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Environmental Assessment of Ground Water Compliance at the Riverton, Wyoming, Uranium Mill Tailings Site

Final

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Plate - Will be provided upon request. Click Don Metzler or Audrey Berry to request.

Acronyms and Abbreviations

ACL	alternate concentration limit
CFR	U.S. Code of Federal Regulations
DOE	U.S. Department of Energy
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
ft	foot
IHS	Indian Health Services
MCL	maximum concentration limit
NEPA	National Environmental Policy Act
PEIS	Programmatic Environmental Impact Statement
RRM	residual radioactive material
UMTRA	Uranium Mill Tailings Remedial Action (Project)
UMTRCA	Uranium Mill Tailings Radiation Control Act

1.0 Introduction

The U.S. Department of Energy (DOE) is in the process of selecting a ground water compliance strategy for the Riverton, Wyoming, Uranium Mill Tailings Remedial Action (UMTRA) Project site (Figure 1).

In November 1978, the Uranium Mill Tailings Radiation Control Act (UMTRCA) was enacted to protect the public and the environment from radiological hazards associated with the processing of uranium ore. Title I of UMTRCA required the Secretary of Energy to designate inactive processing sites that are contaminated with residual radioactive material (RRM)[1] and may present hazards. The Riverton site is one of 24 sites designated by the Secretary.

Title I also required the U.S. Environmental Protection Agency (EPA) to develop standards to comply with UMTRCA's requirement to protect the public and the environment. Standards were developed in two phases. The first phase involved development of standards for contaminated surface materials such as soil, debris, and buildings. Remediation of surface contamination has been completed at most sites. The second phase involved development of ground water regulations, which EPA made final on January 11, 1995, and codified at Title 40 of the *U.S Code of Federal Regulations*, Part 192 (40 CFR 192).

In anticipation of EPA's ground water regulations, DOE established the UMTRA Ground Water Project in 1991 to evaluate the 24 designated sites for potential ground water contamination. A baseline risk assessment and site observational work plan were prepared for most sites to determine the public health and environmental risks associated with RRM and to evaluate the options that would ensure compliance with ground water regulations.

To comply with the requirements of the National Environmental Policy Act (NEPA) and to address the options that would ensure compliance with ground water regulations (40 CFR 192) at the 24 sites, DOE prepared the *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project* (PEIS) (DOE 1996). A Record of Decision was issued in April 1997 in which DOE selected the "proposed-action" alternative for conducting the UMTRA Ground Water Project. The proposed-action alternative gave DOE the option of implementing the compliance strategy best suited for each site. The compliance strategies outlined under the proposed-action alternative were active remediation, natural flushing, no ground water remediation,[2] or any combination of the three. These options, identified as "strategies" in the PEIS, provide the possible alternatives for this site-specific Environmental Assessment (EA).

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[1] Residual Radioactive Material (RRM) is defined in the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) (42 USC 4321 *et seq.*) and in the Programmatic Environmental Impact Statement for the UMTRA Ground Water Project. See also Appendix A of this EA.

[2] "No remediation" is not the same as the "no action" alternative discussed in this EA. The "no remediation" sites require activities such as site characterization to show that no remediation is warranted.

