.*

Field ID	Test Date	Sample Location/Area	Northing	Easting	Required Thickness	Measured Thickness (ft)	Comments
GHP-2-A-1	6/9/06	GHP-2	792772	837123	≥ 0.45 ft	0.45	
GHP-2-A-2	6/9/06	GHP-2	793030	836977	≥ 0.45 ft	0.77	
GHP-2-A-3	6/9/06	GHP-2	792954	837080	≥ 0.45 ft	0.77	
GHP-2-A-4	6/9/06	GHP-2	792483	837104	≥ 0.45 ft	0.79	
GHP-2-A-5	6/28/06	GHP-2	793024	836602	≥ 0.45 ft	0.56	
GHP-2-A-6 *	6/28/06	GHP-2	792755	836735	≥ 0.45 ft	0.61	In-place gradation ID = GHP-2 A-4
GHP-2-A-7	6/28/06	GHP-2	792661	836799	≥ 0.45 ft	0.63	
GHP-2-A-8	6/28/06	GHP-2	792881	836691	≥ 0.45 ft	0.58	
GHP-2-A-9	6/28/06	GHP-2	793070	836530	≥ 0.45 ft	0.59	
GHP-2-A-10 *	7/7/06	GHP-2	792794	836096	≥ 0.45 ft	0.46	In-place gradation ID = GHP-2 A-5
GHP-2-A-11	7/7/06	GHP-2	792883	836388	≥ 0.45 ft	0.53	
GHP-2-A-12	7/7/06	GHP-2	792406	836412	≥ 0.45 ft	0.49	
GHP-2-A-13	7/7/06	GHP-2	792475	836270	≥ 0.45 ft	0.54	
GHP-2-A-14 *	7/8/06	GHP-2 - Type A Bedding	791804	836688	≥ 0.225 ft	0.32	In-place gradation ID = GHP-2 A-6
GHP-2-A-15	7/8/06	GHP-2 - Type A Bedding	791827	836504	≥ 0.225 ft	0.43	
GHP-2-A-16	7/8/06	GHP-2 - Type A Bedding	792005	836335	≥ 0.225 ft	0.48	
GHP-2-A-17	7/8/06	GHP-2 - Type A Bedding	792075	836192	≥ 0.225 ft	0.41	
GHP-2-A-18	7/8/06	GHP-2 - Type A Bedding	792266	836002	≥ 0.225 ft	0.41	
GHP-2-A-19	7/8/06	GHP-2 - Type A Bedding	792573	835964	≥ 0.225 ft	0.24	
GHP-2-A-20	7/19/06	GHP-2 - Type A Bedding	793370	836325	≥ 0.225 ft	0.41	
GHP-2-A-21	7/19/06	GHP-2 - Type A Bedding	793189	836121	≥ 0.225 ft	0.64	
GHP-2-A-22	7/19/06	GHP-2 - Type A Bedding	792895	835928	≥ 0.225 ft	0.30	
GHP-2-A-23	7/19/06	GHP-2 - Type A Bedding	792644	835758	≥ 0.225 ft	0.37	
GHP-2-A-24 *	7/20/06	GHP-2 - Type A Bedding	793510	836458	≥ 0.225 ft	0.45	In-place gradation ID = GHP-2 A-7
GHP-2-A-25	7/31/06	GHP-2 - Type A Bedding	791733	836722	≥ 0.225 ft	0.41	
GHP-2-A-26	8/2/06	GHP-2	791492	837035	≥ 0.45 ft	0.47	
GHP-2-A-27	8/2/06	GHP-2 - Type A Bedding	793391	836324	≥ 0.225 ft	0.36	
GHP-2-A-28	8/4/06	GHP-2 - Type A Bedding	792943	836979	≥ 0.225 ft	0.50	
GHP-2-A-29	8/9/06	GHP-2 - Type A Bedding	791730	836914	≥ 0.225 ft	0.30	

Table 5.14 Erosion Protection In-Place Visual Depth Check Test Locations and Results: 2000-2002, 2004, 2006

Gradation Type B: Required Thickness = Minimum of 90% of 0.5 ft

Field ID	Test Date	Sample Location/Area	Northing	Easting	Required Thickness	Measured Thickness (ft)	Comments
B-1 *	8/14/01	Heap Leach - 6:1 Slope	791204	838181	≥ 0.45 ft	0.90	
B-2 *	8/26/02	Above Grade	793701	837206	≥ 0.45 ft	1.00	
B-2 Rev	8/28/02	Above Grade	793701	837221	≥ 0.45 ft	1.00	Verification test (not included in frequency)
B-3 *	9/3/02	Above Grade	793783	837387	≥ 0.45 ft	0.85	
B-4 *	9/6/02	Above Grade	793921	836830	≥ 0.45 ft	0.86	
B-4 Rev	9/6/02	Above Grade	793933	836835	≥ 0.45 ft	0.82	Verification test (not included in frequency)
B-5 *	9/9/02	Above Grade	793877	838098	≥ 0.45 ft	0.86	
B-6 *	9/9/02	Above Grade	793705	838731	≥ 0.45 ft	0.89	
B-7 *	9/10/02	Above Grade	793825	839499	≥ 0.45 ft	0.89	
B-8 *	9/10/02	Above Grade	792965	838760	≥ 0.45 ft	0.66	
B-9 *	9/10/02	Above Grade	793378	839478	≥ 0.45 ft	0.88	
B-10 *	9/11/02	Above Grade	792575	839069	≥ 0.45 ft	0.84	
B-11 *	9/11/02	Above Grade	792700	838249	≥ 0.45 ft	0.99	
B-12 *	9/12/02	Gap - 1% Slope (Top)	792275	838269	≥ 0.45 ft	0.98	
B-13 *	9/16/02	Gap - 1% Slope (Top)	792528	837466	≥ 0.45 ft	0.80	
B-14 *	9/16/02	Gap - 5:1 Slope	792478	837140	≥ 0.45 ft	0.95	
B-15 *	9/16/02	Heap Leach - 5:1 Slope	791580	837131	≥ 0.45 ft	0.90	
B-16 *	9/17/02	Heap Leach - 10:1 Slope	790781	837697	≥ 0.45 ft	0.49	
B-16 Rev	9/20/02	Heap Leach - 10:1 Slope	790819	837743	≥ 0.45 ft	0.48	Verification test (not included in frequency)
B-17 *	7/20/04	A-9 - Top	790525	836917	≥ 0.45 ft	0.85	North of West Diversion Channel
B-18 *	7/20/04	A-9 - Top	790282	837617	≥ 0.45 ft	0.68	
B-19 *	7/21/04	A-9 - Top	789890	837130	≥ 0.45 ft	0.74	
B-20 *	7/21/04	A-9 - Top	789380	837500	≥ 0.45 ft	0.80	
B-21 *	7/21/04	A-9 - Top	789846	837701	≥ 0.45 ft	0.73	
GHP-2-B-1	6/15/06	GHP-2	793032	837304	≥ 0.45 ft	0.45	
GHP-2-B-2	6/15/06	GHP-2	793138	837013	≥ 0.45 ft	0.56	
GHP-2-B-3 *	8/28/06	GHP-2	793071	836679	≥ 0.45 ft	0.76	In-place gradation ID = GHP-2 B-1
GHP-2-B-4 *	8/29/06	GHP-2	792678	836992	≥ 0.45 ft	0.48	In-place gradation ID = GHP-2 B-2

