Department of Energy
Office of Legacy Management

JAN 29 2009

Myron Fliegel
U.S. Nuclear Regulatory Commission
Mail Stop T8 F5
Washington, DC 20555-0001

Subject: Draft Revised Long-Term Surveillance Plan for the Shirley Basin South, Wyoming, UMTRCA Title II Site

Dear Mr. Fliegel:

Enclosed for the U.S. Nuclear Regulatory Commission's (NRC) review and concurrence are four copies of the draft revised *Long-Term Surveillance Plan for the Shirley Basin South (UMTRCA Title II) Disposal Site, Carbon County, Wyoming* (LTSP).

The draft revised LTSP is complete, except for a placeholder that was left in Appendix A for the NRC acceptance letter for this revised LTSP.

The U.S. Department of Energy (DOE) has revised the previously approved original LTSP (dated December 2004) to incorporate ground water monitoring changes. The changes were prompted by the exceedance of alternate concentration limits (ACLs) for radium-228 and cadmium in two monitor wells at the site. Our investigation of this occurrence indicated that the ACLs for these two constituents had been exceeded on numerous occasions prior to the site being transferred to DOE. To address this noncompliance issue, DOE, in consultation with NRC, installed additional monitor wells at the site and reevaluated the ground water monitoring program.

Six new monitor wells were installed down gradient of the disposal cell in fall 2008—three in each of the two uppermost aquifers (Upper Sand and Main Sand aquifers)—to provide a better understanding of the ground water conditions at the site. The new wells were sited along predicted contaminant migration paths presented in the ACL application prepared by the former licensee. The ACL application and supporting documentation, historical ground water data, and data from the newly installed wells were reviewed and analyzed. The resulting ground water monitoring evaluation is included in Appendix D of the revised LTSP.

Proposed changes incorporated into the revised LTSP and are summarized as follows.

- Section 2.3.5 "Site Geology" was expanded based on the research and construction associated with installing the new monitor wells. Included is a new figure representing a cross section through the site (Figure 2–5).

- Section 2.5 "Ground Water Conditions" was rewritten based on the research and construction associated with installing the new monitor wells.
- Section 3.7 "Environmental Monitoring" was rewritten to incorporate the results of the ground water monitoring evaluation. Several constituents, including radium-228 and cadmium, were determined to be naturally occurring and not good indicators of cell performance; therefore, DOE proposes that they be removed from the ground water monitoring program. DOE proposes to monitor the following constituents that are likely to be the best indicators of disposal cell performance: radium-226, thorium-230, uranium, chloride, nitrate, sulfate, and TDS. The respective ACLs and ground water protection standards for these constituents remain unchanged from the original LTSP.
- DOE determined that original well MW-54-SC, documented as representing the uppermost (Upper Sand) aquifer, is actually continuously screened through both the Upper Sand and Main Sand aquifers. To avoid potential cross contamination between the aquifers, DOE proposes to decommission the well. A replacement monitor well (MW-101-SC), screened in the Upper Sand aquifer, was installed near well MW-54-SC.

Other minor changes were made throughout the revised LTSP to make it up-to-date with current document standards and protocols.

Your prompt reply with any comments to this draft revised LTSP is appreciated. It is our desire to decommission monitor well MW-54-SC as soon as possible, dependent on NRC concurrence to this LTSP. Please call me at (720) 377-9682 if you have questions.

Sincerely,

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Scott Surovchak
Site Manager

Enclosures

cc w/enclosures:
File: SBS 505.15 (Roberts)

cc w/o enclosures:
S. Cohen, NRC
R. Bush, DOE-LM
C. Carpenter, Stoller (e)
D. Johnson, Stoller (e)
M. Widdop, Stoller (e)

LMS/SBS/S00799-1.0

Long-Term Surveillance Plan for the Shirley Basin South (UMTRCA Title II) Disposal Site, Carbon County, Wyoming

February 2009

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(Formerly DOE-LM/GJ766-2004)

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Long-Term Surveillance Plan for the Shirley Basin South (UMTRCA Title II) Disposal Site, Carbon County, Wyoming

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Acronyms and Abbreviations

ACL	alternate concentration limit
BLM	U.S. Bureau of Land Management
CAP	corrective action program
CFR	*Code of Federal Regulations*
COC	constituent of concern
DOE	U.S. Department of Energy
LM	DOE Office of Legacy Management
LTSP	long-term surveillance plan
mg/L	milligrams per liter
MW	monitor well
NRC	U.S. Nuclear Regulatory Commission
pCi/L	picocuries per liter
PMF	probable maximum flood
POC	point of compliance
TDS	total dissolved solids
UMTRCA	Uranium Mill Tailings Radiation Control Act
USC	*United States Code*

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1.0 Introduction

1.1 Purpose

This Long-Term Surveillance Plan (LTSP) explains how the U.S. Department of Energy (DOE) will fulfill general license requirements of Title 10 *Code of Federal Regulations* Part 40.28 (10 CFR 40.28) as the long-term custodian of the former Petrotomics (Texaco) Shirley Basin uranium mill tailings disposal site in Carbon County, Wyoming. The DOE Office of Legacy Management (LM) in Grand Junction, Colorado, is responsible for the preparation, revision, and implementation of this LTSP (Revision 1.0) for the Shirley Basin South, Wyoming, disposal site, which specifies procedures for inspecting the site, monitoring, maintenance, annual and other reporting requirements, and maintaining site records.

1.2 Legal and Regulatory Requirements

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Title 42 *United States Code* Part 7901 (42 USC 7901), as amended, provides for the remediation (or reclamation) and regulation of uranium mill tailings at two categories of mill tailings sites, Title I and Title II. Title I includes former uranium mill sites that were unlicensed as of January 1, 1978, and essentially abandoned. Title II includes uranium milling sites under specific license as of January 1, 1978. In both cases, the licensing agency is the U.S. Nuclear Regulatory Commission (NRC), or in the case of certain Title II disposal sites, an Agreement State. The former Petrotomics Shirley Basin site is regulated as a Title II site under UMTRCA. The State of Wyoming is not an Agreement State.

Federal regulations under 10 CFR 40.28 provide for the licensing, custody, and long-term care of uranium and thorium mill tailings sites closed (reclaimed) under Title II of UMTRCA. NRC issues a general license for the custody and long-term care, including monitoring, maintenance, and emergency measures necessary to ensure that uranium and thorium mill tailings disposal sites will be cared for in a manner that protects public health, safety, and the environment after closure (completion of reclamation activities). The general license becomes effective when NRC or an Agreement State terminates the current specific license and when NRC accepts a site-specific LTSP.

The original LTSP for the Shirley Basin South disposal site (DOE 2004) received NRC concurrence on June 8, 2005 (Appendix A). The NRC acceptance letter for this revision of the LTSP (Revision 1.0) is also included in Appendix A.

Requirements of the LTSP and general requirements for the long-term custody of the Shirley Basin South site are addressed in various sections of the LTSP (Table 1–1).

The plans, procedures, and specifications in this LTSP are based on the guidance document *Guidance for Implementing the Long-Term Surveillance Program for UMTRCA Title I and Title II Disposal Sites* (DOE 2001). Rationale and procedures in the guidance document are considered part of this LTSP.

Table 1–1. Requirements of the LTSP and for the Long-Term Custodian (DOE) of the Shirley Basin South, Wyoming, Disposal Site

Requirements of the LTSP		
	Requirement	*Location*
1.	Description of final site conditions	Section 2.0
2.	Legal description of site	Appendix A
3.	Description of the long-term surveillance program	Section 3.0
4.	Criteria for follow-up inspections	Section 3.5.1
5.	Criteria for maintenance and emergency measures	Section 3.6.3
Requirements for the Long-Term Custodian (DOE)		
	Requirement	*Location*
1.	Notification to NRC of changes to the LTSP	Section 3.1
2.	NRC permanent right-of-entry	Section 3.1
3.	Notification to NRC of significant construction, actions, or repairs at the site.	Sections 3.5 and 3.6

1.3 Role of the Department of Energy

In 1988, DOE designated the Grand Junction, Colorado, office as the program office for managing long-term surveillance and maintenance of DOE disposal sites that contain regulated low-level radioactive materials and portions of sites that do not have a DOE mission after cleanup, as well as other sites (including Title II sites) as assigned, and to establish a common office for the security, surveillance, monitoring, and maintenance of those sites.

LM was formally established in December 2003. The LM mission includes "...implementing long-term surveillance and maintenance projects at sites transferred to LM to ensure sustainable protection of human health and the environment."

2.0 Final Site Conditions

Reclamation at the Shirley Basin South mill facility in Carbon County, Wyoming, consisted of demolishing site structures and relocating the contaminated structural materials and contaminated mill site soils to the Shirley Basin South disposal cell adjacent to the former mill.

2.1 Site History

The Petrotomics uranium mill began operation in 1962 as a 500-ton-per-day mill. In 1968, the mill was expanded to 1,000-tons-per-day production by the addition of thickeners, leach tanks, and another solvent extraction circuit. In 1970, the mill was expanded again to a capacity of 1,500 tons per day (Getty 1981).

The ore being processed through the mill came from open pit mines in the immediate vicinity of the mill. The mill was a conventional acid leach uranium-ore processing plant (Getty 1981). Chemical reagents used in the milling and solvent extraction process included ammonia, sodium chlorate and chloride, and sulfuric acid.

The tailings from milling operations were placed in the tailings pond from the beginning of operation in 1962. In 1977, an amendment to the NRC license allowed a new dam to be constructed over the original dam. The new dam, completed in 1979, raised the elevation of the tailings impoundment approximately 35 feet (Getty 1981).

In 1985, due to the depressed uranium market, the mining and milling operations were shut down, and mill decommissioning commenced. Mill components that were not salvaged and sold were buried or placed in the disposal cell (Petrotomics 2001).

NRC approved the reclamation plan in 1989. Reclamation included remediation of the contaminated aquifer underlying the impounded tailings. Groundwater was pumped from numerous extraction wells until the tailings and the aquifer were essentially dewatered. The pumped water was evaporated in lined ponds. Further remediation was impractical; therefore, Petrotomics applied for alternate concentration limits (ACLs) in 1996 and was granted NRC concurrence in 1998. The cell cover was completed in 2000, and final site reclamation was completed in 2001 (Petrotomics 2001).

2.2 General Description of the Disposal Site Vicinity

The Shirley Basin South disposal site is located in rural Carbon County, approximately 48 miles south of Casper and 35 miles north of Medicine Bow, Wyoming (Figures 2–1 and 2–2).

The site is at an elevation of about 7,100 feet. The area topography is typical of eastern Wyoming plains with moderate elevation changes. Topography in the immediate vicinity of the site is characterized by rolling hills and valleys. Elevation differences of 250 feet are present within 2 to 3 miles of the site (Getty 1981).

The climate of the Shirley Basin is arid to semiarid, with low annual precipitation (approximately 10 inches) and a frost-free growing season of less than 90 days. More than 50 percent of the annual precipitation is received during the months of April, May, and June in

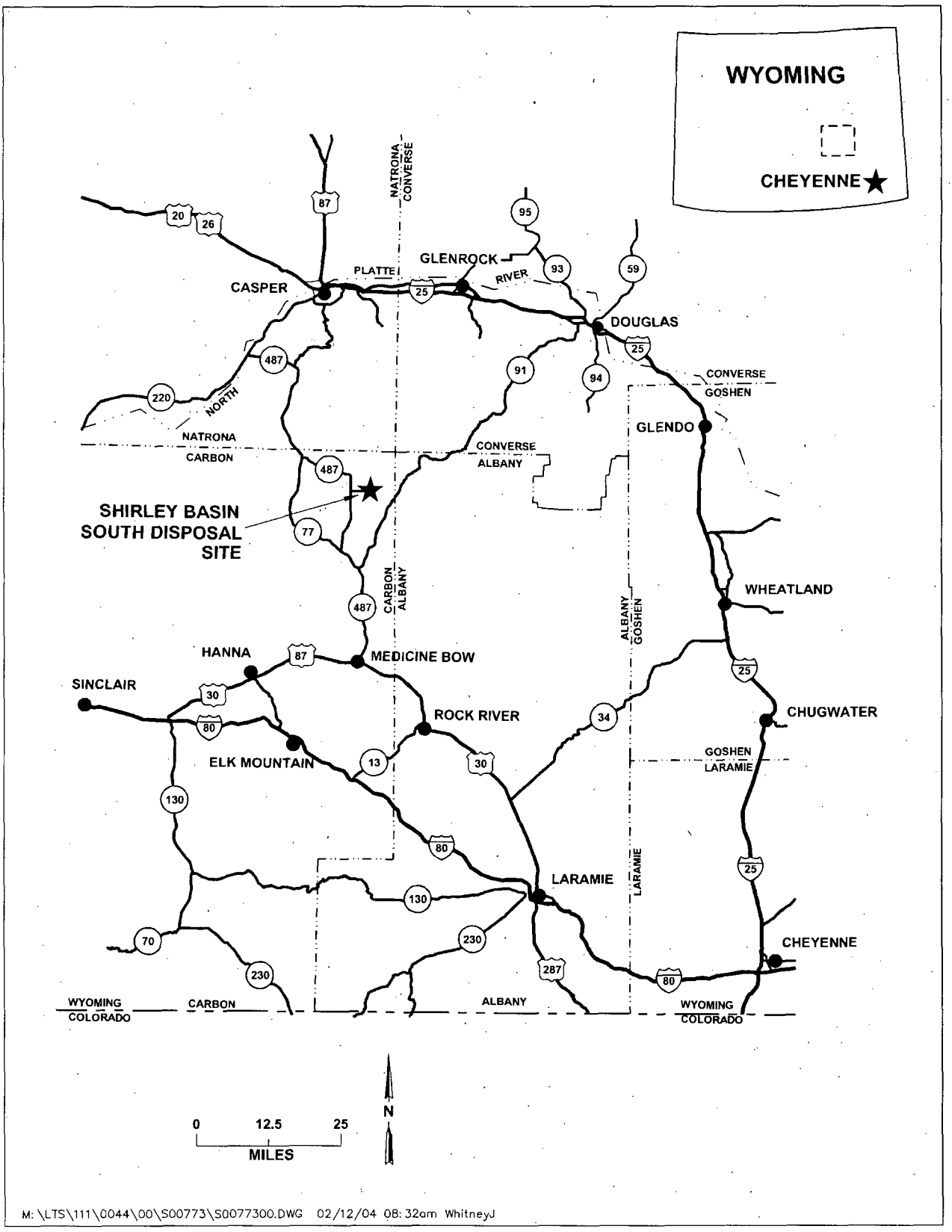

Figure 2–1. General Location Map of the Shirley Basin South, Wyoming, Disposal Site