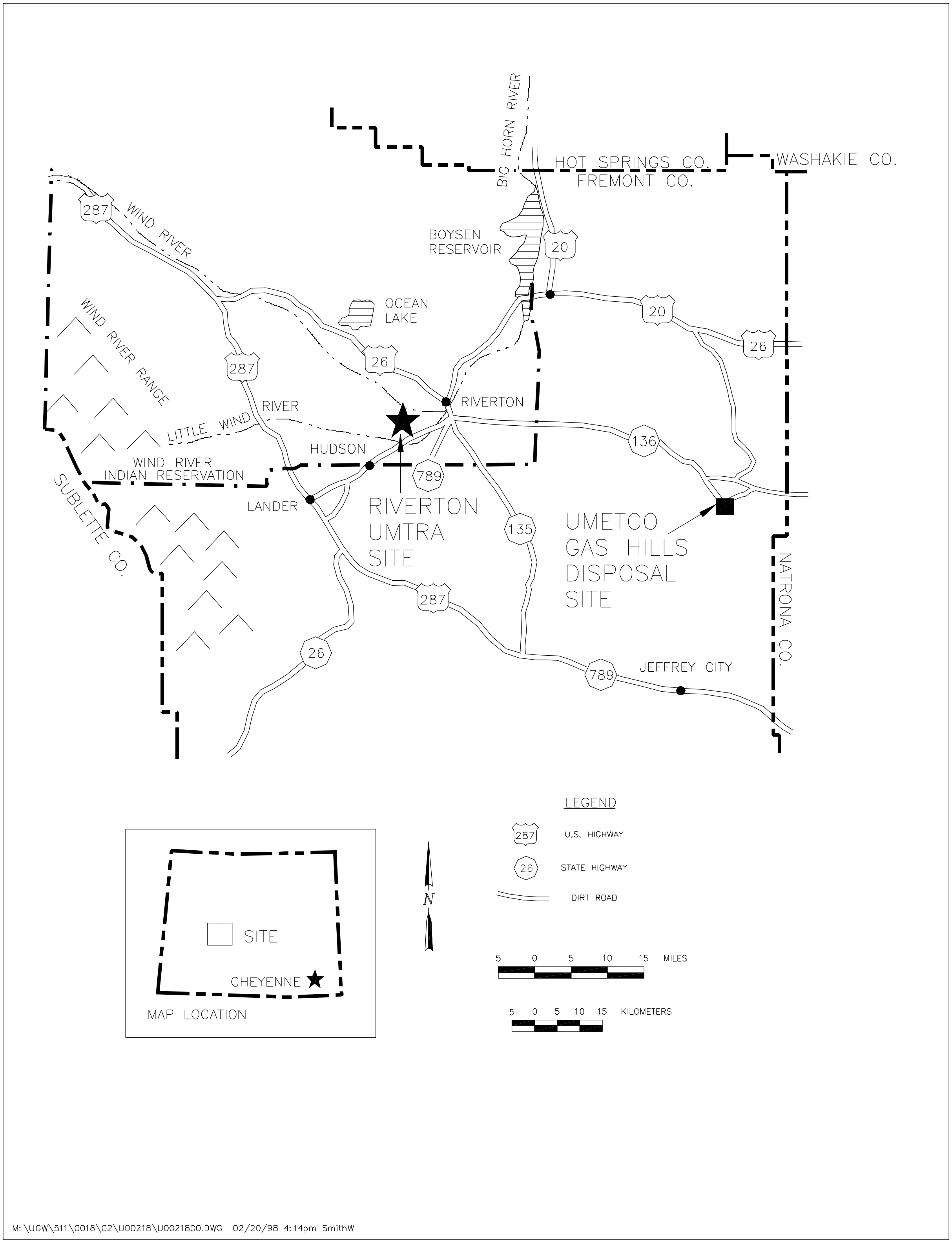

Figure 1. Location of the Riverton Site

DOE used a consistent, risk-based framework established in the proposed-action alternative of the PEIS to identify the specific strategy for the Riverton site that would comply with ground water regulations and ensure protection of public health and the environment (see Figure 2). The step-by-step decision process in the PEIS led DOE to the natural-flushing ground water remediation strategy (discussed in Section 3 of this EA) as the selected compliance strategy at the Riverton site. The decision to select this strategy is further supported by the Baseline Risk Assessment (DOE 1995) and the Site Observational Work Plan (DOE 1998). Therefore, this EA discusses the natural-flushing and no-action compliance strategies for the Riverton site. On the basis of data gathered during the site characterization and the subsequent site conceptual model, the active-remediation and no-remediation compliance strategies identified in the PEIS are not being considered and are not addressed. The issues discussed and the environmental impacts analyzed in this EA are tiered to the PEIS as allowed by NEPA regulations in 10 CFR 1021.210(c).

1.1 Site Location and Description

The Riverton, Wyoming, UMTRA site is in Fremont County, 2 miles southwest of the city of Riverton (Figure 1) and is within the boundaries of the Wind River Indian Reservation (Northern Arapaho and Shoshone) on land now owned by the State of Wyoming. The site is on alluvial deposits between the Wind River, one mile north, and the Little Wind River, about 4,000 ft southeast (Figure 3). The three aquifers that underlie the site are discussed in Section 4.4. Only the uppermost aquifer, which at the Riverton site consists of an unconfined surficial aquifer and an underlying semiconfined aquifer, is within the purview of 40 CFR 192. There is no evidence of a hydraulic connection to the deeper confined aquifer, which is segregated from the uppermost aquifer by an aquitard.[3] Consequently, protection of water quality in the deeper confined aquifer is encompassed by other ground water regulations. Several domestic wells are installed in the confined aquifer, which is a source of potable water. Ground water from the uppermost aquifer ultimately discharges to the southeast into the Little Wind River.

Section 3.2.21 of the PEIS (DOE 1996) provides a physical description of the Riverton UMTRA site. Weather, climate, geology, surface water, flora and fauna, historical and cultural resources, socioeconomics, and transportation at the Riverton site are described in detail in the *Environmental Assessment-Remedial Action at the Riverton Uranium Mill Tailings Site, Riverton, Wyoming* (Surface EA) (DOE 1987).

1.2 Site Background

When uranium milling operations ceased in 1963, approximately one million cubic yards of tailings were stockpiled on 70 acres southeast of the millsite. An additional 70 acres north of the tailings pile and 50 acres southeast of the tailings pile were also contaminated as a result of ore stockpiling, milling activities, and windblown tailings.

[3] An aquitard is a relatively impermeable, confining layer that retards but does not completely prevent the flow of water to or from an adjacent aquifer.