Gradation Type C: Required Thickness = Minimum of 90% of 1.0 ft (except for GHP-2 = Min. of 90% of 10 inches or 0.83 ft)

See results on following page.

Table 5.14 Erosion Protection In-Place Visual Depth Check Test Locations and Results: 2000-2002, 2004, 2006

Field ID	Test Date	Sample Location/Area	Northing	Easting	Required Thickness	Measured Thickness (ft)	Comments
C-1 *	8/26/02	Above Grade	794217	836922	≥ 0.9 ft	1.33	
C-1 Rev	8/28/02	Above Grade	794201	836997	≥ 0.9 ft	1.23	Verification test (not included in frequency)
C-2 *	8/28/02	Above Grade	794582	837280	≥ 0.9 ft	1.06	
C-2 Rev	8/28/02	Above Grade	794595	837197	≥ 0.9 ft	1.38	Verification test (not included in frequency)
C-3 *	8/29/02	Above Grade	794832	837534	≥ 0.9 ft	1.08	
C-4 *	9/3/02	Above Grade	794205	837275	≥ 0.9 ft	1.10	
C-5 *	9/4/02	Above Grade	794233	838133	≥ 0.9 ft	1.40	
C-6 *	9/4/02	Above Grade	794292	838602	≥ 0.9 ft	1.40	
C-7 *	9/4/02	Above Grade	794422	837797	≥ 0.9 ft	1.20	
C-8 *	9/5/02	Above Grade	794827	838118	≥ 0.9 ft	1.36	
C-9 *	9/5/02	Above Grade	794619	838909	≥ 0.9 ft	1.30	
C-10 *	9/5/02	Above Grade	794412	839315	≥ 0.9 ft	1.19	
C-11 *	9/5/02	Above Grade	794282	839715	≥ 0.9 ft	1.32	
C-12 *	9/5/02	Above Grade	793847	839873	≥ 0.9 ft	1.53	
C-13 *	9/6/02	Above Grade	792876	839673	≥ 0.9 ft	1.36	
C-14 *	9/6/02	Above Grade	793335	840089	≥ 0.9 ft	1.42	
C-15 *	9/11/02	Gap - 10:1 Slope	792281	838598	≥ 0.9 ft	0.95	
C-16 *	9/20/02	Heap Leach - 5:1 Slope	791240	837490	≥ 0.9 ft	1.28	
C-17	6/23/04	A-9 - West Diversion Channel	789584	836755	≥ 0.9 ft	1.05	East Slope
C-18	6/23/04	A-9 - West Diversion Channel	789535	836582	≥ 0.9 ft	1.02	
C-19 *	6/23/04	A-9 - West Diversion Channel	789630	836611	≥ 0.9 ft	1.12	
C-20 *	6/28/04	A-9 - West Diversion Channel	789460	836774	≥ 0.9 ft	0.95	East Slope
C-21 *	6/28/04	A-9 - West Diversion Channel	789645	836339	≥ 0.9 ft	1.12	West Slope
C-22	7/22/04	A-9 - West Diversion Channel	790350	836720	≥ 0.9 ft	1.74	West Slope
C-23 *	7/22/04	A-9 - South Face	789130	837070	≥ 0.9 ft	1.24	
C-24 *	7/22/04	A-9 - East Diversion Channel	788930	837690	≥ 0.9 ft	1.22	Flat area near E. diversion channel
C-25	7/22/04	A-9 - East Diversion Channel	789250	837770	≥ 0.9 ft	1.14	West Slope
C-26 *	7/22/04	A-9 - East Diversion Channel	790090	837890	≥ 0.9 ft	1.15	Top north of E. diversion channel
C-27	8/11/06	A-9 - West Diversion Channel	789002	836392	≥ 0.9 ft	1.45	
C-28	9/30/06	A-9 - West Diversion Channel	789142	836422	≥ 0.9 ft	1.40	
GHP-2-C-1 *	8/17/06	GHP-2	791887	836416	≥ 0.75 ft	0.92	
GHP-2-C-2 *	8/24/06	GHP-2	792620	835884	≥ 0.75 ft	1.20	
GHP-2-C-3 *	8/24/06	GHP-2	793474	836509	≥ 0.75 ft	1.20	
GHP-2-C-4	8/29/06	GHP-2	791787	836747	≥ 0.75 ft	1.16	
GHP-2-C-5	8/29/06	GHP-2	791974	836226	≥ 0.75 ft	0.85	
GHP-2-C-6	8/29/06	GHP-2	792000	836240	≥ 0.75 ft	0.77	
GHP-2-C-7	8/29/06	GHP-2	793248	836231	≥ 0.75 ft	1.15	
GHP-2-C-8	8/29/06	GHP-2	793104	836108	≥ 0.75 ft	0.96	
GHP-2-C-9	8/29/06	GHP-2	793675	836624	≥ 0.75 ft	1.00	

Section 6

6.0 COMPLETED SOIL AND GROUNDWATER CLEANUP DECOMMISSIONING ACTIVITIES

As discussed Section 1, this Construction Completion Report is the final in a series of submittals demonstrating that the Gas Hills Site meets the requirements for license termination. The other key submittals document the final radiological status for soil cleanup areas and the gamma exposure rate survey results for the five repositories. These reports are:

- *Final Status Survey Report and Addendum 1* (Initial submittal in 2003, finalized on September 2, 2004) – Approved by the NRC on September 27, 2004, as documented in the corresponding TER.
- *Final Status Survey Addendum 2* (May 11, 2005) – Approved by the NRC on September 1, 2005, as documented in the corresponding TER.
- *Final Status Survey Report, Addendum 3* (January 22, 2007) – currently undergoing NRC review.