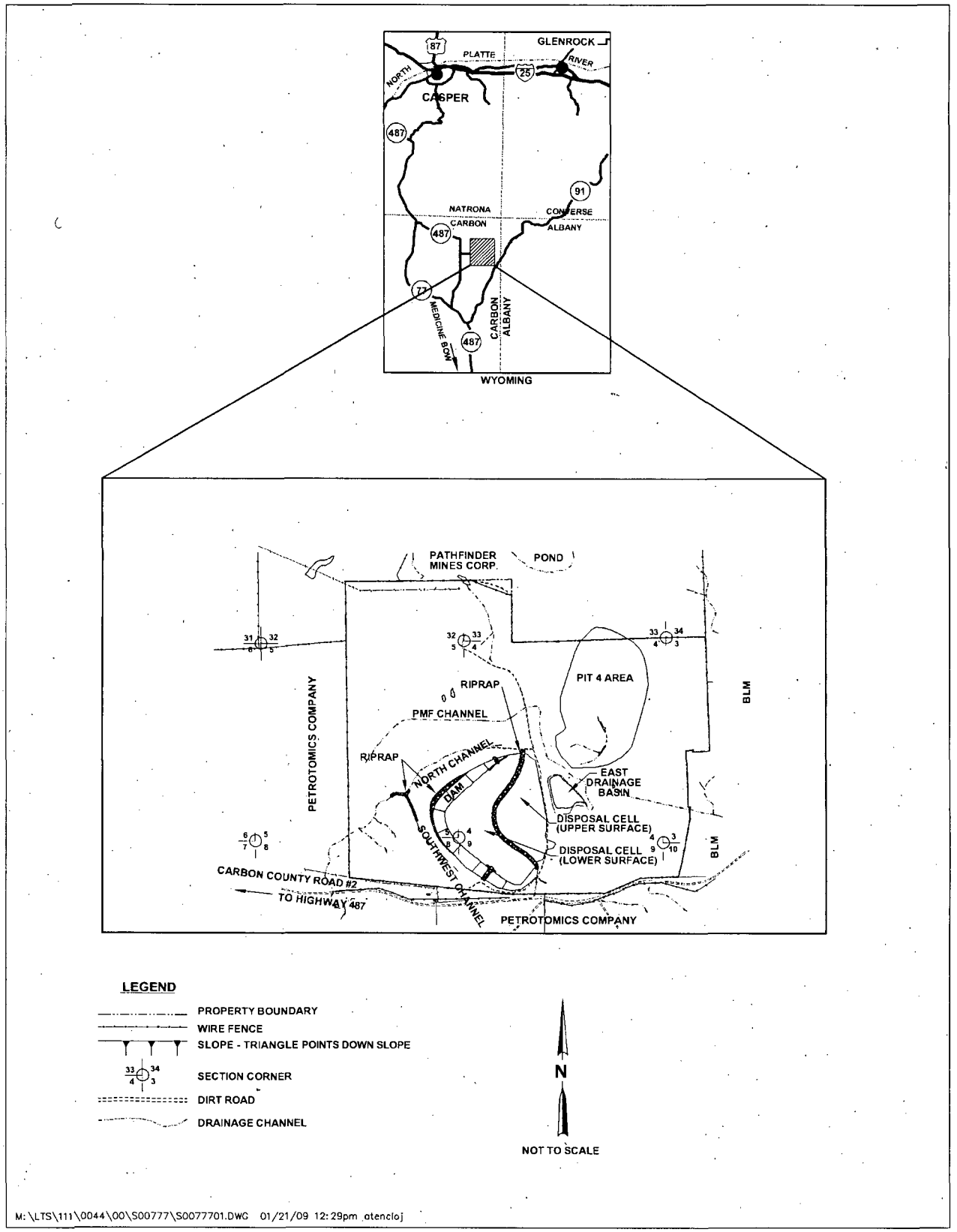

Figure 2–2. Vicinity Location Map Shirley Basin South, Wyoming, Disposal Site

the form of wet snows and rain. Temperatures vary from summer highs near 100 °F to winter lows near –40 °F. The seasons are distinct, with mild summers and harsh winters.

Spring and fall are transitional seasons, with warm days and cold nights. Heavy snowfalls can occur during both spring and fall. Extreme fluctuations in temperatures from day to day and in annual precipitation from year to year are common. These climatic variations have a strong effect on vegetation and in determining land capabilities and use. Summers are accompanied by prevailing southwesterly winds that become stronger as fall approaches. Winter winds are often from the northwest, creating blizzard conditions (Getty 1981).

The primary land uses in the immediate surrounding vicinity are livestock grazing during the summer season, wildlife habitat, and mineral exploration and extraction. Numerous reclaimed open pit mines exist within and in the immediate vicinity of the site. About 3 miles north of the site is the UMTRCA Title II Pathfinder Shirley Basin mine and mill site.

2.3 Disposal Site Description

2.3.1 Site Ownership

The United States Government owns the 1,512-acre Shirley Basin South disposal site property. Supporting real estate information is presented in Appendix B. The site, illustrated on Plate 1, is entirely fenced with a barbed-wire stock fence.

2.3.2 Directions to the Disposal Site

From Casper, Wyoming, travel southwest on State Highway 220 approximately 20 miles to the junction with State Highway 487. Turn left and proceed south on State Highway 487 for approximately 38 miles, passing the entrance to the Pathfinder Shirley Basin North site while en route to the Shirley Basin South site. Turn left and proceed east on Carbon County Road #2 for approximately 2 miles to the site. The site is on the north side of the county road. Alternatively, from Medicine Bow, Wyoming, travel north on State Highway 487 for approximately 33 miles and turn right on Carbon County Road #2.

2.3.3 Description of Surface Conditions

The disposal cell occupies approximately 142 acres in the southwest portion of the disposal site property. To the northeast of the disposal cell and mostly on the disposal site is a reclaimed and partially backfilled 153-acre former open pit mine known as Pit 4. A man-made hill located in the northwest portion of the site is a reclaimed spoils pile from mine overburden. Reclaimed first-generation open pit uranium mines and spoils piles are present in the southeast portion of the site. Site topography is shown on Plate 2.

The final surface conditions at the Shirley Basin South site incorporate a combination of rock armoring, contouring, and revegetation to achieve the necessary surface water and runoff control and erosion protection to satisfy the longevity design requirements. The revegetated surfaces have been planted with a mix of prairie grasses that have proven to be successful in reclaiming disturbed areas at the site and will provide soil stability.

A combination of contoured topography, drainage swales, and diversion channels convey incident surface water away from the tailings disposal cell. Surface water is conveyed off site or to closed drainage basins on site that are sized to accommodate the runoff from the design precipitation event. Critical portions of the surface drainage system where design basis flow velocities could cause erosion are armored with durable rock riprap.

North of the disposal site on property owned by the Pathfinder Mines Corporation is a very large former open pit mine known as Pit 33. Groundwater is currently refilling the pit. This refilling will continue until the pre-mining equilibrium water table is reestablished. Part or all of the Pathfinder Mines site will eventually be transferred to DOE and become the Shirley Basin North Title II site.

2.3.4 Permanent Site Surveillance Features

Boundary monuments, a site marker, and warning signs are the permanent long-term surveillance features at the Shirley Basin South disposal site. These features, shown on Plate 1, will be inspected and maintained as necessary as part of the passive institutional controls for the site.

Twenty-six survey monuments mark the final site boundary. These monuments are a combination of the standard UMTRCA disposal site aluminum-cap monuments placed by the surveyor on behalf of Petrotomics Corporation, and brass-cap monuments placed by the U.S. General Land Office, the Bureau of Land Management (BLM), and previous property boundary surveys. Two witness corners, identified as boundary monuments BM–23 and BM-23A, were placed in lieu of a corner monument to mark the unstable north property corner on the steep slope in the southwest part of Pathfinder's Pit 33.

One unpolished granite marker with an incised message identifying the site of the Shirley Basin South disposal cell is placed on site property just inside the main entrance gate adjacent to the county road. The message on the granite site marker is shown on Figure 2–3.

Twenty-five warning signs displaying the DOE 24-hour telephone number (Figure 2–4) were placed around the tailings disposal cell and former mill site, each approximately 500 feet apart. Nine more signs were placed along the site property boundary at positions most likely to be approached from off site.

2.3.5 Site Geology

The Shirley Basin is a southeastward extension of the Wind River Basin and lies between the Sweetwater Arch and the Laramie Range. The Laramie Mountains are to the northeast, and the Shirley Mountains are to the southwest. It is an area of low to moderate relief (Getty 1981).

The Eocene-age Wind River Formation is the uppermost geologic formation at the site. It was deposited in large streams that drained the Granite Mountains highland to the southwest and consists of interbedded, poorly cemented layers of sandstone, conglomerate, siltstone, and claystone. The characters and thicknesses of the beds vary greatly and are subject to abrupt lateral changes (Getty 1981, Petrotomics 1997). Well lithologic logs show that the formation dips approximately 1 degree to the northeast in the immediate vicinity of the disposal cell.

SHIRLEY BASIN SOUTH, WYOMING

DATE OF CLOSURE: OCTOBER 2000

TONS OF TAILINGS: 6,316,000

RADIOACTIVITY: 974 Curies, Ra-226

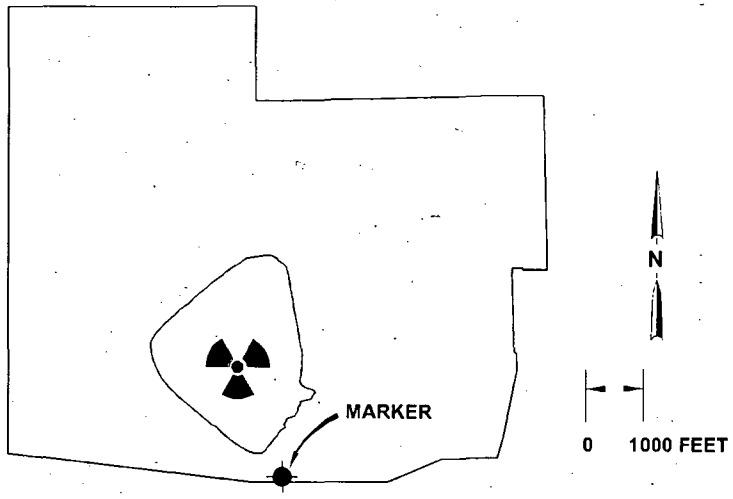

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Figure 2–3. Site Marker at the Shirley Basin South, Wyoming, Disposal Site