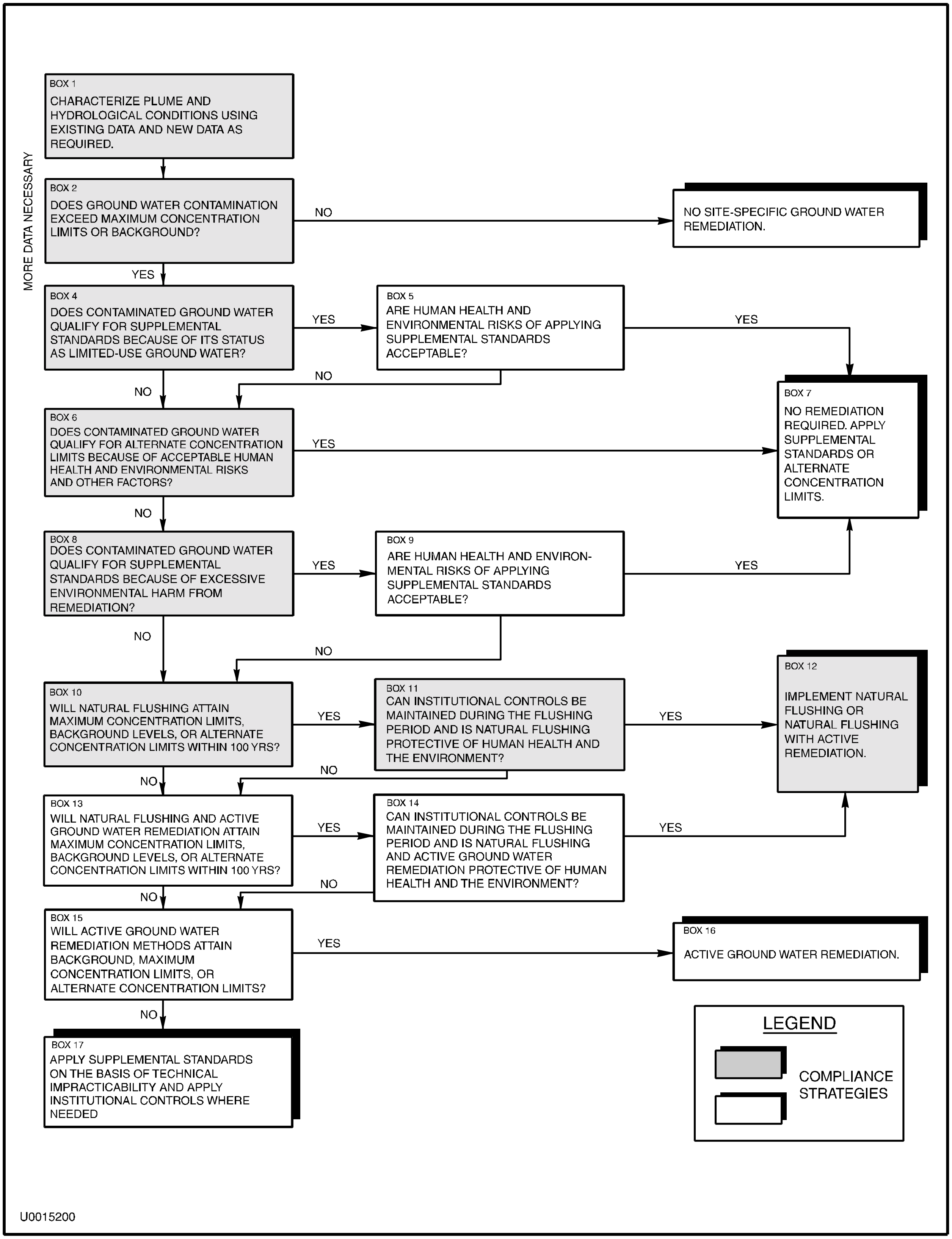

Figure 2. Compliance Selection Framework Established by the Proposed Action of the PEIS

A sulfuric acid plant that was part of the milling operations is still being operated by the Koch Sulfur Products Company at the northwest corner of the original site. The sulfuric acid plant is not affiliated with DOE. Approximately 70 gallons per minute of process water from the facility flows into a retention pond, then into an unlined ditch, into the West Side Irrigation Ditch, and eventually into the Little Wind River southeast of the site (see Plate 1).

Environmental effects of the Surface Remediation Project were evaluated in the Surface EA (DOE 1987). Surface remediation was completed in 1990. The Finding of No Significant Impact for surface remediation (June 1987), in addition to authorizing surface remediation, stated that DOE would comply with ground water protection standards.

A cooperative agreement with the tribes for surface remediation was not required because the mill tailings were on land acquired by the State of Wyoming within the boundaries of the tribal lands. However, because contaminated ground water has migrated from the State-owned land onto tribal land, DOE is attempting to negotiate a cooperative agreement with the Northern Arapaho and Shoshone Tribes for ground-water compliance activities.

DOE screened for listed RRM constituents as outlined in 40 CFR 192.02(c)(1). Ground water sampling has been performed at the Riverton site since the early 1980s. The sampling program has included collecting samples from DOE monitor wells, designated surface-water and sediment locations, and residential wells near the site (see Figure 3 and Plate 1).

Most of DOE's monitor wells that were installed during pre-1990 investigations were decommissioned during surface remediation. However, 42 wells remained, and DOE installed 20 additional wells in 1995 and 1996 to further define the extent and magnitude of contamination in the surficial and semiconfined aquifers. Section 3.1.1 of the Site Observational Work Plan describes the monitor well installation methods and well locations.

Surface-water and sediment sampling was conducted at 14 locations to determine the potential effects of ground water migration into the Little Wind River, the oxbow lake, and adjacent wetlands areas (see Plate 1).

Table 4-1 of the Site Observational Work Plan (DOE 1998) lists the domestic wells sampled, years sampled, aquifers in which the wells are installed, and water use. Section 4.1.2 of that document states that all wells used as potable water sources are drawing water from the confined aquifer and that none of the wells in the confined aquifer are affected by contamination in the uppermost aquifer.

The Baseline Risk Assessment (DOE 1995) identified 24 chemicals that exceeded background (naturally occurring) concentrations. Fourteen of these constituents were eliminated from further evaluation because of low toxicity, low concentrations compared to high dietary intake, or because concentrations were within nutritional ranges.

The screening rationale for the remaining 10 constituents is presented in Table 1. Those constituents were evaluated according to guidance provided in Appendix B of the PEIS. Results of that evaluation indicated that arsenic, manganese, molybdenum, sulfate, and uranium in the surficial aquifer could adversely affect human health if contaminated ground water were used as the sole source of drinking water. This conclusion was based on very conservative assumptions (see the Baseline Risk Assessment for more detail). Data collected after completion of the Baseline Risk Assessment further support this conclusion, although contaminant concentrations have decreased with time.

Table 1. Screening Rationale for Ground Water Constituents of Potential Concern for Human Health

Contaminant	Retained Yes (Y) / No (N)	Rationale
Arsenic	N	Concentrations are well below MCL; usually at detection limit.
Manganese	Y	Concentrations in several wells exceed health-based levels.
Molybdenum	Y	Concentrations in several wells exceed MCL.
Nickel	N	Concentrations in all wells are at detection limits or below health-based levels.
Sulfate	Y	Concentrations in several wells exceed suggested guidelines.
Vanadium	N	Concentrations in all wells are at detection limits or below health-based levels.
Uranium	Y	Concentrations in several wells exceed MCL.
Lead-210	N	Concentrations in most wells are at detection limit; decay product of uranium; retaining uranium addresses this contaminant.
Thorium-230	N	Concentrations in most wells are at detection limit; decay product of uranium; retaining uranium addresses this contaminant.
Polonium-210	N	Concentrations exceed standards, but by retaining uranium, this contaminant is addressed.

Manganese, molybdenum, and sulfate present a potential noncarcinogenic risk; uranium and, to a lesser extent, arsenic present the only carcinogenic risk. After further evaluation of data, including results of the most recent (1997) round of sampling (DOE 1998, Appendix B2), arsenic was eliminated as a constituent of potential concern because concentrations have decreased through time and are currently within the historical range of background values. The remaining constituents—manganese, molybdenum, sulfate, and uranium—are considered constituents of concern with respect to human health at the Riverton site.

A screening-level ecological risk assessment was conducted to qualitatively evaluate ecological risks associated with contaminated ground water. The first phase of that assessment is documented in the Baseline Risk Assessment (DOE 1995, Section 7) and is supplemented with additional data collected in 1995. Soils, sediments, and surface water were sampled at locations such as the Little Wind River, the oxbow lake, and wetland areas where ground water intersects the land surface. Vegetation was sampled to evaluate root uptake of contaminants. Contaminant concentrations were compared to benchmarks such as livestock watering guidelines and the Wyoming water quality criteria for protection of aquatic life.