Another key document supporting license termination is the *Final Application for Alternate Concentration Limits for Gas Hills, Wyoming*. (Umetco 2001, as updated). This submittal was updated and approved by the NRC on March 29, 2002. This section provides a brief summary of all the completed soil and groundwater decommissioning actions.

6.1 Summary of Completed Soil Decommissioning Activities

The Final Status Survey cleanup and characterization activities focused on those areas affected with 11e.(2) byproduct material that are not covered with an NRC-approved cover. These areas, shown on Figure 1.1 and Plate 1, include:

1) Gas Hills Pond (GHP)-1, the former evaporation pond located northwest of the former mill facilities;
2) the Windblown Area, the area affected with windblown byproduct material located directly north and northeast (downwind) of the Above-Grade Tailings Impoundment;
3) the former DW-6 Process Water Pipeline;
4) the North and South Evaporation Ponds; and
5) Carbide Draw south of the County Road.

The key reports documenting completion of these Final Status Survey activities are listed above and summarized in Table 6.2

Table 6.1. Summary of Key Umetco Reports Documenting Decommissioning and Completion of Gas Hills Site Final Status Survey Activities

Umetco Report or Plan	Description – Endpoints Addressed	Subsequent NRC Correspondence & Approval	Primary NRC Conclusions
Final Status Survey Report Initial submittal: October 27, 2003 Final submittal reflecting NRC comments: August 2004 (letter dated September 2, 2004). This included revisions to Volume 1, and was submitted in along with Addendum 1 (see below)	• Final status survey results for the windblown, DW-6 pipeline, and GHP No. 1 • Exposure rate measurements for the AGTI and the Heap Leach	The NRC staff completed the review and requested additional information by letter dated December 31, 2003. The Umetco response and Addendum 1 to the Report were submitted by letter dated April 16, 2004. Page changes for Volume 1 of the Report and Addendum 1 were requested by staff on July 22, 2004. *NRC Approval:* September 27, 2004	Based on review of these documents and inspection records, the NRC determined that the final status survey essentially complies with the approved survey plan, and that the Report documents that radiological conditions meet the requirements for the areas addressed and that the areas addressed meet applicable criteria and are suitable for release based on the level of licensed material remaining.
Final Status Survey Report Addendum 1, April 2004 Submitted by letter dated April 16, 2004 Revised Final: August 2004	Umetco's responses to NRC comments and their request for additional information (12/31/03 letter) on the October 2003 FSSR submittal. A key part of this addendum was the rationale and analysis supporting Umetco's request for Alternative Criteria to 10 CFR 40, Appendix A, Criterion 6(6). Documentation supporting this request included a risk assessment, cost-benefit analysis, and comparative analysis (off-site risk vs. on-site risk) evaluating the risk to public health, safety and environment.	*NRC Approval:* September 27, 2004	The Addendum requested and justified an alternate soil criterion of "no further remedial action" for the four specific areas mentioned above. This was done based on the NRC's suggestion in the December 2003 request for additional information. In the TER supporting the 9/27/04 approval, the NRC determined that, since the four areas are essentially at local background radiation levels, alternate criteria are not needed and Criterion 6(6) has been met.

Table 6.1. Summary of Key Umetco Reports Documenting Decommissioning and Completion of Gas Hills Site Final Status Survey Activities

Umetco Report or Plan	Description – Endpoints Addressed	Subsequent NRC Correspondence & Approval	Primary NRC Conclusions
Final Status Survey Report, Addendum 2, May 2005 Submitted by letter dated May 11, 2005	This report documents the results of the final radiological surveys and sampling for the completed A-9 Repository cover, including the gamma exposure rate survey for the A-9 Repository, frost protection material verification sampling for Ra-226 content, and radon emission rate measurements. This report also presents results of soil sampling from a portion of the Susquehanna Haul Road.	*NRC Approval:* September 1, 2005	The NRC concluded that: 1) the direct gamma exposure from the A-9 Repository has been reduced to background levels in compliance with 10 CFR Part 40, Appendix A, Criterion 6(1); 2) the Ra-226 specific activity in the A-9 Repository cover is consistent with background levels and the radon emission rate from the cover complies with the limit in 10 CFR, Appendix A, Criterion 6(2); and 3) the Susquehanna Haul Road is not contaminated with byproduct material.
Final Status Survey Report, Addendum 3 January 2007 Submitted by letter dated January 22, 2007	This report is the third and final addendum to Umetco's Final Status Survey Report. This addendum addresses the conformance of the repository covers of GHP-2 Repository and C-18 Deep Burial Repository with the applicable criteria in 10 CFR 40, Appendix A.	Currently undergoing NRC review.	Not Applicable

6.2 Summary of Groundwater Decommissioning Activities

As part of the license termination process, in addition to the satisfactory completion of surface remedial actions (documented in Volumes II through V) and the documentation of completed site decommissioning discussed above, the NRC is also required to document the completion of ground-water corrective actions. Umetco's groundwater corrective action activities began in 1983 and continued until 2002, when the corrective action program was terminated upon NRC's approval of Umetco's ACL proposal entitled *Final Application for Alternate Concentration Limits for Gas Hills, Wyoming* (Umetco 2001). This submittal was updated and approved by the NRC on March 29, 2002, on which date the corrective action program was terminated. A summary of related submittals is provided in Table 6.2.