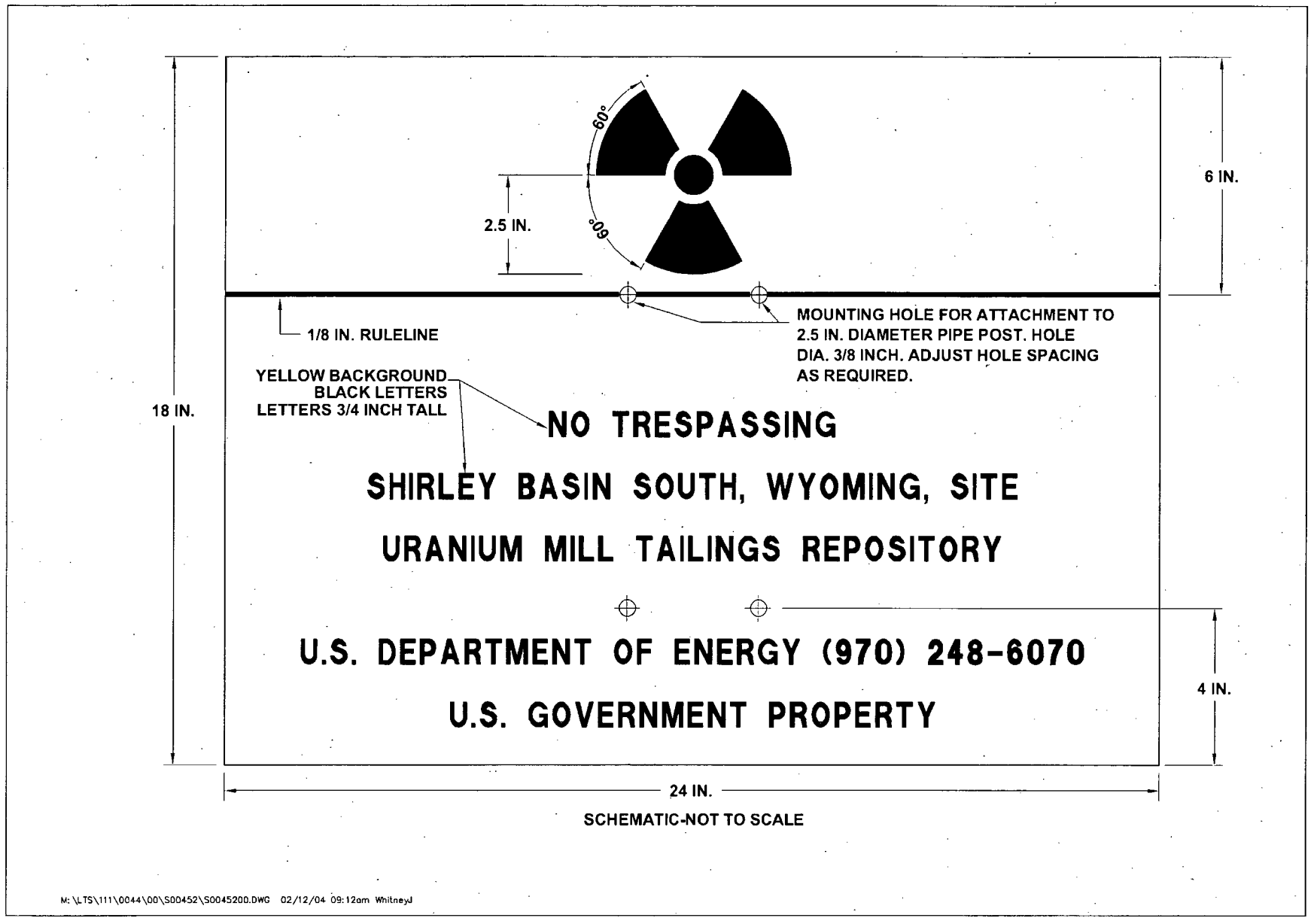


Figure 2–4. Warning Sign at Shirley Basin South, Wyoming, Disposal Site

Roll-front uranium deposits are found in major sandstone beds, or units, throughout the Wind River Formation. Although numerous sandstone units and locally isolated lenses occur within the Wind River Formation at the site, only three have hydrogeologic significance: the Upper Sand, Main Sand, and Lower Sand units. The Upper Sand and Main Sand units are represented on the cross section shown on Figure 2–5. The cross section follows the northeast dip of the units, and its location is shown on Plate 2. Depths and thicknesses of the Upper Sand and Main sand units shown on the cross section were derived from lithologic logs of the DOE monitor wells and geophysical logs conducted and analyzed by the former licensee (Petrotomics 1997).

The Upper Sand unit crops out immediately south of the disposal cell and is the shallowest continuous sandstone unit under the cell. It ranges from 10 to 40 feet in thickness and averages about 15 feet in thickness downgradient of the cell until it coalesces with the underlying Main Sand unit in the Pit 4 area.

Generally, the Main Sand unit is separated from the overlying Upper Sand unit by 10 to 40 feet of claystone composed of volcanic-ash-derived swelling clays. The claystone layer acts as an aquitard; however, it is absent beneath the northern tip of the disposal cell and at the mine location. The Main Sand unit crops out south of the site and has an average thickness of about 50 feet in the vicinity of the disposal cell. This unit contained the uranium ore body that was open-pit mined at the site. At the mine location, known as Pit 4, the Main Sand unit was at its greatest thickness and coalesced with the Upper Sand unit, resulting in a combined average thickness of approximately 140 feet (Figure 2–5). This entire thickness was mined in Pit 4.

An aquitard more than 50 feet thick consisting of interbedded claystones, siltstones, and thinly-bedded sandstones separates the Main Sand unit from the Lower Sand unit. The Lower Sand unit, approximately 100 feet thick at the site, was unaffected by uranium mineralization and yields the largest quantity and best quality of groundwater in the Shirley Basin (Petrotomics 1996). A well (MW-K.G.S.#3) completed in this aquifer at the site provided a potable water supply for mine operations.

During reclamation activities, the outer wall of Pit 4 was recontoured, and the pit was partially backfilled with excavated mine overburden (Figure 2–5). The current bottom elevation is slightly above the upper surface of the Upper Sand unit as it existed prior to mining operations. This was done to prevent surface ponding of groundwater flowing through the Upper Sand and Main Sand units.

2.4 Disposal Cell Design

2.4.1 Containment Dam

The original tailings impoundment consisted of an earthen dam constructed around 1963. The embankment was approximately 5,000 feet long with a maximum height of 35 feet. An expansion of the tailings embankment was completed in 1979. This expansion resulted in a crest length of approximately 6,400 feet, a top width of 50 feet, and a maximum height of 75 feet. The tailings were pumped to the impoundment as a slurry mixture (Getty 1981). This tailings dam, which is horseshoe-shaped in plan view, was incorporated into the disposal cell design as the containment dam.

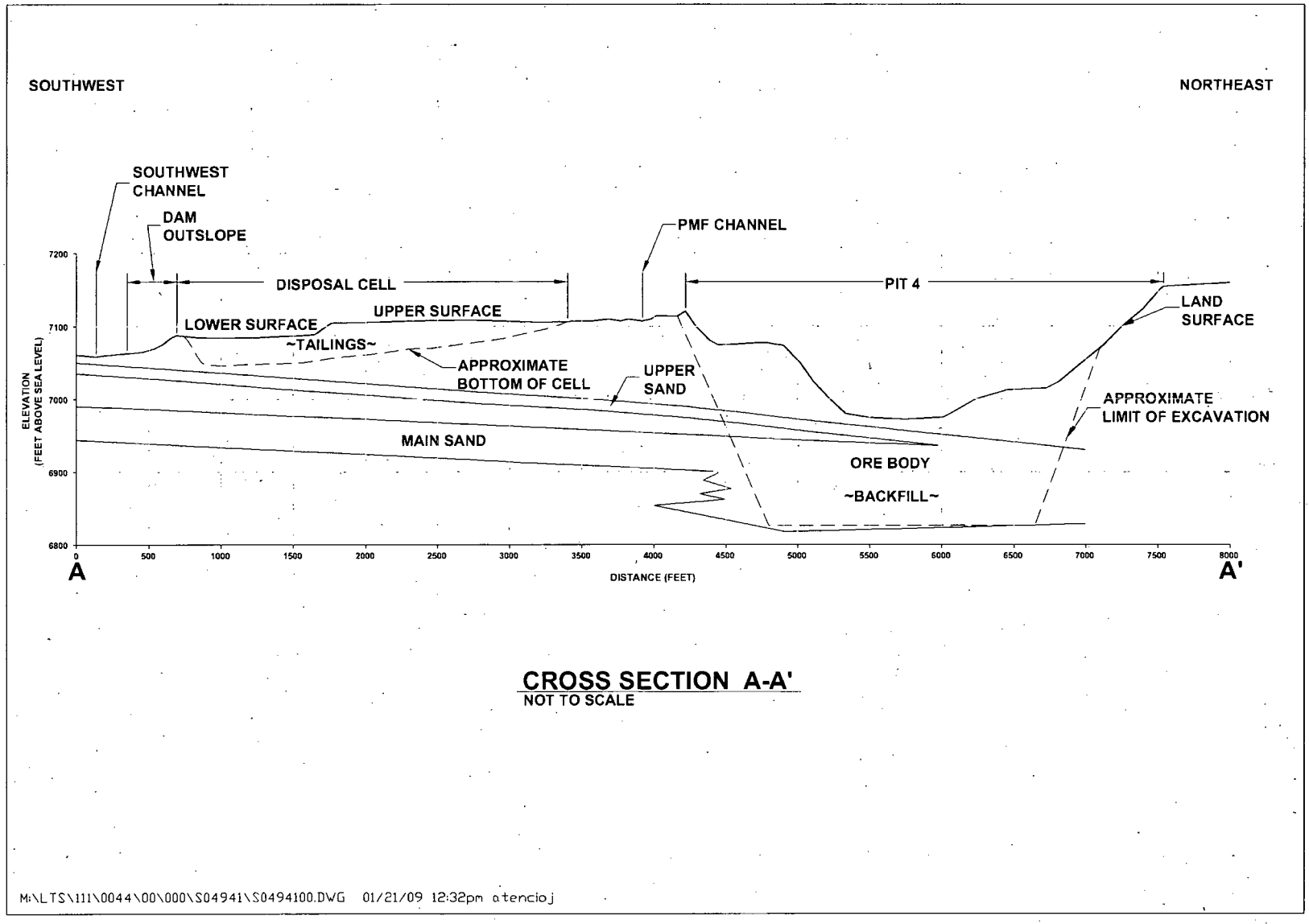


Figure 2–5. Cross Section A–A' of the Shirley Basin South, Wyoming, Disposal Site

2.4.2 Disposal Cell Cover

The unlined tailings pile was reclaimed in place behind the containment dam. The reclaimed tailings impoundment (disposal cell) covers approximately 142 acres. The objective of the disposal cell cover is to isolate the uranium mill tailings from the surrounding environment. This is accomplished by reducing radon gas emissions from the tailings, minimizing infiltration of precipitation that could potentially leach contaminants into the subsurface, and physically containing the contaminated materials to prevent dispersion.

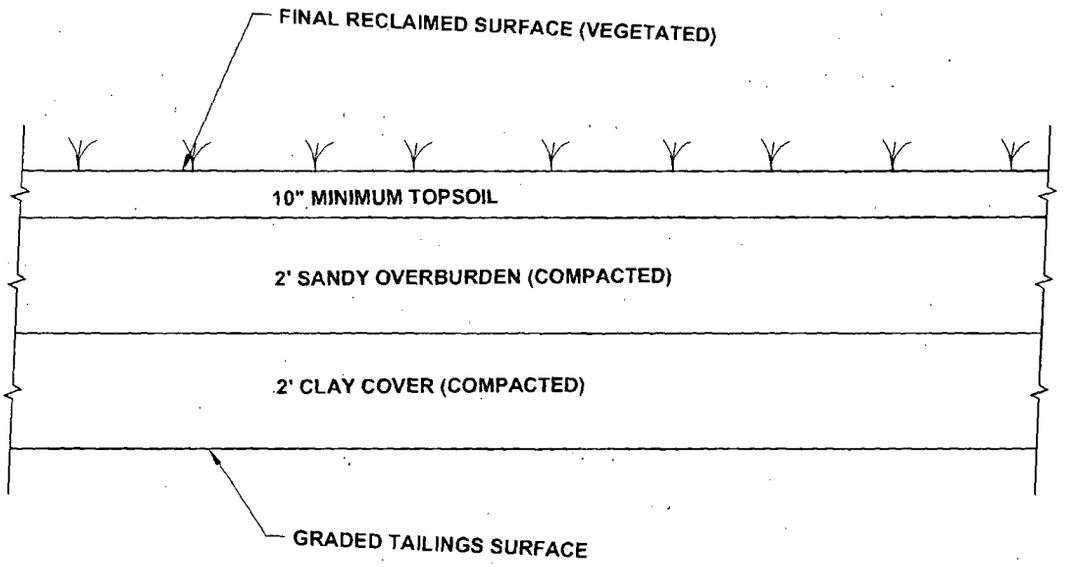
The disposal cell cover, sloped to shed precipitation runoff, consists of 2 feet of compacted clay, 2 feet of compacted sandy overburden, and a minimum of 10 inches of topsoil (Figure 2–6). The compacted clay layer performs as a radon barrier that effectively attenuates the radon gas through radioactive decay, thus reducing emission rates to the atmosphere to levels below regulatory standards. The sandy layer allows precipitation that infiltrates through the topsoil to discharge from the cover without eroding the radon barrier. The topsoil layer, vegetated primarily with grasses that are well adapted to the area, protects the sandy layer and radon barrier from erosion. Although the tailings were reclaimed in place without an underlying liner, groundwater remediation essentially dewatered the tailings. Consequently, contaminants in the tailings are not expected to leach into underlying aquifers as long as the cover performs as designed.

2.4.3 Surface Water Diversion System

The surface water diversion system consists of a combination of contoured surfaces, diversion channels, and drainage basins (Plate 2). Riprap armor was placed on the steeper slopes and flow concentration points where design flow velocities would have the potential to erode the tailings encapsulation surfaces without riprap armoring.

Precipitation falling on roughly the east half of the upper disposal cell surface will flow into the east drainage basin. Rain falling on roughly the west half of the upper surface will flow down a riprap-armored 5:1 slope to the lower tailings area. Precipitation falling on the lower disposal cell surface, in addition to runoff from the upper surface, is conveyed to either the north swale discharge point or the south swale discharge point and on into the north diversion channel or the southwest diversion channel, respectively. The two discharge points are armored with riprap. Precipitation will also be shed down the face of the tailings dam outslope into either the north or southwest diversion channels. The steeper sections (5:1 slope) of the tailings dam outslope are also armored with riprap. Water in the north and southwest diversion channels flows to the riprap-armored channel confluence point and is discharged to a southwest-trending natural drainage feature. The diversion channel system hydraulically isolates the tailings, preventing erosion over the long term and helping to achieve the necessary impoundment stability (Petrotomics 2001).