Contaminant concentrations in the surficial aquifer at the site are insufficient to present a risk to plants through root uptake. Molybdenum and sulfate in the ground water could concentrate in the soil and build up to levels toxic to plants if contaminated ground water were used continuously for irrigation. Molybdenum concentrations in ground water could be detrimental to livestock if contaminated ground water were used to irrigate forage plants; sulfate concentrations in the ground water exceed the level that EPA considers protective of livestock. Iron and uranium concentrations in the oxbow lake exceed the Wyoming water quality criteria for protection of aquatic life. However, the oxbow is expected to eventually fill in with sediment. Contaminants discharging into the Little Wind River from the surficial aquifer are rapidly diluted to background concentrations and present no risk to ecological receptors. For further detail, see the Baseline Risk Assessment (DOE 1995) and the Site Observational Work Plan (DOE 1998).

DOE, the U.S. Department of Housing and Urban Development, and the Indian Health Services (IHS) have jointly funded the construction of a water supply system to serve residents near the site. The alternate water supply will consist of a storage tank filled with potable water from wells installed in the deeper confined aquifer upgradient (west) of the site. The water is supplied to eliminate the possibility of using contaminated ground water in the surficial aquifer as a drinking-water source. The system (shown on Plate 1) will have up to 13 miles of water line and a capacity to serve 100 to 130 homes. All domestic water near the site is currently taken from the deeper confined aquifer. Water lines at residences that use the confined aquifer will be disconnected and tied to the new water-supply lines.

IHS has prepared NEPA documentation (Environmental Review/Categorical Exclusion BI 97–837, March 13, 1997) for installation of the new water supply.

2.0 Need for DOE Compliance Action

DOE is required by UMTRCA to comply with ground water regulations that pertain to ground water beneath and near the Riverton site that is contaminated with RRM as a result of historical processing of uranium ore. Ground water compliance strategies applicable to the Riverton site are designed to be protective of human health and the environment.

3.0 Proposed-Action and No-Action Alternatives

3.1 Proposed-Action Alternative

On the basis of the PEIS compliance selection framework (Figure 2), DOE would implement the natural-flushing compliance strategy with institutional controls and monitoring. Natural flushing (also known as natural attenuation) is a process in which natural geochemical and biological processes and ground-water movement decrease contaminant concentrations in the aquifer through time. The purpose of this approach is to ensure that risks associated with the constituents of concern—manganese, molybdenum, sulfate, and uranium—are mitigated using the proposed compliance strategy. Some of the sulfate contamination is attributed to a source other than the millsite. Consequently, when the remediation goals are met for manganese, molybdenum, and uranium, it will be assumed that millsite-related sulfate has flushed through the surficial aquifer as well.

The following conditions are requirements of the natural-flushing compliance strategy [40 CFR 192.12(c)(2)]:

- Natural attenuation must decrease RRM concentrations to background levels, maximum concentration limits (MCLs), or alternate concentration limits (ACLs) within 100 years.

- Institutional controls must be implemented that will effectively protect public health and the environment.

- Ground water must not be used currently or in the projected future as a source of public drinking water.

A site conceptual model, supported by hydrogeologic and geochemical data, supports the finding that natural ground water movement and geochemical processes will meet the regulatory requirements for natural flushing of contaminants in the uppermost aquifer. Application and success of the natural-flushing alternative will be demonstrated through a monitoring program as required by 40 CFR 192(c)(3). Table 2 identifies 19 monitoring locations and the rationale for monitoring those locations under the proposed-action alternative. The rationale in Table 2 has been modified from the Site Observational Work Plan to provide a more detailed explanation of the reason for selecting these locations. Constituents to be monitored include arsenic, manganese, molybdenum, nickel, sulfate, and uranium. Arsenic and nickel will be monitored because of sporadic historical presence; continued monitoring will ensure that those constituents do not present a risk. Figure 3 and Plate 1 show the sampling locations. Ground water and surface-water locations would be monitored yearly for 5 years, then once every 5 years thereafter.

At each sampling location, when analytical data from three successive annual rounds of sampling indicate that contaminant concentrations have decreased to MCLs, ACLs, or background, sampling will be discontinued at that location. Sediment and vegetation would be sampled once initially and again after 5 years. At that time DOE will compare analytical results to benchmark values and determine if additional sampling is necessary.

Institutional controls at the Riverton site would include the alternate water supply system being constructed by IHS. Reservation authorities have agreed to place restrictions on use of ground water in the contaminated portion of the surficial aquifer and to place a moratorium on drilling permits issued for the affected area.

Table 2. Sample Locations for Future Monitoring at the Riverton UMTRA Site

Future Sample Location		Rationale
Sediment sample locations	747 (oxbow lake)	No benchmarks have been exceeded. However, continued monitoring will determine if contaminants are accumulating as a result of contaminated surface water in the oxbow lake.
	746 (wetland east of site)	Because manganese could present risk of toxicity to benthic organisms, sediment samples will be collected in the wetlands.
	744 (on site)	Although nickel concentration barely exceeded the State of Wyoming ecological surface-water benchmark in 1995, concentrations in 1997 were below the benchmark value. Continued monitoring will verify that concentrations are decreasing through time.
Vegetation sampling locations	747 (oxbow lake)	Uranium concentration exceeded the benchmark for dietary source for wildlife. Monitor for contaminants that exceed screening benchmarks for dietary source for wildlife.
	744 (on site)	Historically, arsenic exceeded wildlife screening benchmarks. As contaminant concentrations in ground water decrease, continued monitoring will assess consequent effects on vegetation.
Surface water sampling locations	747 (oxbow lake)	Uranium concentration exceeded the Wyoming aquatic life criteria. Continued monitoring will verify that uranium concentrations are decreasing throughout the period of natural flushing.
	749 (Koch Ditch)	Arsenic, lead, and nickel exceeded benchmarks; sulfate concentrations are above background values. Continued monitoring will determine if these constituents from an off-site source affect the natural flushing of site-related contaminants.
	794 (upgradient—Little Wind River)	Baseline data to determine the concentrations of site-related contaminants in the Little Wind River.
	796 (downgradient—Little Wind River)	Monitor for site-related contaminants downgradient in the Little Wind River.
Surficial aquifer sampling locations	706 (south of the Little Wind River)	Verify that site-related contaminants do not cross to the south beneath the Little Wind River.
	707 (north of the Little Wind River, center of plume)	Monitor concentrations of site-related contaminants in the center of the plume.