Detailed information regarding site hydrogeology and groundwater quality is provided in the ACL report and subsequent submittals. Water resource uses are characterized and updated regularly in Umetco's annual reports.

Table 6.2. Groundwater Alternate Concentration Limit (ACL) Submittal History

Preface: License Condition 35, the primary license condition pertaining to groundwater remediation, states the following: The ACLs for groundwater contained in Umetco's application dated May 11 and May 18, 2001, as revised by submittals of July 30, 2001, December 3, 2001, March 4, 2002, October 2, 2002, and June 17, 2005 have been approved for this site. The licensee shall implement a groundwater compliance monitoring program that includes the following:

> Conduct monitoring as described in the Groundwater Monitoring Plan (ACL Application, Appendix M), in the January 5, 2004 submittal. The validation of ACL exceedance will be in accordance with Section 4 of Appendix M. The licensee shall submit this monitoring data to the NRC by September 30th of each year and include groundwater contour maps, contamination iso-concentration maps, and trend graphs.

Latter included in Umetco annual reports; see SUA-648 license for remaining LC 35 language. [Applicable Amendments: 6, 8, 11, 15, 21, 32, 34, 40, 41, 43, 48, 50, 53, 56]. (*The latter language reflects the most recent revised license as of April 2007.*) This table summarizes the contents of each ACL submittal; those followed by an asterisk (*) denote those cited in the current license (i.e., the submittal dates referred to above).

Report or Submittal	Submittal Date(s)	Summary of Contents / NRC Approval
Umetco's Initial ACL Submittal	February 18, 1999	Application requesting ACLs and adjustments to background levels for certain groundwater constituents.
Submittals in Response to the NRC's April 17, 2000 Request for Additional Information		
Revised ACL Application (Rev. 1), submitted by letters May 11 and May 18, 2001	May 11, 2001* May 18, 2001*	May 11, 2001: Revised ACL Document, Volumes I and II May 18, 2001: Umetco's response to the NRC's request for additional information, consisting of a 15-page comment-response document.
Supplementary information in response to NRC comments.	July 30, 2001*	Appendix C revisions/supplement.
Revised ACL Application (Rev. 2), submitted by letter dated December 3, 2001	December 3, 2001*	Attachment 1 to 12/3/01 letter summarized all edits made to document, including revisions to: • Tables 2.9, 2.10, 2.14 • Figures 2.20, 2.21 • Replaced entire Appendix B (Geochemical Model) • Appendix C (Numerical Groundwater Flow Model), including replacement of text and figures *ADDED Appendix M (Monitoring Plan)
Interim ACL submittal	February 11, 2002	Deleted gross alpha as ACL constituent and modified ACL Appendix M monitoring plan to include criteria for defining an ACL exceedance and identifying unpredicted plume behavior

Table 6.2. Groundwater Alternate Concentration Limit (ACL) Submittal History

Report or Submittal	Submittal Date(s)	Summary of Contents / NRC Approval
Appendix M Revisions	March 4, 2002*	Revisions made to Appendix M text, Attachment M-1 (& tables), and Figures 1a/1b through 8a/8b.
ACL Approved by License Amendment 48: March 29, 2002		
Appendix M Revisions: Replaced Table M-1 and Attachment M-1, Table 5 and Figures 4a, 4b, 7a, and 7b	October 2, 2002*	The submittal provided page changes for Appendix M of the approved application, including: • Table M-1 (replaced) • Attachment M-1, Table 5 (replaced) • Figures 4a, 4b, 7a and 7b (replaced) Revisions included correction of a typographical error and correction of the location of the newly installed MW 82 and its associated chloride and sulfate levels. LC 35 changes approved by License Amendment 50, December 5, 2002 (no TER).
ACL Application, Revised Appendix M (Groundwater Monitoring Plan) Based on groundwater monitoring conducted in 2003 indicating higher than predicted levels of sulfate and chloride at MW28, Umetco modified the initial conditions in the groundwater flow and transport model (chloride and sulfate distributions) to improve the match between simulated and observed results.	January 5, 2004*	Appendix M was revised to reflect the model changes described in column 1. No parameters in the model were changed other than the initial concentration distribution for chloride and sulfate. The NRC reviewed this submittal and concluded that the revised Appendix M (Table 6.5, modification of target levels in well MW28 for chloride and sulfate) is adequate to predict movement of the plume. LC 35 was then revised by License Amendment 53 (2/23/04, see below) to require Umetco to conduct groundwater monitoring, whereby validation of an ACL exceedance will be in accordance with Section 4 of Appendix M (see LC 35 language in the Preface to this table).
Revised Appendix M Approved by License Amendment 53: February 23, 2004		
Umetco License Amendment Request, supporting report entitled: *Determination of Lead-210 ACL for the Southwestern Flow Regime*	June 17, 2005* *Supplemental analyses sent by email on January 6, 10, and 24, 2006; and March 9 and 20, 2006.*	Analyses and documentation supporting Umetco's request to increase the Lead-210 ACL for the southwestern flow regime from 46.7 pCi/l to 189 pCi/l. Corresponding LC 35 changes approved by License Amendment 56, March 24, 2006 (see below).
Revised Pb-210 ACL Approved by License Amendment 56: March 24, 2006		

7.0 SUMMARY AND CONCLUSIONS

In summary, this Construction Completion Report demonstrates that all work documented herein for the Gas Hills Site repositories was performed in accordance with the designs and procedures in the approved reclamation plans. Additionally, it verifies that the completed covers satisfy the requirements established in 10 CFR 40, Appendix A, Criteria 4 (c), (d), (e), and 6(1), with regard to reasonable assurance of stability and control of the contaminated material and limitation of the radon flux from the disposal areas to the atmosphere to 20 pCi/m^2-s. The completion of construction activities in accordance with these criteria is demonstrated largely by the as-built drawings and quality control test documentation provided in Volumes II through V of this report.