Located north of the disposal cell is the probable maximum flood (PMF) channel that is designed to isolate and protect the disposal cell from precipitation runoff in areas topographically upgradient of the disposal cell (Petrotomics 2001). Part of the PMF channel drains to the west and discharges to a small, closed basin. A larger drainage area is captured by the portion of the PMF channel that flows eastward and discharges into the east drainage basin, which is a closed basin just east of the tailings embankment. The drainage basins are large enough to accommodate the PMF water volumes.



TYPICAL DISPOSAL CELL COVER CROSS SECTION

NOT TO SCALE

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Figure 2–6. Typical Disposal Cell Cover Cross Section at the Shirley Basin South, Wyoming, Disposal Site

2.5 Groundwater Conditions

The uppermost aquifers at the site are in the Upper Sand and Main Sand units of the Wind River Formation. Both aquifers originate at outcrops near the south boundary of the site, and neither is used as a source for drinking water or for any other beneficial purposes on or downgradient of the site. The groundwater quality is generally poor because of naturally occurring uranium mineralization and human activities related to uranium exploration and mining that occurred in the area from the late 1950s to the early 1990s.

Although these aquifers are hydraulically distinct units over portions of the site, they act as a single hydrologic unit where the claystone aquitard between them is not present. As discussed in Section 2.3.5, the two units coalesce beneath the northern tip of the disposal cell and in the immediate vicinity of Pit 4. The Upper Sand and Main Sand units dip to the northeast at the site, and the natural groundwater flow direction follows the dip to the northeast. Pit 4 is located directly along the flow path of groundwater from the disposal cell location.

These aquifers were affected by seepage from the tailings impoundment during milling operations. Although the recovery of tailings seepage water had been ongoing for a number of years, the groundwater corrective action program (CAP) formally began in 1988. The CAP was designed to recover contaminated groundwater and to control and minimize the spread of the tailings seepage (Petrotomics 1996). Site seepage recovery and groundwater remediation activities essentially dewatered the Upper Sand aquifer and the impounded tailings, thus reducing the source term. The extracted water was evaporated on site in lined ponds; the liners and accumulated evaporites eventually were disposed of in the cell.

The CAP was able to significantly reduce constituent concentrations but did not achieve the site cleanup standards because continued efforts to dewater the aquifer proved to be unproductive. The results of the CAP, consequently, were considered to be as low as reasonably achievable. Therefore, Petrotomics Company applied to NRC for ACLs in 1996 (Petrotomics 1996). After discussion and amendments to the application, NRC concurred with the request for ACLs in October 1998 (NRC 1998). ACLs were granted for constituents of concern, as discussed in Section 3.7.

Mining operations at Pit 4 not only dewatered the Upper Sand and Main Sand aquifers in the vicinity of the pit, but also removed the confining layers of the aquifers. This removal reduced the potentiometric surface of the aquifers at that location. This factor, plus the subsequent partial backfilling of the pit, permanently altered the hydrogeologic character of the combined Upper Sand/Main Sand unit at that location by changing the historical groundwater flow path and transmissivity. Former mining and dewatering activities at Pathfinder's Pit 33 north (downgradient) of the site also changed the hydrogeologic character of the aquifers. Excavation at Pit 33 removed the confining layers over the Main Sand unit; however, the pit was not backfilled and currently is filling primarily from groundwater flow.

As part of the reclamation plan, Pit 4 was partially backfilled to a bottom elevation several feet higher than the former top of the Upper Sand unit. This was done to prevent ponding of groundwater by keeping the water table below the bottom of the pit. Water that ponds at the bottom of the pit is expected to be ephemeral and be from rainfall and snowmelt. The backfill

effectively acts as a sump for meteoric water captured in the pit, which will recharge the aquifer and alter its quality according to the quality of the runoff and leached minerals from the backfill.

Because of the hydrogeologic alterations of the Main Sand and Upper Sand aquifers caused by mining and reclamation operations at Pit 4 and Pit 33, the aquifers at the site are not expected to return to pre-mining conditions.

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3.0 Long-Term Surveillance Program

3.1 General License for Custody and Long-Term Care

States have right of first refusal for custody and long-term care of Title II disposal sites (UMTRCA, Section 202 [a]). On July 15, 1994, the State of Wyoming declined custody and long-term care of the Shirley Basin South site (State of Wyoming 1994). Because the State declined this right, the site was transferred to DOE for custody and long-term care.

NRC accepted the original LTSP for this site on June 8, 2005 (Appendix A). Concurrently, NRC terminated Petrotomics' license, SUA-551, and the site was included under the NRC's general license for custody and long-term care (10 CFR 40.28 [b]). The deed and title to the site subsequently were transferred from Petrotomics to DOE.

Although sites are designed to last "for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years" [10 CFR 40, Appendix A, Criterion 6], there is no termination of the general license for the DOE's custody and long-term care of the site (10 CFR 40.28 [b]).

Should changes to this LTSP (Revision 1.0) be necessary, NRC must be notified of the changes, and the changes may not conflict with the requirements of the general license. Additionally, representatives of NRC must be guaranteed permanent right-of-entry for the purpose of periodic site inspections. Permanent right-of-way is provided at the site entrance gate that borders the Carbon County Road #2 public right-of-way.

3.2 Requirements of the General License

To meet the requirements of NRC's license under 10 CFR 40, Section 28, and 10 CFR 40, Appendix A, Criterion 12, the long-term custodian must, at a minimum, fulfill the following requirements. The section in the LTSP in which each requirement is addressed is given in parentheses.

- Annual site inspection (Section 3.3)
- Annual report (Section 3.4)
- Follow-up inspections and inspection reports, as necessary (Section 3.5)
- Site maintenance, as necessary (Section 3.6)
- Emergency measures in the event of catastrophe (Section 3.6)
- Environmental monitoring (Section 3.7)

3.3 Annual Site Inspection

3.3.1 Frequency of Inspections

At a minimum, sites must be inspected annually to confirm the integrity of visible features at the site and to determine the need, if any, for maintenance, additional inspections, or monitoring (10 CFR 40, Appendix A, Criterion 12).

To meet this requirement, DOE will inspect the Shirley Basin South disposal site once each calendar year. The date of the inspection may vary from year to year, but DOE will endeavor to inspect the site approximately once every 12 months unless circumstances warrant variance. Any variance to this inspection frequency will be explained in the inspection report. DOE will notify NRC and the State of Wyoming of the inspection at least 30 days in advance of the scheduled inspection date.

3.3.2 Inspection Procedure

For the purposes of inspection, the Shirley Basin South disposal site is divided into sections called *transects*. Each transect, listed in Table 3–1 and shown on Figure 3–1, will be covered during the course of each inspection.

Table 3–1. Inspection Transects at the Shirley Basin South, Wyoming, Disposal Site

Transect	Description
Disposal Cell Cover	Integrity of the upper and lower surfaces of the disposal cell and the riprap-armored slope between the two surfaces.
Containment Dam and Diversion Channels	Integrity of the dam and its riprap-armored slope and swale discharge points; integrity of the north and southwest diversion channels and their riprap-armored confluence; and integrity of the PMF channel and its drainage basins.
Balance of Site and Site Perimeter	Condition of the remaining features of the site including land surfaces (stability and vegetation), site marker, warning signs, boundary monuments, and the perimeter fence and gates. Also included is observation of land at least 0.25 mile outside of the site perimeter for changes in use that could adversely impact the site.

The annual inspection will be a visual walk-through. The primary purpose of the inspection is to look for evidence of erosion, settlement, or cracking of the disposal cell cover; structural discontinuity of the containment dam; significant erosion of the diversion channels and the balance of the site; degradation of vegetation throughout the site (e.g., overgrazing); and vandalism, trespassing, or any other occurrences that could result in adverse impacts to the site. Disposal site and disposal cell inspection techniques are described in detail in Attachment 4 of the guidance document (DOE 2001).

In addition to inspection of the site itself, inspectors will note changes and developments in the area surrounding the site that potentially could adversely impact the site. Significant changes within this area could include development or expansion of human habitation, local groundwater or surface water use, uranium exploration or extraction, road building, erosion, or other changes in land use.

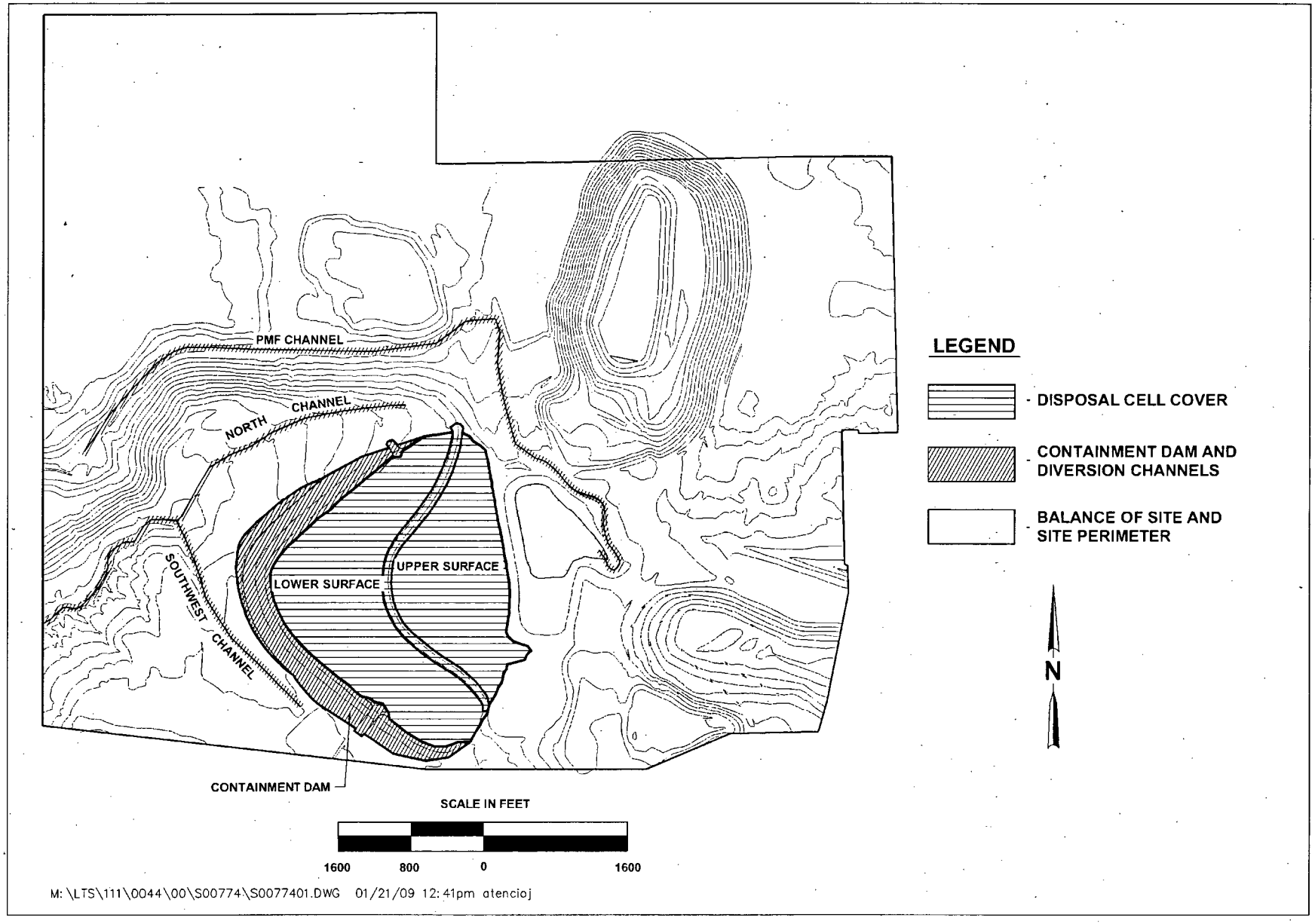

Figure 3–1. Inspection Transects for the Shirley Basin South, Wyoming, Disposal Site

Photographs may be taken to document unusual conditions such as active erosion features or evidence of vandalism, as well as steady-state conditions indicating the successful performance of site features. The photos can also be used to monitor changes in site features from year to year. Representative photos will be included in the inspection report.

3.3.3 Inspection Checklist

The inspection is guided by the inspection checklist. A typical site-specific inspection checklist for the Shirley Basin South disposal site is presented in Appendix C.

The checklist is subject to revision. At the conclusion of an annual site inspection, inspectors will make notes regarding revisions to the checklist, if necessary, in anticipation of the next annual site inspection. Revisions to the checklist will include such items as new discoveries or changes in site conditions that must be inspected and evaluated during the next annual inspection.

3.3.4 Personnel

Annual inspections normally will be performed by a minimum of two inspectors. Inspectors will be experienced scientists and/or engineers who have been specifically trained for the purpose through participation in previous site inspections.

Scientists will include geologists, geomorphologists, hydrologists, biologists, and environmental specialists representing various fields (e.g., ecology, soils, range management). Engineers typically will be specialists in civil or geotechnical engineering. If serious or unique problems develop at the site, more than two inspectors may be assigned to inspect and evaluate specific concerns.