Table 2. Sample Locations for Future Monitoring at the Riverton UMTRA Site (continued)

Surficial aquifer sampling locations (continued)	710 (background)	Baseline data to determine contaminant concentrations in the surficial aquifer.
	716 (Cluster 3, northeast edge of plume)	Monitor contaminant concentrations in the northeast edge of the plume.
	718 (west edge of the plume)	Monitor contaminant concentrations in the west edge of the plume.
	722 (north edge of the plume)	Monitor contaminant concentrations in the north edge of plume.
	731 (south of Koch Sulfur Products, west edge of the plume)	Monitor west edge of the plume and potential contribution from off-site sources.
Semiconfined aquifer sampling locations	705 (north of the Little Wind River, center of the plume)	Monitor the center of the plume in the semiconfined aquifer for contaminant concentrations and movement.
	717 (Cluster 3, northeast edge of the plume)	Monitor contaminant concentrations in the northeast edge of the plume.
	719 (west edge of the plume)	Monitor contaminant concentrations in the west edge of the plume.
	723 (north edge of the plume)	Monitor contaminant concentrations in the north edge of the plume.
	732 (south of Koch Sulfur Products, west edge of the plume)	Monitor west edge of the plume and potential influence from off-site sources.
	735 (south of the Little Wind River)	Monitor for site-related contaminants south of Little Wind River.

Because analytical results of ground water monitoring under the proposed-action alternative would be distributed routinely to stakeholders and local libraries, the public would be kept informed of any changes in ground water contaminant concentrations.

3.2 No-Action Alternative

The *U.S. Code of Federal Regulations*, Title 10, Part 1021, "National Environmental Policy Act Implementing Procedures," subpart 321, "Requirements for environmental assessments," directs DOE to consider the no-action alternative. DOE has screened for contaminants and compiled sufficient data to evaluate the compliance strategies outlined in the PEIS. The no-action alternative within the context of this EA means that no further activities would be conducted to assess compliance with ground water regulations, and no further data would be collected to characterize ground water. No institutional controls, including operation and maintenance of the new water supply system, would be implemented. No monitoring would be conducted under the UMTRA Ground Water Project.

4.0 Affected Environment and Environmental Consequences

4.1 Resources Eliminated From Consideration

NEPA and DOE's NEPA regulations direct that only the environmental issues or resources that may be affected by the proposed-action and no-action alternatives should be described in an EA. Riverton site-specific documents such as the Surface EA (DOE 1987), the Site Observational Work Plan (DOE 1998), and the Baseline Risk Assessment (DOE 1995) evaluated potentially affected resources. The following issues and resources are not affected and therefore are not addressed in this EA:

Resource or Issue	Rationale
Air quality	No air emissions would result from the proposed action.
Noise	The proposed action would not produce noise.
Threatened and endangered species	Ground water monitoring would not disrupt habitat or vegetation; no surface-disturbing activities are planned.
Wilderness	No proposed or designated wilderness areas are near the site.
Wild and scenic rivers	No proposed or designated wild and scenic rivers are near the site.
Prime or unique farmland	No prime or unique farmland is near the site.
Cultural resources	Because the proposed action would produce no surface-disturbing activities, cultural resources would not be affected.
Soils productivity, capability, erosion	Ground water would not be used as irrigation in sufficient quantities to cause contaminant buildup in soil or to cause soil erosion.
Timber resources	No timber resources are on or near the site.
Mineral and energy resources	Mineral and energy resources are not associated with the proposed action.

This EA focuses on selecting an appropriate strategy to address contaminated ground water. The strategy is selected on the basis of ground water regulations and an evaluation of risks to human health and ecological receptors as a result of exposure to ground water contaminants at the site.

Each subsection identifies the resource or issue to be addressed, describes the affected environment, then discusses the environmental consequences related to that issue for both the proposed-action and no-action alternatives.

4.2 Climate

4.2.1 Affected Environment

The climate in the Riverton area is semiarid to arid. Annual precipitation is approximately 8 inches; most precipitation falls from April through June. During spring runoff from the Wind River Mountains west of the site, the Wind River and Little Wind River transport large volumes of water through the Riverton area. Temperature and wind are not expected to affect natural flushing and are not discussed further.

4.2.2 Environmental Consequences

Because the uppermost aquifer is recharged by inflow from the Wind River to the northwest, annual fluctuations in snowpack and associated spring runoff have a periodic short-term effect on the rate of natural flushing at the site. The conceptual site model (DOE 1998) indicates that the mass of contaminated ground water would flush into the Little Wind River within the next 100 years. This same scenario would be true under the no-action alternative.

4.3 Land Use

4.3.1 Affected Environment

The Riverton site is in Fremont County, which comprises approximately 9 million acres of predominantly agricultural land. The Wind River Indian Reservation accounts for approximately 2.2 million acres of Fremont County land. The contaminated ground water underlies a small portion of the reservation. Other than low density residential housing, which is on the north and south boundaries of the Riverton site, land in the area is used primarily as pasture for livestock. Some residents have vegetable gardens. There are no known plans for large-scale residential, commercial, industrial, or recreational projects near the contaminant plume during the proposed natural-flushing period.

4.3.2 Environmental Consequences

Proposed Action

The proposed action would have no adverse effects on land use. The current land uses—primarily agricultural and sparse residential—would continue because of the availability of potable water, river-supplied irrigation water, and the water supply system constructed by IHS. Institutional controls such as placing restrictions on access and use would prevent withdrawal of water from the contaminated portion of the surficial aquifer for domestic use.

No Action

No restrictions on land use or access would be in place. This alternative would have no effect on land use.

4.4 Ground Water

4.4.1 Affected Environment

Background Ground Water Quality

The background quality of ground water was determined by assessing regional ground water conditions within the surficial and semiconfined aquifers. Section 4.3.2 of the Site Observational Work Plan provides a detailed description of background conditions. Analytical results from eight upgradient wells in the surficial aquifer and from two upgradient wells in the semiconfined aquifer indicate that upgradient concentrations of constituents of concern are near or below laboratory detection limits.