The DOE is currently preparing the Long-Term Surveillance Plan (LTSP) and a final site inspection is scheduled for September 2007. The anticipated implementation of the Long-Term Care Boundary (LTCB) and corresponding land transfer is as follows: Termination of Umetco's license will occur upon completion and acceptance of reclamation activities. Because the State of Wyoming declined to take title (letter of July 15, 1994 from D. Hemmer to J. Virgona), Umetco anticipates that long-term custodial care will be transferred to the DOE. All land within the proposed LTCB is currently under the control of either Umetco or the BLM.

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Attachment 1

ATTACHMENT 1

NRC Technical Evaluation of the September 2004 Final Status Survey Report and Addendum 1

Submitted by letter dated September 27, 2004
TER dated September 21, 2004

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 27, 2004

Mr. Thomas Gieck, Remediation Manager
Umetco Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

SUBJECT: THE UMETCO MINERALS CORPORATION'S FINAL STATUS SURVEY REPORT FOR THE GAS HILLS URANIUM MILL SITE, SUA-648 (TAC LU0040)

Dear Mr. Gieck:

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of the Final Status Survey Report (Report) submitted by Umetco Minerals Corporation's (Umetco) letter dated October 27, 2003, additional information (Addendum 1) dated April 16, 2004, and the revised Report Volume 1 and text of Addendum 1 dated September 2, 2004. As stated in our acknowledgment e-mail dated November 18, 2003, data for several areas are missing from the Report because these areas could not be surveyed this calendar year. As indicated in the enclosed Technical Evaluation Report, the staff determined that the partial report adequately demonstrates compliance with the applicable regulations for the areas addressed. The staff intends to perform a confirmatory survey of remediated areas during a site visit on October 13, 2004.

Umetco will provide the required additional data as an Addendum to the Report when the A-9 Repository, C-18 Pit, and Pond 2 covers are complete, per the commitment contained in your letter dated January 26, 2004. The NRC staff review of this data will be documented in a letter to Umetco. Both that letter and this one should be referenced in the Construction Completion Report.

If you have any questions concerning this letter or the enclosure, please contact Ms. Elaine Brummett of my staff at (301) 415-6606 or via e-mail to esb@nrc.gov.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,

Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-0299
License No.: SUA–648

Enclosure: Technical Evaluation Report for Status Survey

cc: M. Moxley, DEQ WY

TECHNICAL EVALUATION REPORT FOR UMETCO MINERALS CORPORATION'S STATUS SURVEY REPORT FOR THE GAS HILLS URANIUM TAILINGS SITE

Docket No.: 40-0299 **License No.:** SUA-648

DATE: September 21, 2004

FACILITY: Umetco Minerals Corporation - Gas Hills Uranium Tailings Site, Wyoming

TECHNICAL REVIEWER: Elaine Brummett

PROJECT MANAGER: Elaine Brummett

SUMMARY AND CONCLUSIONS:

By letter dated October 27, 2003, Umetco Minerals Corporation (Umetco) submitted the "Final Status Survey Report" (Report) to demonstrate that one of the requirements under 10 CFR 42(j)(2) has been completed as a step in termination of the license. The Nuclear Regulatory Commission (NRC) staff noted on November 18, 2003, that the submittal was a partial report as it did not contain all the pertinent radiological information. A short part of the A-9 haul road, and the A-9 Repository and Pond 2 covers cannot be surveyed until reclamation is complete.

The NRC staff completed the review and requested additional information by letter dated December 31, 2003. The Umetco response and Addendum 1 to the Report were submitted by letter dated April 16, 2004. Page changes for Volume 1 of the Report and Addendum 1 were requested by staff on July 22, 2004, and the revised text was provided on September 2, 2004. Based on review of these documents and inspection records, the staff has determined that the final status survey essentially complies with the approved survey plan, and that the Report documents that radiological conditions meet the requirements for the areas addressed.

BACKGROUND:

The Umetco Gas Hills site is located in a remote area of central Wyoming, in Fremont and Natrona Counties, approximately 60 miles east of Riverton. The restricted area of the site consists of approximately 542 acres, of which Umetco owns 280 acres and the rest is under the jurisdiction of the U.S. Bureau of Land Management. The mill was constructed in 1959 and was shut down in 1984. Mill building decommissioning was completed in 1993.

The Umetco site soils were contaminated with mill tailings and mill solutions that are regulated under 10 CFR Part 40, as byproduct material. In 1993, Umetco performed soil cleanup on 4 acres north of the restricted area, using a background radium (Ra-226) value of 2.2 pCi/g and procedures required by License Condition 30.B. Reports on additional soil contamination and proposed revisions to the Ra-226 background value were submitted in 1996, 1999, and 2000, and the NRC staff provided comments. Background Ra-226 and uranium values are difficult to quantify because the site is on land containing natural deposits of uranium, open pit uranium mines are on and adjacent to the site, and the Wyoming Abandoned Mines Program has used mine overburden (spoils) to fill some adjacent open pit mines so that surface soil contains up to 20 pCi/g Ra-226.

The North and South evaporation ponds are mentioned in Addendum I, but data is not included in the Report because the NRC approved the remediation plan and radiological data for this area on December 9, 1999 (Amendment 42). The plan stated that pond sludge and the upper clay liner were removed and borehole data and geochemical studies indicated that mine spoils (overburden soil containing naturally occurring uranium and radium that was excavated from the mine pit areas) were beneath the liner, so no further remediation was required.

Three revised documents (Background Characterization Report, Final Status Survey (FSS) Plan, and the East Canyon Creek Risk Assessment) were submitted by Umetco on September 15, 2000. Additional clarification was provided by Umetco's letter of November 17, 2000. The NRC staff approved the FSS Plan, and the "no action" alternative for East Canyon Creek (including the part of Carbide Draw north of the county road) on April 5, 2001. The Quality Control Program was provided by Umetco on August 14, 2000, indicating that 5 percent of the soil samples are to be sent to an outside laboratory as quality control samples. The draft procedures were reviewed with the FSS Plan and the final versions were reviewed during the July 2002 NRC inspection.