3.4 Annual Report

Results of the annual site inspection will be included in an annual site inspection and monitoring report for all UMTRCA Title II sites licensed under 10 CFR 40.28. The annual report will be submitted to NRC within 90 days of the last UMTRCA Title II site inspection of that calendar year (10 CFR 40, Appendix A, Criterion 12). If the annual report cannot be submitted within 90 days, DOE will notify NRC of the circumstances. Copies of the annual inspection report will also be distributed to the State of Wyoming and any other stakeholders who request a copy.

3.5 Follow-up Inspections

3.5.1 Criteria for Follow-up Inspections

Follow-up inspections are unscheduled inspections. Criteria necessitating follow-up inspections are specified by 10 CFR 40.28 (b)(4). DOE will conduct follow-up inspections should the following occur:

- A condition is identified during the annual site inspection, or other site visit, that requires personnel, perhaps personnel with specific expertise, to return to the site to evaluate the condition; or

- An extreme natural event is known to have occurred (e.g., earthquake, flood, or fire), or DOE is notified by a citizen or outside agency that conditions at the site are substantially changed.

DOE will establish and maintain lines of communications with local law enforcement and emergency response agencies to facilitate notification in the event of significant trespass, vandalism, or natural disaster. Because of the remote location of the Shirley Basin South site, DOE recognizes that local agencies may not necessarily be aware of current conditions at the site. However, these agencies will be requested to notify DOE or provide information should they become aware of a significant event that might affect the security or integrity of the site.

DOE may request the assistance of local agencies to confirm the seriousness of a condition before conducting a follow-up inspection or emergency response.

The public may use the 24-hour DOE telephone number posted prominently on the entrance sign to request information or to report a problem at the site.

Once a condition or concern is identified at the site, DOE will evaluate the information and determine whether a follow-up inspection is warranted. Conditions that may require a routine follow-up inspection include changes in vegetation; erosion; storm damage; low-impact human intrusion; minor vandalism; or the need to evaluate, define, or perform maintenance tasks.

Conditions that threaten the safety or the integrity of the disposal site may require a more immediate (nonroutine) follow-up inspection. Slope failure, disastrous storm, major seismic event, wildfire, and deliberate human intrusion are among these conditions.

DOE will use a graded approach with respect to follow-up inspections. Urgency of the follow-up inspection will be in proportion to the seriousness of the condition. Timing of the inspection may be governed by seasonal considerations. For example, a follow-up inspection to investigate a vegetation problem may be scheduled for a particular time of year when growing conditions are optimum. A routine follow-up inspection to perform maintenance or to evaluate an erosion problem might be scheduled to avoid snow cover or frozen ground.

In the event of "unusual damage or disruption" (10 CFR 40, Appendix A, Criterion 12) that threatens or compromises site safety, security, or disposal cell integrity, DOE will:

- Notify NRC pursuant to 10 CFR 40, Appendix A, Criterion 12, or 10 CFR 40.60, whichever is determined to apply.
- Begin the DOE occurrence notification process (DOE Order 232.1).
- Respond with an immediate follow-up inspection or emergency response team.
- Implement measures as necessary to contain or prevent dispersion of radioactive materials (Section 3.6).

3.5.2 Personnel

Inspectors assigned to follow-up inspections will be selected on the same basis as for the annual site inspection (see Section 3.3.4).

3.5.3 Reports of Follow-up Inspections

Results of routine follow-up inspections will be included in the next annual inspection and monitoring report (Section 3.4). Separate reports will not be prepared unless DOE determines that it is advisable to notify NRC or other outside agency of a problem at the site.

If follow-up inspections are required for more serious or emergency reasons, DOE will submit to NRC a preliminary report of the follow-up inspection within the required 60 days (10 CFR 40, Appendix A, Criterion 12).

3.6 Routine Site Maintenance and Emergency Measures

3.6.1 Routine Site Maintenance

UMTRCA disposal sites are designed and constructed so that "ongoing active maintenance is not necessary to preserve isolation" of radioactive material (10 CFR 40, Appendix A, Criterion 12). The tailings impoundment has been designed and constructed to negate the need for routine maintenance.

The cover of the tailings impoundment was constructed with minimal slope to promote positive drainage while minimizing runoff water velocities. The cover has been revegetated with indigenous plant species that are expected to endure for the long term. Because of the vegetation and minimal slopes, adverse wind or water erosion impacts that would require maintenance are not expected. Areas where runoff water could achieve erosion-causing velocities have been armored with riprap.

However, if an inspection of the disposal site reveals degradation, damage, or vandalism of an as-built feature, repairs will be conducted to reestablish the as-built condition. DOE will perform routine site maintenance as needed based on best management practices. Results of routine site maintenance will be summarized in the annual site inspection and monitoring report.

3.6.2 Emergency Measures

Emergency measures are the actions that DOE will take in response to "unusual damage or disruption" that threaten or compromise site safety, security, or integrity. DOE will contain or prevent dispersal of radioactive materials in the unlikely event of a breach in cover materials.

3.6.3 Criteria for Routine Site Maintenance and Emergency Measures

Conceptually, there is a continuum in the progression from minor routine maintenance to large-scale reconstruction of the tailings impoundment following a potential disaster. Criteria required by 10 CFR 40.28 (b)(5) for triggering particular DOE responses for each progressively more serious level of intervention are not easily defined because the nature and scale of all potential problems cannot be foreseen. The information in Table 3–2 will, however, serves as a guide for appropriate DOE responses. The table shows that the difference between routine maintenance and emergency response is primarily one of urgency and degree of threat or risk. DOE's priority level (urgency) in the first column of Table 3–2 bears an inverse relationship with its estimate of probability. The highest priority response is also believed to be the least likely to occur.

Table 3–2. DOE Criteria for Maintenance and Emergency Measures

Priority	Description[a]	Example	Response
1	Breach of disposal cell with dispersal of radioactive material.	Seismic event that exceeds design basis and causes massive discontinuity in cover.	Notify NRC. Immediate follow-up inspection by DOE emergency response team. Emergency actions to prevent further dispersal, recover radioactive materials, and repair breach.
2	Breach without dispersal of radioactive material.	Partial or threatened exposure of radioactive materials.	Notify NRC. Immediate follow-up inspection by DOE emergency response team. Emergency actions to repair the breach.
3	Breach of site security.	Human intrusion, vandalism.	Restore security; urgency based on assessment of risk.
4	Maintenance of specific site surveillance features.	Deterioration of signs, monuments, markers, fence.	Repair at first opportunity.
5	Minor erosion or undesirable changes in vegetation.	Erosion not immediately affecting disposal cell, invasion of undesirable plant species.	Evaluate, assess impact, respond as appropriate to address problem.

[a]Other changes or conditions will be evaluated and treated similarly on the basis of risk.

3.6.4 Reporting Maintenance and Emergency Measures

Routine maintenance completed during the previous 12 months will be summarized in the annual inspection and monitoring report.

In accordance with 10 CFR 40.60, within 4 hours of discovery of any Priority l or 2 event listed in Table 3–2, DOE will notify the following group at NRC:

Decommissioning and Uranium Recovery Licensing Directorate
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission

The phone number for the required 4-hour contact to the NRC Operations Center is (301) 816-5100.

3.7 Environmental Monitoring

3.7.1 Background

DOE conducts groundwater monitoring at the Shirley Basin South site. The primary purpose of the groundwater monitoring program is to monitor disposal cell performance.

NRC granted ACLs for uranium, radium-226, radium-228, thorium-230, cadmium, chromium, nickel, lead, and selenium at point-of-compliance (POC) wells (NRC 1998, NRC 2002). The original LTSP also required monitoring of chloride, nitrate, sulfate, and total dissolved solids (TDS), because these constituents can be useful indicators of contaminant migration. Wyoming Class III groundwater protection standards for livestock use are applicable for chloride, sulfate, and TDS.

If an ACL is exceeded at a POC well, or trends indicate a groundwater protection standard may be exceeded at the site boundary, DOE will inform NRC and the Wyoming Department of Environmental Quality of the results and conduct confirmatory sampling. If the confirmatory sampling verifies the exceedance, DOE will develop an evaluative monitoring work plan and submit that plan to NRC for review prior to initiating the evaluative monitoring program. Results of the evaluative monitoring program will be used, in consultation with NRC, to determine if corrective action is necessary. ACLs designated in the original LTSP (DOE 2004) have been exceeded at the site, resulting in the evaluation and revision of the groundwater monitoring program as described in the following sections.

3.7.2 Initial Groundwater Monitoring Program

DOE acquired the site in June 2005. The original monitoring network consisted of wells MW-5-SC, MW-40-SC, MW-51-SC, and MW-54-SC completed in the Upper Sand aquifer, wells MW-5-DC, MW-10-DC, and MW-19-DC completed in the Main Sand aquifer, and well MW-K.G.S. #3 completed in the Lower Sand aquifer. Monitor wells MW-5-SC, MW-51-SC, MW-5-DC, and MW-19-DC were designated as the POC wells. DOE subsequently determined that well MW-54-SC was continuously screened through both the Upper Sand and Main Sand aquifers.

DOE conducted its first annual sampling event in July 2005. Sample results indicated that the approved ACL for cadmium was exceeded in POC well MW-5-SC, and the ACL for radium-228 was exceeded in POC well MW-5-DC and also in non-POC well MW-54-SC. DOE subsequently notified NRC and the State of Wyoming of the results in a letter dated October 20, 2005, and reported all analytical results to NRC in the annual inspection report. As required, DOE conducted confirmatory sampling on December 1, 2005. Analytical results for the second sampling event confirmed that the ACLs were exceeded at the respective wells, and the results were forwarded to NRC and the State of Wyoming.

3.7.3 Evaluation of Monitoring Program

Historical groundwater quality data provided by the former licensee indicates that cadmium exceeded the approved ACL of 0.079 milligram per liter (mg/L) in well MW-5-SC on numerous occasions prior to DOE receiving the site. However, cadmium concentrations in this well have been below the ACL since the December 2005 sampling event, averaging approximately 0.04 mg/L.

In wells MW-54-SC and MW-5-DC, radium-228 concentrations exceeded the ACL of 25.7 mg/L in July 2005 and for all subsequent sampling events. Although the ACL had not been exceeded in well MW-5-DC since 1993, an upward trend had been occurring since October 2002. Radium-228 concentrations in well MW–54–SC have exceeded the ACL on numerous occasions since groundwater monitoring began at the site in 1988. Current radium-228 concentrations in both of

these wells are below historical high concentrations that occurred during groundwater remediation activities.

Because the confirmatory sampling verified that ACLs were exceeded at the site, DOE developed an evaluative monitoring plan. NRC approved the DOE proposal to expand the groundwater monitoring network by installing several new wells and to reevaluate the monitoring program. DOE installed six new monitor wells downgradient of the disposal cell in fall 2008: three in the Upper Sand aquifer (MW-100-SC, MW-101-SC, and MW-102-SC) and three in the Main Sand aquifer (MW-110-DC, MW-112-DC, and MW-113-DC). The wells were located along projected contaminant migration paths estimated through groundwater modeling (Petrotomics 1996). Because well MW-54-SC was continuously screened through both aquifers and presents a risk of cross-contamination, DOE will decommission it; new well MW-101-SC replaces MW-54-SC. DOE reevaluated the monitoring program, and the evaluation is provided in Appendix D. The reevaluation is summarized in the following paragraphs.

Leakage of tailings leachate was expected because the disposal cell is unlined. However, groundwater remediation activities essentially dewatered the encapsulated tailings (Petrotomics 1996). Because the cover design significantly minimizes infiltration of runoff water into the tailings, additional leaching of contaminants from the tailings into groundwater is not expected.

Based on the hazard assessment performed as part of the ACL application (Petrotomics 1996) and other available data, it is apparent that not all of the constituents of concern listed in Section 3.7.1 are likely to be in or derived from by-product material, nor are all of them good indicators of disposal cell performance. Both the Upper Sand and Main Sand units contain uranium ore; therefore, constituents related to uranium mineralization are likely to occur naturally in the groundwater, even in the absence of processing-related activities.

Background groundwater concentrations at the site were not well characterized, primarily because the upgradient outcrops of the Upper Sand and Main Sand units are so close to the disposal cell; consequently, these aquifers essentially do not exist upgradient of the cell. However, the ACL application noted that naturally occurring concentrations of nickel, radium, and uranium in the area may be elevated above water quality standards (Petrotomics 1996).

Water quality data from mill liquids derived from several mill runs indicated that concentrations of cadmium, chromium, lead, nickel, and selenium were all below detection limits. Concentrations of chloride, sulfate, and TDS, however, were present at significant levels. The most prevalent constituents in concentrated tailings pond water, collected after months of evaporation, were chloride, sulfate, radium-226, thorium-230, and uranium. Groundwater quality data from tailings monitoring wells confirm that the most important indicators of site-related contamination are chloride, sulfate, radium-226, thorium-230, and uranium (Appendix D).

DOE's monitoring results have indicated that radium-228 concentrations have been steadily increasing in wells MW-54-SC and MW-5-DC. Radium-228 is a decay product of naturally occurring thorium-232, and elevated concentrations at the site have been attributed to natural thorium in the uranium ore (Petrotomics 1996). Thorium-232 is very immobile; therefore, the source of radium-228 in groundwater must be close to the affected wells. Cadmium is also a naturally occurring constituent of uranium ore. As the aquifers rebound hydrologically from dewatering activities, it is likely that geochemical rebound is occurring as well. Increases in

some constituent concentrations in the groundwater, such as radium-228 and cadmium, consequently may represent a reestablishment of equilibrium of groundwater with naturally occurring constituents in the sand units. Therefore, radium-228 and cadmium should not be considered as indicator constituents for disposal cell performance.