Hydrogeologic Setting and Constituents of Concern

Figure 4 shows a geologic cross section of the five hydrogeologic units that underlie the Riverton site. Section 4.3.1 of the Site Observational Work Plan (DOE 1998) provides a detailed discussion of the hydrogeologic setting. In descending depth, the units consist of the surficial aquifer, a leaky shale aquitard, a semiconfined sandstone aquifer, a shale aquitard, and a confined sandstone aquifer. Water-level and analytical data indicate that the surficial and semiconfined aquifers are hydraulically connected. Contaminant concentrations are higher in the surficial aquifer, which was characterized more rigorously than the less-contaminated semiconfined aquifer. The surficial aquifer and the semiconfined aquifer together make up the uppermost aquifer, which is the aquifer affected by milling activity. There is no evidence of a hydraulic connection between the uppermost aquifer and the deeper confined aquifer, which appears to be unaffected by past milling activities. Therefore, the confined aquifer is not discussed in detail.

Ground water analyses indicate that contaminated ground water in the uppermost aquifer extends from the former tailings pile area to the Little Wind River, approximately 3,000 ft southeast of the former tailings pile. An estimated 320 million gallons of ground water in the uppermost aquifer is contaminated with RRM.

Section 4.3.3 of the Site Observational Work Plan presents a description of the extent of contamination in the surficial and semiconfined aquifers. Only molybdenum, sulfate, and uranium show a consistent presence in the surficial aquifer (Figures 5, 6, and 7). A comparison of contaminant concentrations in samples from monitor well 101 upgradient of the former tailings pile with those from well 722 downgradient of the former pile shows that molybdenum concentrations in the downgradient well are comparable to background levels and have remained constant since 1993. However, sulfate and uranium concentrations in well 722 remain higher than those at monitor well 101. Farther downgradient from well 722, well 707 (approximately 400 ft from the Little Wind River) generally shows the highest concentrations of site-related constituents of concern in the surficial aquifer; these concentrations indicate that the centroid of the contaminant plume is most likely near well 707 and migrating toward the Little Wind River (DOE 1998).

The tailings piles were removed in 1990. Data from wells 722 and 707 indicate that sulfate and uranium are moving in the ground water toward the Little Wind River at a slower rate than molybdenum and that the highest concentrations of these contaminants have moved approximately 2,600 ft from the source area. Data also indicate that elevated sulfate levels are not solely associated with the former millsite; continuing elevated levels of sulfate west of the plume and along the western edge of the plume may be a result of contamination originating off site.

Ground water elevations beneath the site fluctuate seasonally as a result of snowmelt and runoff from the Wind River Mountains to the west. Snowmelt and spring runoff account for the largest volume of recharge. The surficial aquifer also receives seasonal recharge from irrigation ditches.

4.4.2 Environmental Consequences

Proposed Action

According to the conceptual site model (DOE 1998), about eight pore volumes (about 7,900 acre-feet) of ground water will move southeast from the former millsite to the Little Wind River within 100 years, and surface-water flows will dilute RRM concentrations to safe or natural levels. This natural-flushing strategy complies with ground water regulations in 40 CFR 192 and with the compliance strategies authorized in the PEIS. Because some contamination would remain in the uppermost aquifer during the period of natural flushing, institutional controls would be implemented throughout the surficial aquifer from the millsite southeast to the Little Wind River.

These controls would consist of construction and maintenance of the alternate supply of potable water for residents near the site, restrictions on the use of contaminated ground water, and a moratorium on drilling new wells in the contaminated aquifer. Although use of ground water during the natural-flushing period could result in adverse human-health and ecological effects as discussed in the Baseline Risk Assessment, the risks would lessen over time. Monitoring at the locations listed in Table 2 would confirm the rate and success of natural flushing.

No Action

Ground water will also flush naturally under the no-action alternative. Over time, contaminated ground water in the uppermost aquifer will move to the Little Wind River. However, monitoring to determine the rate and success of natural flushing would not be required.

Institutional controls would not be implemented, thereby increasing the possibility of intentional or inadvertent use of ground water in the uppermost aquifer. Because DOE would not monitor contaminant concentrations, no information of the progress of natural flushing would be available to the public.

4.5 Surface Water and Sediments

4.5.1 Affected Environment

Figure 3 and Plate 1 show the surface-water bodies near the Riverton site. Section 3.6.1 of the Surface EA (DOE 1987) discusses surface-water quality. Section 4.3.3 of the Site Observational Work Plan discusses the surface-water and sediment sampling program and the extent of contamination.

Topography and Land Features

The Riverton site lies within the Wind River Basin, which is part of the Wyoming Basin subdivision of the Middle Rocky Mountain physiographic province. Structurally, the Wind River Basin is bounded by uplifts to the north, south, and west. Topography was greatly influenced by glaciation. Major topographic features include the Wind River and the Little Wind River and the Wind River Mountains and the Owl Creek Mountains, which extend to more than 13,000 ft above sea level. These features result in a generally easterly and southeasterly flow of water toward and through the Riverton site.

A topographic profile established across the Little Wind River from monitor well 737 on the north side of the river to monitor wells 706 and 735 on the south side of the river (Plate 1) indicated that ground water discharges from the uppermost aquifer into the Little Wind River. The conceptual site model (DOE 1998) and the 1995 topographic profile show that the surface of the river is topographically lower than the ground water elevations on either side of the river. Recharge to the aquifer and natural ground water gradient will cause ground water to move to the east and southeast during the natural-flushing period. Environmental consequences of discharge to the river are discussed in Sections 4.6 and 4.7.

Lakes, Rivers, and Sediments

The Wind River is approximately one mile north of the Riverton site and is the primary recharge source for the uppermost aquifer. The river has a drainage basin of approximately 2,300 square miles. The Little Wind River is approximately 4,000 ft southeast of the site and has a drainage basin of approximately 2,000 square miles. Both rivers meet approximately 2.5 miles east of the site. Ground water from the uppermost aquifer discharges into the recently formed oxbow lake southeast of the site. The oxbow lake was within the main channel of the Little Wind River until 1994. Tables 4–8, 4–9, and 4–10 of the Site Observational Work Plan list contaminant concentrations in surface-water, sediment, and vegetation samples. Uranium and sulfate have been detected in concentrations above background in samples collected from the oxbow lake.