The Report addressed soil cleanup in Pond 1 (11 acres), the northern Windblown Area (111 acres surveyed and about 70 acres impacted), the DW-6 process water pipeline (3 miles long), Carbide Draw between the tailings dam and the county road, and three small trash pits. The volumes of soil removed and placed in the A-9 Repository during remediation are: Pond 1 - 30,000 cubic yards (cy), windblown area - 4,950 cy, pipeline trench - 18,338 cy, and Carbide Draw - 6,324 cy, for a total of 59,680 cy.

The Report also contains the gamma exposure survey data on the covers of the Above Grade Tailings Impoundment (AGTI) and Heap Leach Area (200 acres) to demonstrate compliance with Part 40, Appendix A, Criterion 6(1). Umetco indicated by letter dated January 26, 2004, that the required gamma exposure rates on the A-9 Repository, C-18 Pit, and Pond 2 covers, and data for a portion of the A-9 haul road will be provided as Addendum 2 and Addendum 3 to the Report after cover construction and road cleanup are completed.

TECHNICAL EVALUATION:

The NRC staff evaluated the Report for compliance with the approved FSS Plan and 10 CFR Part 40, Appendix A, Criterion 6(6) for soil cleanup. The impoundment covers were evaluated for compliance with the portion of Criterion 6(1), which states, "Direct gamma exposure from

the tailings or wastes should be reduced to background levels." This review was also performed to determine if the Report complies with 10 CFR 42(j)(2) in providing a radiation survey demonstrating that the site is suitable for release. To support this determination, the site was inspected and soil decommissioning activities were observed by an NRC inspector on July 31, 2002.

Building Cleanup

The FSS Plan indicated that the only building in the restricted area is a mobile soils laboratory and that it will be disposed in the tailings disposal cell when site reclamation is complete. However, the Report (page 4) stated that the laboratory will be surveyed and released. In response to NRC comment 2, the Addendum indicated that two laboratory trailers are on site. Umetco indicated that the newer trailer, Soils Lab A, should meet release criteria for unrestricted use, considering the trailer as a piece of equipment that will be moved off the site. The older trailer is presumed to be heavily contaminated and would be demolished and placed in the A-9 Repository.

Soil Criteria

The Windblown Area (north of the AGTI) has an approved Ra-226 soil background value of 6.1 pCi/g. Uranium/radium deposits were known to exist north of, and in, this area. The FSS Plan indicated that the other cleanup areas are adjacent to or within mining areas and that the site-wide background value of 10 pCi/g Ra-226 would apply.

Petroleum Cleanup

During the 2002 excavation of the north end of Pond 1, a petroleum odor was detected in the area of the former mill solvent catchment basin. This area was excavated an additional 6 feet until the odor was no longer detected. Later, five soil samples were analyzed for total petroleum hydrocarbon content because records indicated that a kerosene spill was the likely source of the contamination. The kerosene was used in the uranium recovery process so the contaminated soil is byproduct material, but the NRC has no cleanup limits for kerosene. Since kerosene is a Diesel Range Organic (DRO), the Wyoming cleanup standard for DRO of 100 mg/kg was used. None of the post-excavation samples exceeded 10 mg/kg.

Equipment and Procedures

The primary gamma survey method utilized a collimated (2 by 2-inch NaI crystal) detector, mounted on an all terrain vehicle, 12 inches above the land surface and coupled to a global positioning system. This and other equipment used in the final status survey appear to be as described in the FSS Plan. The procedures listed in Table 3.2 of the Report were reviewed during an NRC inspection in July 2002.

Radium-Gamma Correlation and Gamma Guideline

The initial radium-gamma correlation was submitted to the NRC by letter dated August 6, 2001. The staff provided approval with two conditions that Umetco addressed in Section 3.0.2 of the

Report. Appendix C-3 of the Report provided data from 150 soil samples that Umetco used to establish a revised gamma-radium correlation after excavation. Umetco did correlations for each meter used, and separate correlations for the Windblown Area and Pond 1.

The new correlations have low strength, but various data manipulations and evaluations were performed by Umetco to justify the gamma guideline used. Considering the data, site conditions, and the additional excavation in certain areas to assure soil cleanup, the gamma guideline appears adequate.

Quality Assurance

According to page 14 of the Report, all Pond 1 soil samples were shipped to an outside laboratory for analysis of Ra-226, Th-230 and U-nat. Five percent of the samples from the Windblown Area were also sent outside for confirmatory Ra-226 analysis. A portion of each sample was archived for potential future confirmatory analysis by the NRC. Data collection and management procedures were discussed in Appendix A of the Report. The quality assurance aspects of the decommissioning process were apparently followed per commitments in the FSS Plan.

Remedial Efforts

In August 2000, the Pond 1 liner was removed with other materials. A gamma survey and soil sampling in 2001 provided data for 383 (100 m^2) grids. Twenty grids with the highest gamma levels and samples from three test pits were analyzed for U-238 and Th-230 in addition to Ra-226. After a geochemical investigation (including chemical, mineralogic (X-ray diffraction) and petrographic analysis plus geochemical modeling), additional excavation and gamma surveys were conducted in May 2002. Of the geochemical test pits, three apparently were impacted by pond solution. Three to four feet of material in the northern section were indicated for removal but Umetco removed up to 6 feet of material to be conservative. Also, the pipeline trench was excavated several feet below the visible tailings, the southern portion of Carbide Draw was excavated to bedrock, and the trash pits were excavated 1 to 3 feet below the level of the trash.

Survey Results

Since Pond 1 was constructed on mine overburden, the gamma readings in some spots were higher after excavation. The average Ra-226 increased from 17 to 19 pCi/g after more soil removal (spots excavated to 10 feet deep). The final survey encompassed 4400 grids and provided 55,566 data points. According to Figure 5.15 in Volume II of the Report, 383 grids were surveyed and 5.8 percent were above the 25 pCi/g subsurface Ra-226 standard in the northern end of the Pond. The highest estimated value was about 40 pCi/g. The backfill will be over one foot in depth for this area as well as the pipeline trench and the trash pits.

For the Windblown Area, over 235,000 gamma data points were obtained for 4400 grids and 403 grids (9 percent) failed to meet the Criterion 6(6) surface soil Ra-226 criterion.
The pipeline trench results indicate that Ra-226 estimates for the majority of the 233 grids are

well below the 25 pCi/g standard. Only 10 grids exceed this standard and these are adjacent to the B-5 Pit. The maximum grid value was 30 pCi/g and likely reflects mining residue, not NRC licensed material.