Following installation of the new monitor wells, DOE sampled the entire monitoring network in late October 2008. Original well MW-51-SC, which regularly contains minimal water and is difficult to sample, and new wells MW-101-SC and MW-102-SC were dry at the time of the sampling event. This is indicative of the dewatering that occurred during mining and groundwater remediation. Furthermore, it is possible that the Upper Sand aquifer near Pit 4 may never recover to its pre-mining condition, because it will likely drain to the unconfined backfill in the pit (see Figure 2–5).

Concentrations of radium-228 in wells MW-54-SC and MW-5-DC continued to be greater than the original ACL but were less than the previous sampling event in August 2008. Sulfate and TDS concentrations continued to be greater than the groundwater protection standards for wells MW-5-SC, MW-54-SC, and MW-5-DC (these standards were exceeded in well MW-51-SC during the August 2008 event, also). No ACLs or groundwater protection standards were exceeded in the new wells that were sampled.

3.7.4 Revised Groundwater Monitoring Program

Based on the above evaluation, the revised monitoring program for cell performance will include analyses of chloride, nitrate, sulfate, radium-226, thorium-230, and uranium concentrations. Measurement parameters including electrical conductivity, pH, and water levels will also be obtained during sampling events. The locations of the monitor wells in the groundwater monitoring network are shown on Figure 3–2.

Chloride, nitrate, and sulfate are highly mobile, so their behavior should serve as early indicators of any degradation of cell performance. Chloride and nitrate do not occur naturally in the aquifers; their presence in the groundwater would be processing or tailings related because of the chemical reagents used in the milling and solvent extraction process. Although sulfuric acid was used at the site, sulfate may not be as definitive an indicator because sulfide minerals (primarily iron pyrite) occur naturally in the mineralized units at the site.

The constituents and their NRC-approved ACLs and applicable State of Wyoming groundwater protection standards are listed in Table 3–3. The objectives of groundwater monitoring are to verify that the ACLs for radium-226, thorium-230, and uranium are not exceeded at the POC wells, thus indicating that the disposal cell is performing as designed, and to verify that the concentrations for chloride, sulfate, and TDS at the site boundary remain protective.

The groundwater monitoring program is summarized in Table 3–4. Results of the program will be included in the annual inspection report (Section 3.4). Concentration-versus-time graphs for sulfate and uranium will be reported for all wells. Groundwater flow directions for the Upper Sand and Main Sand aquifers will also be reported.

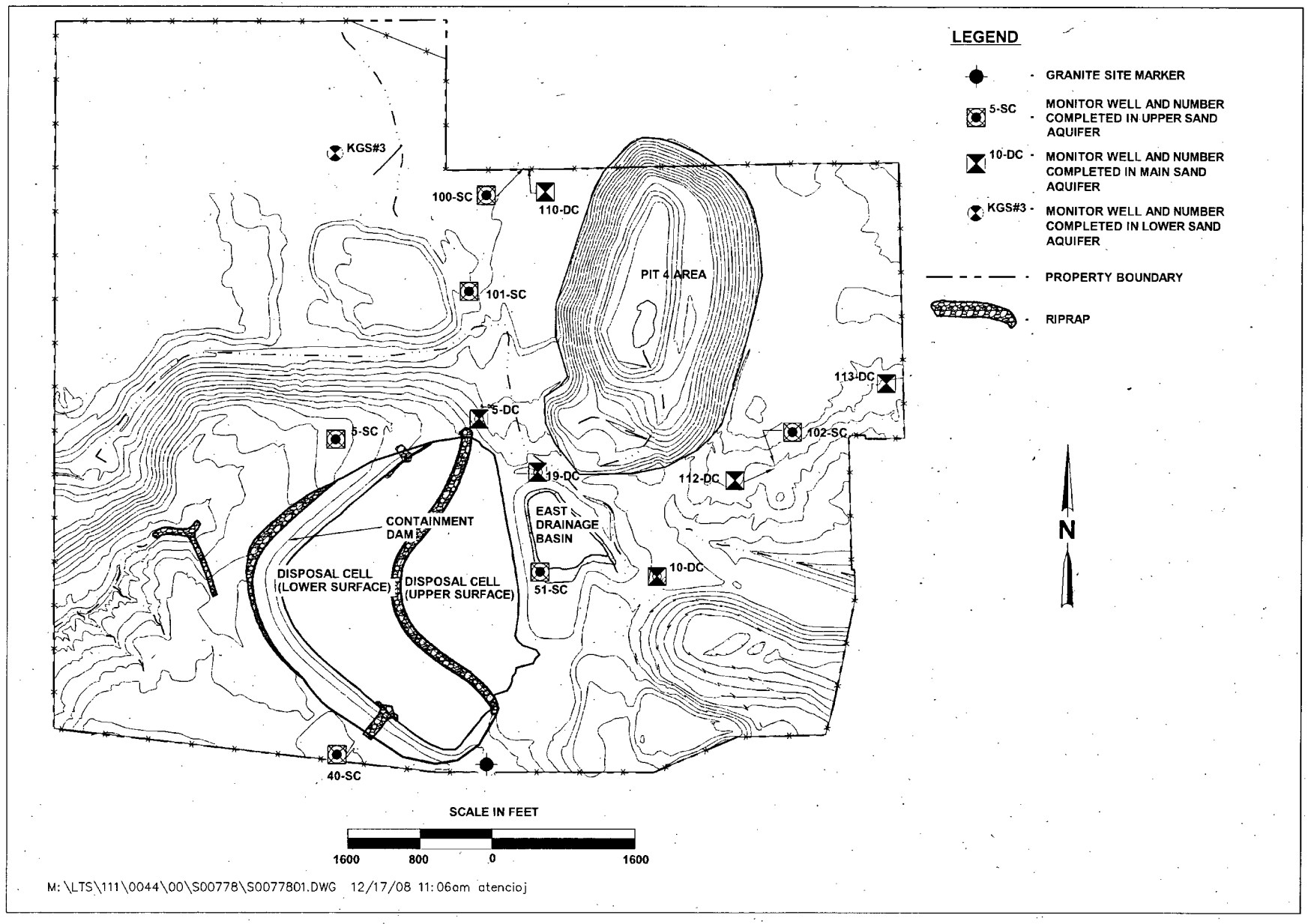

Figure 3–2. Groundwater Monitoring Network at the Shirley Basin South, Wyoming, Disposal Site

Table 3–3. Constituents, ACLs, and Groundwater Protection Standards for the Shirley Basin South, Wyoming, Disposal Site

Constituent	ACL	Groundwater Protection Standard[a]
Radium-226	91.3 pCi/L	NA
Thorium-230	2,409 pCi/L	NA
Uranium	9.2 mg/L	NA
Chloride	NA	2,000 mg/L
Nitrate	NA	NA
Sulfate	NA	3,000 mg/L
TDS	NA	5,000 mg/L

[a]Wyoming Class III groundwater protection standards for livestock use.
Key: ACL = alternate concentration limit; mg/L = milligrams per liter; NA = not applicable; pCi/L = picocuries per liter

Table 3–4. Groundwater Monitoring Plan for the Shirley Basin South, Wyoming, Disposal Site

Well Designation	Monitoring Frequency[a]	Constituents	Comments
Upper Sand Aquifer			
MW-5-SC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	POC well
MW-40-SC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Upgradient well
MW-51-SC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	POC well
MW-100-SC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
MW-101-SC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
MW-102-SC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
Main Sand Aquifer			
MW-5-DC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	POC well
MW-10-DC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
MW-19-DC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	POC well
MW-110-DC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
MW-112-DC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
MW-113-DC	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	Downgradient well
Lower Sand Aquifer			
MW-K.G.S. #3	Annually	Radium-226, thorium-230, uranium, chloride, nitrate, sulfate, TDS	To verify no degradation from contaminated aquifers.

[a]Frequency subject to change after monitoring program evaluations.
Key: POC = point-of-compliance; TDS = total dissolved solids

The groundwater monitoring program will be evaluated every 5 years to determine that the cell is performing as designed (i.e., no evidence of leakage). The monitoring frequency will be reduced as recommended by these evaluations, For example, monitoring frequency may be reduced to once every 3 years or once every 5 years. A change in monitoring frequency will occur following NRC concurrence but will not necessitate a revision to the LTSP. If the evaluation recommends discontinuation of groundwater monitoring, the LTSP will be revised and submitted to NRC for concurrence.

Once every 10 years, beginning in 2010, DOE will check the records at the Wyoming State Engineer's Office to determine if there have been significant changes in water demands in the vicinity of the site. Other nearby activities that could affect the site groundwater conditions, such as uranium exploration or extraction, will be noted during annual site inspections and subsequently evaluated.

3.8 Institutional Controls

The Shirley Basin South disposal site is owned by the U.S. Government, and DOE protects the site through institutional controls such as deed restrictions, inspections, and appropriate signage. DOE may also use fences and gates to control site access, and does so for this site. Once every 10 years, beginning in 2010, DOE will verify that the property deed remains on file in the Carbon County Courthouse.

3.9 Records

LM receives and maintains selected records to support post-closure site maintenance. These records contain critical information required to protect human health and the environment, manage land and assets, protect legal interests of DOE and the public, and mitigate community impacts resulting from the cleanup of legacy waste. The records are managed in accordance with the following requirements.

- 44 USC 29, *Records Management by the Archivist of the United States and by the Administrator of General Services*, Chapter 31, "Records Management by Federal Agencies," and Chapter 33, "Disposal of Records."
- 36 CFR 12, Subchapter B, "Records Management."
- DOE G 1324.5B, *Implementation Guide.*

3.10 Quality Assurance

All activities related to the surveillance and maintenance of the Shirley Basin South site will comply with DOE Order 414.1A, *Quality Assurance.* Quality assurance requirements are routinely fulfilled by the use of a work-planning process, standard operating procedures, trained personnel, documents and records maintenance, and assessment activities. Requirements will be transmitted through procurement documents to subcontractors if and when appropriate.

3.11 Health and Safety

Health and safety requirements and procedures for LM activities are consistent with DOE orders, federal regulations, and applicable codes and standards. The DOE Integrated Safety Management process serves as the basis for the contractor's health and safety program.

Specific guidance is contained in the *Comprehensive Emergency Management System* (LMS/POL/S04326). This document identifies specific hazards associated with the anticipated scope of work and provides direction for the control of these hazards. During the pre-inspection briefing, personnel are required to review this document to ensure that they have an understanding of the potential hazards and the health and safety requirements associated with the work to be performed.

4.0 References

Comprehensive Emergency Management System, LMS/POL/S04326, continually updated, prepared by S.M. Stoller Corporation for the U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado.

DOE (U.S. Department of Energy), 2001. *Guidance for Implementing the Long-Term Surveillance Program for UMTRCA Title I and Title II Disposal Sites*, U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado, GJO-2001-215-TAR, April.

DOE (U. S. Department of Energy), 2004. *Long-Term Surveillance Plan for the U.S. Department of Energy Shirley Basin South (UMTRCA Title II) Disposal Site, Carbon County, Wyoming,* U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado, DOE-LM/GJ766-2004, December.

Getty (Getty Oil Company), 1981. *Environmental Report for Source Material License SUA-551*, Petrotomics Mill, Docket No. 40-6659, April 1.

NRC (U.S. Nuclear Regulatory Commission), 1998. Letter from J. Holonich, NRC, to R. Juday, Petrotomics Company, Concurrence on Alternate Concentration Limits Source Material License SUA-551, Amendment No. 63, October 6.

NRC (U.S. Nuclear Regulatory Commission), 2002. Letter from D. Gillen, NRC, to S. Pfaff, Petrotomics Company, Petrotomics Company Request for an Alternate Groundwater Protection Standard for Selenium, License Amendment No. 75 to Source Material License SUA-551, September 27.

Petrotomics (Petrotomics Company), 1996. *Petrotomics Tailings Facility Application for Alternate Concentration Limits to Amend USNRC Source Material License SUA-551*, prepared by Shepherd Miller, Inc., September.

Petrotomics (Petrotomics Company), 1997. *Petrotomics Tailings Facility Application for Alternate Concentration Limits, Source Material License SUA-551, Response to NRC Comments,* prepared by Shepherd Miller, Inc., June.

Petrotomics (Petrotomics Company), 2001. *Tailings Reclamation Construction Completion Report*, November.

State of Wyoming, 1994. Letter to Joseph E.Virgona, Project Manager, U.S. Department of Energy, from Dennis Hemmer, Director of the Wyoming Department of Environmental Quality, declining custody of all UMTRCA Title II sites within the State of Wyoming, July 15.