Samples of surface water collected from Koch Ditch and the West Side Irrigation Ditch (locations 749 and 795, Plate 1) in 1997 had concentrations of iron, manganese, sulfate, and total dissolved solids that were elevated above background but were generally lower than concentrations in samples collected from the same locations in 1995. Because the ditches are not within the contaminant plume or its flow path, contaminants at those locations are believed to originate from a source other than the millsite.

Water Use

Surface water and ground water are both used for domestic purposes. The Wind River north of the site is the primary source of Riverton municipal water in the spring and summer. Numerous domestic wells in the deeper confined aquifer are used by residents near the millsite. However, no site-related contaminants have affected this aquifer. Water from the uppermost aquifer at the site is not currently used for drinking water or other domestic purposes. Two shallow wells outside the contaminant plume and northeast of the site (wells 431 and 445, Plate 1) are used occasionally to water livestock and crops. IHS began installation of a potable water supply system to serve residents near the millsite.

The Little Wind River southeast of the site is used for irrigation, livestock watering, and recreational activities such as swimming, boating, and fishing. The oxbow lake has more limited use because of its location, limited public access, and small surface area. It is expected that the oxbow will eventually fill in with sediment.

4.5.2 Environmental Consequences

Proposed Action

Data gathered on water quality and flow demonstrate that the Little Wind River dilutes discharging ground water contaminants to concentrations below those that present risks to human health and the environment and that the contaminant discharge does not adversely affect the river. The Baseline Risk Assessment determined that the exposure pathways of incidental ingestion and dermal absorption that could result from recreational use of the oxbow lake were of negligible concern. Current water uses would be unaffected by the proposed action because the contaminated portion of the surficial aquifer is not used for domestic consumption.

No Action

The no-action alternative would exclude any further sampling, monitoring, and other activities. Although contaminant concentrations at surface-water locations such as the oxbow lake appear to be decreasing through time, no monitoring would be conducted to confirm this trend, and environmental consequences would be unknown.

4.6 Risk to Human Health

4.6.1 Affected Environment

Appendix B of the PEIS describes the methods used to assess the human-health risk at the Riverton site.

Because the tailings and contaminated soil at the site were removed and relocated to a disposal cell, the inhalation exposure pathway is no longer relevant. Also, the contribution of risk from dermal absorption of contaminants was considered insignificant (0.2 percent of the total exposure risk) compared to the contribution from ingestion and was not evaluated in detail (DOE 1995, Section 6). The following are potential means of ingesting contaminants:

- Drinking water directly from the contaminated portion of the uppermost aquifer.

- Consuming dairy products such as milk from cows that have bioaccumulated contaminants as a result of drinking water from the uppermost aquifer.

- Consuming meat from cattle or game that have bioaccumulated contaminants by drinking water from the uppermost aquifer.

- Eating fish that have bioaccumulated contaminants as a result of contaminated ground water discharging into surface waters.

- Eating vegetables or other plants that were irrigated with contaminated ground water or that acquired contaminants through root uptake.

- Incidental ingestion of contaminated surface water or sediments during recreational activities such as swimming or boating.

Ingestion of contaminated ground water from the uppermost aquifer presents a potential risk to human health; that exposure pathway accounts for more than 95 percent of total risk. Manganese, molybdenum, and sulfate account for nearly all the noncarcinogenic risks posed by ingestion of ground water. Uranium and, to a lesser degree, arsenic pose the only potentially significant carcinogenic risk. Because arsenic concentrations at all sampling locations are below MCLs, arsenic is not discussed further. Of greatest concern are the high levels of sulfate, ingestion of which could present a health risk to infants. Because of the continuing contribution of sulfate to the surficial aquifer from a source not associated with the millsite, some risk from sulfate may remain after the mill-related contaminants have flushed through. A more detailed discussion of potential adverse effects of sulfate and other constituents of concern is presented in Section 5.1 of the Baseline Risk Assessment (DOE 1995) and in Section 4.4.4 of the Site Observational Work Plan (DOE 1998).

No drinking-water wells have been installed in the surficial aquifer at or near the Riverton site. All drinking water is obtained from the deeper confined aquifer, hauled from other sources, or provided by the Riverton municipal water system. A continuous source of potable water would be provided for residents potentially affected by the contaminated ground water.

4.6.2 Environmental Consequences

Proposed Action

Human health would be protected by the natural-flushing alternative. Ground water in the uppermost aquifer has not been used historically as a source of domestic or drinking water. Through an agreement with the tribes and DOE, IHS has placed a moratorium on drilling in the area of the contaminant plume and is currently constructing an alternate water supply system (described in Section 1.2) planned for completion in 1998. Therefore, residential use of ground water from the surficial aquifer will not be a concern. Ground water monitoring would provide information about the effectiveness of natural flushing. When ground water standards are met, institutional controls on aquifer use can be removed.

Incidental or occasional exposure to contaminated ground water is possible, particularly where the water discharges to the oxbow lake and the Little Wind River. However, results of the Baseline Risk Assessment (DOE 1995, Section 6) indicate that such limited exposure presents negligible risk. Ground water contaminants are diluted as ground water discharges to surface water and mixes with upstream waters. The most recent sampling data indicate that only one surface-water location, the oxbow lake, has surface-water contaminants that are clearly attributable to the Riverton site and that exceed standards or benchmarks. Exposure to this water would be expected to pose very little risk because the percentage of water ingested through recreational use is likely only a few percent of a person's total daily water intake. Acute levels of contaminants would have to be present to cause adverse reactions to this small degree of exposure, and those concentrations have not been detected, even in ground water. The Baseline Risk Assessment also states that human health would not be affected by eating meat or drinking milk from cattle that have ingested contaminated water. Data also indicate that eating fish, swimming, and eating vegetables irrigated with contaminated surface waters would not adversely affect human health. The risks are believed to be negligible because of limited use of contaminated water by plants and animals and, in turn, the limited exposure people would have to contaminated food.

The Baseline Risk Assessment (Section 4.2) eliminated all exposure pathways except the drinking water pathway because of the very limited degree of risk associated with them.