Carbide Draw south of the county road (Dry Creek Road) was excavated to bedrock so further cleanup in this area is not realistic. The highest estimated Ra-226 grid value was 14.3 pCi/g which meets the 15 pCi/g site surface criterion.

The trash pits were located in mine spoils areas adjacent to the north end of the North Evaporation Pond and in the B-Spoils Area just south of the AGTI. Gamma scans were generally within background ranges. Only pit #3 had elevated Ra-226 levels. Soil samples analyzed for Ra-226, Th-230, and U-nat demonstrate that the U-nat values are similar to the levels of the two other radionuclides so the soil samples likely represent native material. Byproduct material would have low U-nat levels compared to the other radionuclides in the uranium decay chain.

The Report indicated that for four areas; the northern portion of Pond 1, some grids in the Windblown Area, the pipeline trench next to the B-5 Pit, and trash pit #1, cleanup of byproduct material uncovered uranium and radium mineralization (naturally occurring radioactive material (NORM)). Thus some spots had higher gamma levels after remediation than before soil removal. These NORM areas contain natural uranium deposits or uranium mine pit overburden with the same radionuclides (uranium (U-nat), Ra-226, and thorium (Th-230)) as the byproduct material and are very difficult to distinguish from tailings contaminated soil. Umetco had several procedures in the Survey Plan to make this distinction. Umetco found at the beginning of the final survey that these natural deposits were more extensive than previously indicated. In September 2003, Umetco used a germanium detector to better distinguish the areas containing byproduct material from NORM. No compelling differences were found. Any remaining byproduct material is indistinguishable from the immediate area background radiation.

The Addendum requested and justified an alternate soil criterion of "no further remedial action" for the four specific areas mentioned above. This was done based on the NRC staff's suggestion in the December 2003 request for addition information. On reviewing the recent data, staff has determined that alternate criteria are not needed. Since the four areas are essentially at local radiation background levels, and the presence of byproduct material can not be confirmed, Criterion 6(6) has been met.

In addition, Umetco requested approval of an alternate procedure for verification of compliance because the pipeline and trash pits were not surveyed or soil sampled by 100 m^2 grids as required by Criterion 6(6). The configuration of a deep narrow trench and trash pits created geometry problems for gamma detectors and the over excavation and visual inspection assured Umetco of byproduct material removal. Umetco did some soil sampling in the impacted area that was composited over 150 m^2 areas of the pipeline. To provide data by 100 m^2 grids, Umetco used geo-spatial estimation computer tools and gamma survey values. Several soil samples and gamma readings were obtained for each trash pit. Given the data provided, and considering the B-5 Pit as a local reference area for NORM, the staff considers that the procedures are adequate for these areas.

Impoundment Cover Radiation Levels

The average exposure rate measured on the earthen covers of the AGTI and the Heap Leach was 27 uR/hr, therefore, the gamma levels comply with the approved limit of 30 uR/hr. The potential dose is very low and the radiation levels on the Umetco site are comparable to the surrounding area.

CONCLUSIONS:

The staff determined that the approved Plan verification procedure was not followed for all areas, but that the procedures used for the pipeline trench and trash pits provided adequate data. The minor deviations from the FSS Plan do not impact health, safety, or the environment. The Report provides reasonable assurance that the areas addressed meet applicable criteria and are suitable for release based on the level of licensed material remaining.

ATTACHMENT 2

NRC Technical Evaluation of Final Status Survey Addendum 2

Submitted by letter dated September 5, 2001

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 1, 2005

Mr. Thomas E. Gieck
Remediation Leader
Umetco Minerals Corporation
P.O. Box 1029
Grand Junction, CO 81502

SUBJECT: THE UMETCO MINERALS CORPORATION FINAL STATUS SURVEY REPORT, ADDENDUM 2 (TAC LU0087)

Dear Mr. Gieck:

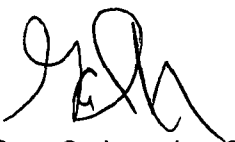
By letter dated May 11, 2005, the Umetco Minerals Corporation (Umetco) submitted Addendum 2 of the Final Status Survey Report (FSSR) for the Gas Hills uranium mill tailings site, for review by the U.S. Nuclear Regulatory Commission (NRC) staff. Addendum 2 of the FSSR provided the results of the gamma exposure rate surveys for the A-9 Repository and soil sampling from a portion of the Susquehanna Haul Road for the presence of byproduct materials. The gamma exposure rate measurements for the A-9 Repository were supplemented with soil sampling, for Ra-226 content, and radon emission rate measurements from the A-9 Repository cover material.

The staff has completed its review of the FSSR, Addendum 2, and concludes that the direct gamma exposure from the A-9 Repository has been reduced to background levels in compliance with 10 CFR Part 40, Appendix A, Criterion 6(1). The staff also concludes that the Ra-226 specific activity in the A-9 Repository cover is consistent with background levels and the radon emission rate from the cover complies with the limit in 10 CFR Part 40, Appendix A, Criterion 6(2). Lastly, the staff concludes that the Susquehanna Haul Road is not contaminated with byproduct material. The staff's review is documented in the enclosed Technical Evaluation Report (TER). This letter and the enclosed TER should be referenced in the forthcoming Construction Completion Report for the Gas Hills tailings site.

If you have any questions regarding this letter, please contact Rick Weller, the NRC Project Manager for the Gas Hills tailings site, at (301) 415-7287 or by e-mail to RMW2@nrc.gov.

In accordance with 10 CFR 2.390 of the NRC's Rules of Practice, a copy of this letter will be available electronically from the Publicly Available Records (PARS) component of NRC's document system Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html.