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Appendix A

NRC Concurrence Documentation

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for NRC Acceptance Letter for Revised LTSP

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

June 8, 2005

Mr. Thomas Pauling, Site Manager
U.S. Department of Energy
Grand Junction Office
2597 B3/4 Road
Grand Junction, CO 81503

SUBJECT: ACCEPTANCE OF THE LONG-TERM SURVEILLANCE PLAN FOR THE PETROTOMICS COMPANY SHIRLEY BASIN SOUTH URANIUM MILL TAILINGS SITE (TAC LU0088)

Dear Mr. Pauling:

On March 25, 2005, the Petrotomics Company (Petrotomics) transferred ownership of the Shirley Basin South uranium mill tailings site in Shirley Basin, Wyoming to the U.S. Department of Energy (DOE), as required by 10 CFR Part 40, Appendix A, Criterion 11, prior to license termination. In this regard, the DOE is the designated long-term custodian of the Shirley Basin South site. Subsequently, by letter dated May 12, 2005, the DOE submitted the final Long-Term-Surveillance Plan (LTSP) for the Shirley Basin South site for review by the U.S. Nuclear Regulatory Commission (NRC) staff. A correction to one page of the LTSP was forwarded to the staff in a DOE letter dated June 1, 2005. The staff has completed its review of the LTSP and determined that the DOE has appropriately addressed the staff's comments provided by letter dated October 25, 2002, on DOE's August 26, 2002, draft LTSP for Shirley Basin South.

The staff concludes that the final LTSP satisfies the requirements in 10 CFR Part 40, Appendix A, Criterion 12, and §40.28 for the long-term surveillance of a tailings disposal site. Accordingly, the NRC hereby accepts the LTSP for the Shirley Basin South site. This acceptance establishes the DOE as the custodian and long-term caretaker of the Shirley Basin South site under the general license specified in §40.28. In a concurrent action, the NRC has terminated Petrotomics' specific Source Materials License SUA-551 for the Shirley Basin South site. An environmental assessment is not required for these actions as they are categorically excluded under 10 CFR Part 51.22(c)(11).

If you have any questions regarding this letter, please contact Rick Weller, the Project Manager for Shirley Basin South, 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 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/NRC/ADAMS/index.html (the Public Electronic Reading Room).

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.: 40-6659
License No.: SUA-551

cc: D. Bergman-Tabbert, DOE GJO
M. Plessinger, Stoller GJO
S. Pfaff, Petrotomics
M. Moxley, WDEQ
R. Hoy, WDEQ

Appendix B

Real Estate Information

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Project: DOE UMTRA
Carbon County, Wyoming

DEED OF CONVEYANCE

THIS CONVEYANCE, made this 1st day of March, 2005, between **PETROTOMICS COMPANY**, a Delaware corporation, (hereinafter the "Grantor"), whose address is 6001 Bollinger Canyon Road, Building K, Room 2008, San Ramon, CA 94583-2324, and the **UNITED STATES OF AMERICA**, of Washington, DC (hereinafter the "Grantee"), consists of three sections.

1. Section 1: Conveyance with General Warranty of Title. For good and valuable consideration, the receipt of which is hereby acknowledged, Grantor hereby grants, conveys, and warrants unto the Grantee the following described real property (hereinafter the "Subject Lands"):

Parcel I

A tract of land located in Sections 32 and 33, Township 28 North, Range 78 West, 6th Principal Meridian, and in Sections 3, 4, 5, 8, 9, and 10, Township 27 North, Range 78 West, 6th Principal Meridian, Carbon County, Wyoming, more particularly described as follows:

Beginning at the NW corner of Section 3, T27N, R78W (Point 1, 614715.32N, 811724.93E), this being the point of beginning; thence N89°33'24"E, 1102.21 ft. (Point 2, 614723.85N, 812827.11E) along the north section line; thence S1°21'41"E, 1620.76 ft. (Point 3, 613103.55N, 812865.61E); thence S1°22'39"E, 1408.25 ft. (Point 4, 611695.70N, 812899.46E); thence S88°40'34"W, 435.28 ft. (Point 5, 611685.65N, 812464.30E); thence N00°00'30"E, 41.10 ft. (Point 6, 611726.74N, 812464.31E); thence S88°38'36"W, 187.13 ft. (Point 7, 611722.31N, 812277.23E); thence S1°22'E, 1321.85 ft. (Point 8, 610400.84N, 812308.76E); thence S1°22'13"E, 157.67 ft. (Point 9, 610243.22N, 812312.53E); thence S78°44'07"E, 34.86 ft. (Point 10, 610236.41N, 812346.72E); thence S1°19'59"E, 306.45 ft. (Point 11, 609930.04N, 812353.85E); thence S11°15'53"W, 256.67 ft. (Point 12, 609678.31N, 812303.71E); thence S11°16'28"W, 942.81 ft. (Point 13, 608753.69N, 812119.38E), to a point in Section 10; thence S15°19'19"W, 354.90 ft. (Point 14, 608411.40N, 812025.60E); thence S88°37'24"W, 982.28 ft. (Point 15, 608387.80N, 811043.60E), to a point in Section 9; thence S67°11'49"W, 1000.61 ft. (Point 16, 608000.00N, 810121.20E); thence due West 121.20 ft. (Point 17, 608000.00N, 810000.00E), which is the old SE corner of the NRC area; thence due West 2333.75 ft. (Point 18, 608000.00N, 807666.25E); thence N83°31'21"W, 4243.34 ft. (Point 19, 608478.70N, 803450.00E), to a point in Section 8; thence due North 7792.11 ft. (Point 20, 616270.81N, 803450.00E), to a point in Section 32; thence due East 3004.07 ft. (Point 22, 616270.81N, 806454.07E), to a point on the 32/33 Section line; thence N89°11'02"E, 1327.53 ft. (Point 23, 616289.72N, 807781.47E) to the NE corner of the S½S½NW¼SW¼ Sec. 33, T28N, R78W, 6th P.M.; thence S00°07'57"W, 1656.54 ft. (Point 24, 614633.19N, 807777.64E) to the SE corner of SW¼SW¼ Sec. 33; thence N89°11'44"E, 1323.70 ft. (Point 25, 614651.77N, 809101.20E) to the 33/4 quarter corner; thence N88°36'45"E, 2624.50 ft. (Point 1,

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Linda A. Smith, CARBON COUNTY CLERK

614715.32N, 811724.93E) to the NW corner of Section 3, the point of beginning.

This parcel contains 1,512.00 acres, more or less.

Parcel II

Township 27 North, Range 78 West, 6th Principal Meridian, Carbon County, Wyoming
Section 9: N½N½SE¼NW¼

This parcel contains 14.92 acres, more or less.

The acquiring federal agency is the Department of Energy.

TO HAVE AND TO HOLD the above described premises, together with all and singular the rights and appurtenances thereof to the same belonging or in anywise appertaining to the use, benefit, and behalf of the Grantee, its successors and assigns, forever.

The Grantor, for itself and its successors, does hereby covenant and agree that it will WARRANT AND FOREVER DEFEND title to the above premises unto the Grantee, its successors and assigns, against all and every person or persons claiming the whole or any part thereof, excepting from Grantor's warranty, however, all easements, rights-of-way, restrictions, exceptions, and reservations of record, including but not limited to reservations or exceptions contained in Patents affecting the Subject Lands or in the acts authorizing the issuance of such Patents, and further excepting from Grantor's warranty all existing easements to High Plains Power, Inc., as reflected in that certain instrument recorded June 10, 2002, in Book 1020, at Page 120 of the records of Carbon County, Wyoming.

2. Section 2: Conveyance with Special Warranty of Title. **FOR THE SAME CONSIDERATION SET OUT ABOVE**, Grantor hereby grants and conveys to Grantee the following water and water rights used on or appurtenant to the Subject Lands, to wit:

(a) the 5-SC monitoring well, Permit Number UW-144485;

(b) the 40-SC monitoring well, Permit Number UW-144486;

(c) the 5-DC monitoring well, Permit Number UW-144487;

(d) the 51-SC monitoring well, Permit Number UW-76138;

(e) the 54-SC monitoring well, Permit Number UW-90022;

(f) the 10-DC monitoring well, Permit Number UW-87372;

(g) the 19-DC monitoring well, Permit number UW-111140;

(h) the KGS #3 (Mine Shop Well) monitoring well, Permit Number UW-31943;

(i) the Pit 4 Surface Water Reservoir, Permit Number 10315 RES;

(j) the East Basin Reservoir, Permit Number 9743 RES; and

(k) all ditches, canals, and structures appurtenant to the aforesaid reservoirs or necessary to the use of any or all water rights related thereto.

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Linda A. Smith, CARBON COUNTY CLERK

TO HAVE AND TO HOLD the above-described water and water rights, together with all and singular the rights, members, and appurtenances thereof to the same belonging or in anywise appertaining to the use, benefit, and behalf of the Grantee, its successors and assigns forever.

The Grantor, for itself and its successors, does hereby covenant and agree that it will **WARRANT AND FOREVER DEFEND** title to the above described water and water rights and appurtenances thereto unto the Grantee, its successors and assigns, against all and every person or persons claiming the whole or any part thereof, by, through, or under the Grantor.

3. Section 3. Quitclaim of Certain Interests. **FOR THE SAME CONSIDERATION SET OUT ABOVE,** Grantor, for itself, its successors and assigns, hereby releases and quitclaims to the Grantee, all right, title, and interest which the Grantor may have in the banks, beds, and waters of any streams bordering the Subject Lands, and also all interest in alleys, roads, streets, ways, strips, gores, or railroad rights of way abutting or adjoining said land and in any means of ingress or egress appurtenant thereto.

IN WITNESS WHEREOF, the Grantor has executed this Deed of Conveyance on the date set forth above.

Petrotomics Company,
a Delaware corporation,

By: _____

Gordon A. Turl, Assistant Secretary

CALIFORNIA ALL-PURPOSE ACKNOWLEDGMENT

State of California
County of Contra Costa } ss.

On March 1, 2005 before me, P. E. Primus
(Date) (Name and Title of Officer (e.g., "Jane Doe, Notary Public"))

personally appeared Carolyn A. Tarl
(Name(s) of Signer(s))

☐ personally known to me
☐ proved to me on the basis of satisfactory evidence

to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

P. E. PRIMUS
COMM. #1413306
NOTARY PUBLIC-CALIFORNIA
CONTRA COSTA COUNTY
My Comm. Expires May 21, 2007

WITNESS my hand and official seal.

P. E. Primus
(Signature of Notary Public)

OPTIONAL

Though the information below is not required by law, it may prove valuable to persons relying on the document and could prevent fraudulent removal and reattachment of this form to another document.

Description of Attached Document

Title or Type of Document: _____

Document Date: _____ Number of Pages: _____

Signer(s) Other Than Named Above: _____

Capacity(ies) Claimed by Signer

Signer's Name: _____

☐ Individual
☐ Corporate Officer – Title(s): _____
☐ Partner – ☐ Limited ☐ General
☐ Attorney-in-Fact
☐ Trustee
☐ Guardian or Conservator
☐ Other: _____

Signer Is Representing: _____

RIGHT THUMBPRINT OF SIGNER
Top of thumb here

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Linda A. Smith, CARBON COUNTY CLERK

Appendix C

Sample Site Inspection Checklist

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[Year] INSPECTION CHECKLIST
SHIRLEY BASIN SOUTH, WYOMING, UMTRCA TITLE II DISPOSAL SITE

Status of Site Inspections

Date of This Revision: [Date]

Last Annual Inspection: [Date]
Inspectors: [Last names]

Next Annual Inspection (Planned): [Date]
Scheduled Inspectors: [Last names]

No.	ITEM	ISSUE	ACTION
1	Access	Consult the LTSP for the access route. Contact Mark Thiesse of Wyoming Department of Environmental Quality at (307)-332-3144 or mthies@state.wy.us	
2	Specific site surveillance features	See attached list.	Inspect and assess need for repairs.
3	Cover of tailings impoundment	The cell cover is vegetated and consists of two surfaces at different elevations separated by a narrow riprap-covered slope. The cover was seeded with prairie grasses and is contoured to drain to the riprap-protected North Swale Discharge and the South Swale Discharge.	Check for evidence of settling and erosion. Check condition of the riprap-covered slope. Check for animal burrows. Evaluate condition of the vegetation. Map infestations of noxious weeds.
4	Containment dam and diversion channels	Portions of the dam and diversion channels are armored with riprap. The PMF channel is unarmored.	Check condition of the riprap and for evidence of settling, slumping, or displacement. Check function of the channels.

No.	ITEM	ISSUE	ACTION
5	Site perimeter and balance of site	The site is graded to promote drainage away from the impoundment. A barbed-wire stock fence surrounds the property. Reclaimed open pit mines are on and in the immediate vicinity of the site.	Check for erosion on site and the condition of the fence. Make a visual check of the immediate vicinity of the site for erosion, changes in land use, disturbances, or other features of possible concern.
6	Grazing agreement	A grazing agreement allows a local rancher, Mr. Heward (307-356-4612), to graze the site, mow the cell cover for hay, and use water from K.G.S. #3 well for stock watering purposes. The agreement calls for Mr. Heward to maintain the perimeter fence.	Check the condition of the site for overgrazing.

Specific Site Surveillance Features—Shirley Basin South, Wyoming, Disposal Site

FEATURE	COMMENT
Access Road	Site access is gained off of Carbon County Road #2.
Entrance Gate	Wire gate.
Entrance and Perimeter Signs (34)	Located around disposal cell and at key locations along the site perimeter.
Perimeter Fence	Barbed-wire stock fence. Maintained by Ron Heward as part of the grazing agreement.
Site Marker (1)	Located near site entrance.
Boundary Monuments (26)	Located at property corners and along the boundary. Includes two witness corners (BM–23 and BM–23A.
Monitor Wells (13)	Upgradient well (Upper Sand aquifer): MW–40–SC POC wells (Upper Sand aquifer): MW–5–SC and MW–51–SC POC wells (Main Sand aquifer): MW–5–DC and MW–19–DC Downgradient wells (Upper Sand aquifer): MW–100–SC, MW–101–SC, and MW–102–SC Downgradient wells (Main Sand aquifer): MW–10–DC, MW–110–DC, MW–112–DC, and MW–113–DC Lower Sand aquifer well: MW–K.G.S. #3

Appendix D

Groundwater Monitoring Evaluation

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Groundwater Monitoring Evaluation for the Shirley Basin South, Wyoming, Disposal Site

January 2009

Purpose and Scope

The long-term surveillance plan (LTSP) for the Shirley Basin South, Wyoming, disposal site requires "evaluative monitoring" in the event that an alternate concentration limit (ACL) in groundwater is exceeded in a point-of-compliance (POC) monitor well at the site. Exceedances of ACLs for cadmium and radium-228 have triggered this evaluation. The purpose of this evaluation is threefold: (1) to determine if the ACL exceedances are related to disposal cell performance; (2) to determine possible causes of ACL exceedances; and (3) to determine if the monitoring plan best fulfills the needs for long-term surveillance of the disposal site. As a result of this evaluation, changes to the existing monitoring requirements of the LTSP are proposed.

Background

The current monitoring requirements were established as a condition of U.S. Nuclear Regulatory Commission (NRC) Source Material License SUA 551 and served the purpose of corrective action monitoring. NRC granted Petrotomics Company's (Petrotomics), the former site licensee, request for ACLs for a number of constituents in October 1998 (NRC 1998) and determined that groundwater corrective action was complete. The site was transferred to the U.S. Department of Energy (DOE) in 2005 upon NRC's concurrence in DOE's LTSP (DOE 2004).

The original LTSP (DOE 2004) incorporated the corrective action monitoring requirements of the Petrotomics license. It called for annual sampling and analysis of wells in the monitoring network for the following constituents for which ACLs were established: cadmium, chromium, lead, nickel, selenium, uranium, radium-226, radium-228, and thorium-230. Sulfate and chloride were also identified as constituents of concern (COC) for the purposes of monitoring.

Recent monitoring data have shown that radium-228 levels for two monitoring wells at the site (POC well MW-5-DC and non-POC well MW-54-SC) have been increasing over the last several years and that the ACL has regularly been exceeded at MW-54-SC since 2001. The ACL for cadmium was exceeded in well MW-5-SC during a single monitoring event. DOE has evaluated recent and historical monitoring data for the site along with other site information.

Natural and Process-Related Chemicals

Background groundwater concentrations for the Shirley Basin South site do not appear to be well-characterized, though the ACL application notes that naturally occurring concentrations of radium, nickel, and uranium in the area may be elevated above water quality standards. This observation is supported by data from the Spook, Wyoming, disposal site, which is located near similar mineralized deposits. The LTSP for that site notes that elevated levels of selenium, uranium, radium-226, and radium-228 are likely naturally occurring and related to the alteration front (DOE 1993). That plan also notes elevated levels of chromium in area groundwater.

Chemical reagents used in the milling and solvent extraction process at the Shirley Basin South site included sulfuric acid, sodium chlorate, sodium chloride, and ammonia. Data from mill liquids derived from several mill runs were presented in the ACL application for the Shirley Basin South site and are reproduced in Table D–1. Concentrations of a number of metals—cadmium, chromium, lead, nickel, and selenium—were all below detection in all samples (though the detection limits were relatively high). Sulfate and chloride, however, were present at significant levels.

Table D–1. Water Quality Data for Mill Liquids (Petrotomics 1996, Table 2–5)

Constituent[a]	HG-1L[b]	HG-2L[b]	HG-3L[b]	LG-1L[c]	LG-2L[c]	LG-3L[c]
Cadmium	<10	<10	<10	<10	<10	<10
Chloride	1,400	950	1,364	725	675	948
Chromium	<10	<10	<10	<10	<10	<10
Lead	<10	<10	<10	<10	<10	<10
Nickel	<10	<10	<10	<10	<10	<10
pH	2.20	2.27	1.94	1.90	2.35	2.15
Selenium	<10	<10	<10	<10	<10	<10
Sulfate	14,000	11,000	13,500	9,250	6,750	9,000
TDS	25,800	24,100	27,100	26,394	17,460	21,773

[a]Concentrations are expressed in milligrams per liter.
[b]Liquid from high-grade (HG) mill runs.
[c]Liquid from low-grade (LG) mill runs.
Key: TDS = total dissolved solids

Mill liquids along with groundwater pumped from downgradient of the site were disposed in the tailings pond. Groundwater quality data from tailings monitor wells are presented in Table D–2. These results confirm that the most important indicators of site-related contamination are chloride, sulfate, uranium, radium-226 and thorium-230, which have generally higher concentrations than the remaining constituents.

An analysis of tailings pond water (Table D–3) indicates that the most prevalent constituents are chloride, radium-226, sulfate, thorium-230, and uranium. Much lower concentrations of cadmium, chromium, nickel, and selenium are present. The pond water sample was collected after several months of evaporation and likely reflects maximum concentrations in disposed fluids.

Reevaluation of LTSP Constituents of Concern

According to 10 CFR 40, Appendix A, Criterion 5B(2), a constituent becomes a "hazardous constituent" regulated by the NRC at a licensed facility if it meets three tests:

(a) The constituent is reasonably expected to be in or derived from the byproduct material in the disposal area;

(b) The constituent has been detected in the ground water in the uppermost aquifer; and

(c) The constituent is listed in Criterion 13 of this Appendix [10 CFR 40, Appendix A].

Table D–2. Groundwater Quality Data for Tailings Monitor Wells (Petrotomics 1996, Table 2–7)

Constituent	PT3 11/22/88	TW4 11/22/88	TW4 2/14/91	TW4 2/20/92	TW4 2/9/93	TW4 3/8/94	TW4 3/8/94	TW4 2/16/95
TDS (mg/L)	37,352	26,288	27,388	27,445	27,814	27,800	28,600	28,400
Chloride (mg/L)	456	354	357	340	356	475	425	375
Sulfate (mg/L)	17,600	16,200	15,100	17,000	17,400	21,500	19,600	19,200
Cadmium (mg/L)	0.17	0.17	0.12	0.12	0.15	0.13	0.13	0.12
Chromium (mg/L)	2.8	0.50	0.27	0.30	0.28	0.26	0.24	0.37
Lead (mg/L)	0.75	0.59	0.28	<0.05	<0.05	0.01	<0.01	<0.005
Nickel (mg/L)	3.7	3.3	4.9	5.2	4.44	5.65	5.41	5.34
Selenium (mg/L)	0.23	<0.001	<0.001	0.002	<0.001	<0.002	<0.002	0.28
Uranium (mg/L)	14.0	3.2	4.3	0.74	2.82	8.74	9.34	8.59
Radium-226 (pCi/L)	0.05	0.62	80	83	79	1,360	1,290	312
Radium-228 (pCi/L)	0.85	1.5	16.1	33	9	8	7	25
Thorium-230 (pCi/L)	23,500	938	1,872	985	1,904	11,900	11,100	7,160

Constituent	TW6 11/22/88	TW7 11/22/88	TW10 11/22/88	TW21 2/27/90	TW21 2/14/91	TW21 2/20/92	TW21 3/1/93	TW21 3/7/94	TW21 2/16/95
TDS (mg/L)	31,082	48,054	22,270	31,919	29,184	34,566	26,560	26,900	28,800
Chloride (mg/L)	363	527	359	378	355	422	325	350	345
Sulfate (mg/L)	18,800	29,000	13,600	20,400	16,400	17,200	19,200	22,800	19,200
Cadmium (mg/L)	0.15	0.23	0.13	0.12	0.13	0.14	0.16	0.09	0.11
Chromium (mg/L)	0.89	3.1	0.08	2.5	1.8	6.3	1.68	0.39	0.78
Lead (mg/L)	0.64	0.88	0.57	0.04	0.28	<0.05	<0.5	0.05	<0.005
Nickel (mg/L)	2.6	4.7	3.0	3.9	4.3	7.5	5.70	4.81	4.21
Selenium (mg/L)	0.008	0.17	<0.001	0.37	0.22	0.12	<0.001	0.01	0.02
Uranium (mg/L)	11.0	28	6.1	21	13.5	11.9	5.98	5.42	3.93
Radium-226 (pCi/L)	1.0	1.2	0.55	2.5	0.54	0.49	0.021	311.0	112.0
Radium-228 (pCi/L)	2.0	2.3	1.5	7.1	0.00	10.5	0.00	5	4
Thorium-230 (pCi/L)	1,170	52,500	1,135	16,395	8,140	4,948	8,483	4,190	2,840

Key: mg/L = milligrams per liter; pCi/L = picocuries per liter; TDS = total dissolved solids

Table D–3. Water Quality Data for Tailings Pond Water (Petrotomics 1996, Table 2–6)

Constituent	Concentration
Cadmium (mg/L)	0.074
Chloride (mg/L)	420
Chromium (mg/L)	2.1
Lead (mg/L)	<1.2
Nickel (mg/L)	4.4
Radium-226 (pCi/L)	151.2
Radium-228 (pCi/L)	Not reported
Selenium (mg/L)	2.3
Sulfate (mg/L)	42,000
Thorium-230 (pCi/L)	170,100
Uranium (mg/L)	16.5

Key: mg/L = milligrams per liter; pCi/L = picocuries per liter

The COCs identified in the license for the site were clearly detected in groundwater and, with the exception of sulfate and chloride, they are listed in Criterion 13 (sulfate and chloride are known byproducts of chemicals used in the milling process). However, based on the hazard assessment performed as part of the ACL application (Petrotomics 1996) and other available site data, there is some question whether all constituents are likely to be in or derived from byproduct material.

As discussed in the previous section, groundwater in the uppermost aquifer at the site has not only been affected by milling-related activities, but also by naturally occurring mineralization. The corrective action for site groundwater served to dewater a large portion of the uppermost aquifer to the point where further remediation was deemed impracticable and corrective action ceased. ACLs were established for all COCs that exceeded water quality standards based on monitoring data collected at the end of the corrective action period.

Concentrations of radium-228 in two wells at the site have been steadily increasing over the last several years. The cadmium concentration in one well also exceeded its ACL during one sampling event. The concern is that these occurrences could be attributable to releases from the disposal cell and that there could be an ongoing problem at the site with respect to groundwater contamination. Monitoring data, however, indicates that concentrations of all COCs for which ACLs were established are within the range of historical values. Furthermore, most of these constituents are known to occur naturally in the mineralized aquifer. As the uppermost aquifer is rebounding hydrologically from the dewatering that occurred during corrective action, it is also likely that some type of geochemical rebound is occurring as well. Increases of mineralization-related constituents in the groundwater may represent an equilibration of groundwater with aquifer material that had previously been pumped dry.

Based on the data included in Tables D–1 through D–3, the most representative (i.e., highest concentration) process-related constituents are sulfate, chloride, thorium-230, and total dissolved solids and, to a lesser extent, uranium and radium-226. The other metals are present in all liquids in much lower concentrations and also occur naturally in the mineralized zones. These minor constituents are of no use in evaluating long-term disposal cell performance. Because sulfate (in the form of sulfides), thorium, uranium, and radium also occur naturally in the ore zones, their behavior in groundwater could be influenced by processes unrelated to disposal cell performance. Chloride is more likely to be disposal-cell related. Though nitrate was not analyzed in mill-related fluids, it is expected to be a good indicator of process-related contamination because ammonia was one of the primary reagents used at the processing site. Nitrate is a major product of ammonia degradation but is not known to occur naturally at the site.

Proposed LTSP Monitoring Revisions

For purposes of monitoring long-term cell performance and fulfilling its stewardship obligations, DOE considers that the original COC list is not appropriate. Several of those constituents are present in only low quantities in the disposal cell and are likely naturally occurring; therefore, they are not good indicators for cell performance. For this reason, DOE proposes to exclude the following constituents from long-term monitoring: cadmium, chromium, lead, nickel, selenium, and radium-228.

DOE proposes to continue monitoring the following constituents that are major components of tailings and byproduct material disposed in the cell: chloride, radium-226, sulfate, thorium-230, and uranium. Nitrate and total dissolved solids are also considered to be indicator parameters. Sulfate, chloride, and nitrate are highly mobile, so changes in the behavior of these constituents should serve as early indicators of any degradation in cell performance.

References

10 CFR 40. U.S. Nuclear Regulatory Commission, "Domestic Licensing of Source Material," *Code of Federal Regulations*.

DOE (U. S. Department of Energy), 1993. *Long-Term Surveillance Plan for the Spook, Wyoming, Disposal Site, Final,* UMTRA-DOE/AL-350215.0000, U.S. Department of Energy Office of Legacy Management, January.

DOE (U. S. Department of Energy), 2004. *Long-Term Surveillance Plan for the U.S. Department of Energy Shirley Basin South (UMTRCA Title II) Disposal Site, Carbon County, Wyoming,* U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado, DOE-LM/GJ766-2004, December.

NRC (U.S. Nuclear Regulatory Commission), 1998. Letter from J. Holonich, NRC, to R. Juday, Petrotomics Company, *Concurrence on Alternate Concentration Limits Source Material License SUA-551, Amendment No. 63,* October 6.

Petrotomics (Petrotomics Company), 1996. *Petrotomics Tailings Facility Application for Alternate Concentration Limits to Amend USNRC Source Material License SUA-551,* prepared by Shepherd Miller, Inc., September.

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