Sincerely,



Gary S. Janosko, Chief
Fuel Cycle Facilities Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

Docket No.: 40-0299
License No.: SUA-648

Enclosure: Technical Evaluation Report for
Final Status Survey Report, Addendum 2

cc: M. Moxley, WDEQ

TECHNICAL EVALUATION REPORT FOR
UMETCO MINERALS CORPORATION
FINAL STATUS SURVEY REPORT, ADDENDUM 2,
FOR THE
GAS HILLS URANIUM MILL TAILINGS SITE

DOCKET NO.: 40-0299

LICENSE NO.: SUA-648

FACILITY: Umetco Minerals Corporation Gas Hills Uranium Mill Tailings Site

TECHNICAL REVIEWER: Rick Weller

PROJECT MANAGER: Rick Weller

BACKGROUND:

In a letter dated May 11, 2005, Umetco Minerals Corporation (Umetco) submitted Addendum 2 of the Final Status Survey Report (FSSR) as part of Umetco's continuing effort to document the results of reclamation and cleanup of 11e.(2) byproduct material at the Gas Hills Uranium Mill Tailings Site. Specifically, Addendum 2 of the FSSR documents the results of the gamma radiation exposure rate surveys for the A-9 Repository (tailings) and soil sampling from the portion of the Susquehanna Haul Road which is not contained within a designed disposal cell. As the Susquehanna Haul Road was previously used as a designated return route for trucks disposing of uranium mill tailings material in the A-9 Repository, it had the potential for becoming contaminated with tailings material. As such, soil samples were obtained at selected locations and depths along the road to be analyzed for the presence of byproduct material. Addendum 2 of the FSSR supplements the information on cleanup progress documented in the FSSR and Addendum 1 submitted by Umetco letter dated September 2, 2004. The staff's review of the September 2, 2004 FSSR and Addendum 1 was provided in a letter dated September 27, 2004.

TECHNICAL EVALUATION:

A-9 Repository Gamma Exposure Surveys:

10 CFR Part 40, Appendix A, Criterion 6(1), states that "Direct gamma exposure from the tailings or waste should be reduced to background levels." To demonstrate compliance with this requirement, Umetco surveyed the completed earthen cover of the A-9 Repository for direct gamma exposure rates. A mean gamma exposure rate of 30 microroentgen per hour (μR /hr) was previously established as the site-wide value for background at the Gas Hills site. One-meter high gamma exposure rate measurements were taken along grid lines approximately 10 meters apart. Both bare and collimated gamma detector readings were taken because of the contribution to exposure rates from gamma "shine" from adjacent naturally occurring radioactive

materials on the south, east, and west boundaries of the below grade A-9 Repository. A total of 38,698 measurements were recorded with the bare detector and 33,446 were recorded with the collimated detector. While the September 2000 Final Status Survey Plan specified a density of one gamma exposure rate measurement per acre of repository surface, the density of readings taken over the 60 acre A-9 Repository was in excess of 550 measurements per acre.

The gamma exposure rate measurements were supplemented with soil sampling, for Ra-226 content, of the final 2 feet of A-9 Repository cover material utilized as frost protection, for comparison with the site-wide background value of 10 picocuries per gram (pCi/g) for Ra-226 specific activity. Lastly, radon emission rates were measured from the A-9 Repository cover for comparison with the regulatory limit in 10 CFR Part 40, Appendix A, Criterion 6(2), of 20 picocuries per square meter per sec (pCi/m^2s) and the radon emission rate data from the Above Grade and Heap Leach Repositories. The soil sample and radon emission rate results were utilized by Umetco to support their determination that the elevated gamma exposure rates from bare detector measurements were due to "shine" not related to materials in the A-9 Repository.

The mean gamma exposure rates for the A-9 Repository were 33 µR/hr from the bare detector surveys and 28 µR/hr from the collimated detector surveys. The collimated detector surveys are consistent with the site-wide value of 30 µR/hr for background at the Gas Hills site. Analysis of composite samples from 23 grid locations within the A-9 Repository cover indicated that the Ra-226 specific activity is also consistent with the site-wide background value of 10 pCi/g. Lastly, the radon emission rate for the A-9 Repository cover was determined to be 3.5 pCi/m^2s, well within the regulatory limit of 20 pCi/m^2s in 10 CFR Part 40 and consistent with radon emission rate measurements from the Above Grade (1.4 pCi/m^2s) and Heap Leach Repositories (1.1 pCi/m^2s).

Susquehanna Haul Road

The Susquehanna Haul Road was previously used by trucks potentially contaminated with uranium mill tailings material and portions of that road are now contained within the Heap Leach and GHP-2 Repositories. However, approximately 722 feet of the road remain that are not contained within a designed tailings cell. As such, Umetco collected soil samples at various grid locations and depths in that portion of the road to analyze for the presence of byproduct material contamination. To analyze for the presence of byproduct material, Umetco obtained soil samples from 22 ten meter square grid locations along the center of the road. Five soil sample locations were selected within each grid to develop a composite sample for each grid. The composite samples were analyzed for Ra-226,Th-230, and U-nat specific activity where U-238 comprises about half of the U-nat activity. The ratio of Ra-226 to U-238 was used to determine the presence of byproduct material.

Regarding the tailings material at Gas Hills, the ratio of Ra-226 to U-238 activity is 13.7, whereas, the ratio of Ra-226 to U-238 in background samples ranges from 2.0 to 0.5. The mean ratio of Ra-226 to U-238 for the 22 grid locations on the Susquehanna Haul Road was 2.01 which corresponds with the upper value of the ratio for Ra-226 to U-238 in background materials at the Gas Hills site. Thus, soil sampling of the Susquehanna Haul Road does not indicate the presence of contamination from tailings or byproduct material.

SUMMARY AND CONCLUSIONS:

The staff concludes that the direct gamma exposure from the A-9 Repository has been reduced to background levels in compliance with 10 CFR Part 40, Appendix A, Criterion 6(1). The staff also concludes that the Ra-226 specific activity in the A-9 Repository cover is similar to background levels and the radon emission rate from the cover complies with the limit in 10 CFR Part 40, Appendix A, Criterion 6(2). Lastly, the staff concludes that the Susquehanna Haul Road is not contaminated with byproduct material.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

"PLATE 1 - FINAL SITE PLAN REFLECTING CONSTRUCTION COMPLETION GAS HILLS, WYOMING"

WITHIN THIS PACKAGE...

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