No Action

Under the no-action alternative, use of the surficial aquifer would not be controlled and water quality of the aquifer would not be monitored. Domestic wells could be installed in the surficial aquifer and used by area residents. On the basis of conservative assumptions made in the Baseline Risk Assessment, users of the water could be almost 10 times more likely to develop cancer than the general population because of exposure to uranium. Intakes of manganese through residential use of the water could be up to 30 times higher than acceptable levels. Sulfate concentrations could produce adverse health effects, particularly in infants. Without a monitoring program, DOE and the public would have no information about changes in ground water conditions.

4.7 Risk to Ecological Receptors

4.7.1 Affected Environment

Ecological receptors at the Riverton site are described in Section 7.2 of the Baseline Risk Assessment (DOE 1995) and consist of numerous species of plants, birds, mammals, reptiles, insects, and aquatic life. The ecological risk assessment was a screening-level activity conducted to determine if ground water contaminants have the potential to adversely affect the biological community at and near the site.

Because the depth to ground water is 6–10 ft below ground surface, plant roots could extend into the water table and acquire contaminants by root uptake. Also, plants may accumulate contaminants if ground water is used to irrigate fields or gardens. Wildlife and livestock may be exposed to contaminants by ingesting surface water that receives inflow from contaminated ground water, by drinking from a pond or tank that was filled with water from the contaminated surficial aquifer, by ingesting plants or animals that have bioaccumulated site-related contaminants, or by incidental ingestion of contaminated sediments during foraging or grooming.

Ecological risks are summarized in Table 3 and in the following discussion. Benchmark values were obtained from Tables 7.1 and 7.2 of the Baseline Risk Assessment (DOE 1995) and from data compiled by Oak Ridge National Laboratory and were compared to analytical results from the 1997 round of sampling.

Table 3. Summary of Ecological Risks

Constituent of Potential Concern	Potential Risk Posed Yes (Y)/No (N)		Comment
	Plants[a]		
	Uptake Through Soil	**Direct Water Uptake**	
Arsenic	N	N	Soil/water concentrations below protective levels (Tables 7.1 and 7.2, DOE 1995)
Manganese	N	Y	Ground water concentrations exceed protective levels (Table 7.2, DOE 1995)
Molybdenum	N	Y	Soil/water concentrations below protective levels (Tables 7.1 and 7.2, DOE 1995)
Nickel	N	N	Ground water concentrations exceeded protective levels in 1997 (Table 7.2, DOE 1995)
Sulfate	Unknown	Y	Ground water concentrations exceed protective levels (Table 7.2, DOE 1995)

Table 3. Summary of Ecological Risks (continued)

Constituent of Potential Concern	Potential Risk Posed Yes (Y) / No (N)		Comment
Plants[a] (continued)			
	Uptake Through Soil	**Direct Water Uptake**	
Uranium	Unknown	N	Ground water concentrations below protective levels (Table 7.2, DOE 1995)
Vanadium	N	N	Ground water concentrations exceeded protective levels (Table 7.2, DOE 1995)
Wildlife[b]			
Arsenic	N		No benchmarks exceeded in surface water
Manganese	N		Wildlife benchmark is not exceeded for surface water (Table 4–8, DOE 1998)
Molybdenum	N		No benchmarks exceeded for surface water
Nickel	N		No benchmarks exceeded for surface water
Sulfate	Unknown		No benchmarks available
Uranium	N		Wildlife benchmark is not exceeded for surface water (Table 4–8, DOE 1998)
Vanadium	N		No benchmarks exceeded for surface water
Aquatic Life[b]			
Arsenic	N		Not detected in surface water
Manganese	Y		Secondary aquatic criteria exceeded in oxbow lake
Molybdenum	N		Not detected in surface water
Nickel	N		Ground water concentrations below ambient water quality criteria
Sulfate	Unknown		Benchmarks not available
Uranium	Y		Benchmark exceeded in oxbow lake only
Vanadium	N		Vanadium at or near detection limits
Livestock			
Arsenic	N		Ground water concentrations below protective levels (Table 7.2, DOE 1995)
Manganese	Y		Ground water concentrations above protective levels (Table 7.2, DOE 1995)
Molybdenum	Y		Ground water concentrations above protective levels (Table 7.2, DOE 1995)

Table 3. Summary of Ecological Risks (continued)

Constituent of Potential Concern	Potential Risk Posed Yes (Y)/No (N)	Comment
	Livestock (continued)	
Nickel	N	Ground water concentrations below protective levels (Table 7.2, DOE 1995)
Sulfate	Y	Ground water concentrations above protective levels (Table 7.2, DOE 1995)
Uranium	N	Ground water concentrations below protective levels (Table 7.2, DOE 1995)
Vanadium	N	Ground water concentrations below protective levels (Table 7.2, DOE 1995)

[a] Section 7.4.1 of the Baseline Risk Assessment (DOE 1995); benchmark values are taken from Tables 7.1 and 7.2.
[b] Benchmarks from the database *Screening Benchmarks for Ecological Risk Assessment,* version 1.6, prepared by Environmental Sciences and Health Sciences Divisions, Oak Ridge National Laboratory, Oak Ridge, Tennessee, October 1996.

Plants

Concentrations of contaminants in soil (due to partitioning from ground water) are insufficient to cause phytotoxicity through root uptake (DOE 1998, Section 4.4.5). Plants whose roots contact ground water directly could be adversely affected because of the levels of manganese, molybdenum, and sulfate. Molybdenum and sulfate could build up to toxic levels in soil by long-term use of contaminated ground water for irrigation.

Livestock

Manganese, molybdenum, and sulfate concentrations in the contaminant plume may present a risk to livestock if contaminated ground water is used for livestock watering; molybdenum concentrations may present a risk if ground water is used to irrigate forage plants.

Aquatic Life

Contaminant concentrations in samples from the Little Wind River at downstream sampling locations were comparable to concentrations in the upgradient background location. In 1997, iron and uranium concentrations in the oxbow lake exceeded Wyoming water quality criteria for the protection of aquatic life. Manganese concentrations in the oxbow lake also exceeded secondary aquatic criteria (DOE 1998).

4.7.2 Environmental Consequences

Proposed Action

The natural-flushing alternative would not adversely affect plant and animal communities because the ground would not be disturbed. Because of the limited opportunities for receptors to directly contact the contaminated ground water, adverse effects are not anticipated. Prolonged contact with contaminants is unlikely because of the limited extent of surface-water and sediment contamination.

No Action

The no-action alternative would place no restrictions on drilling wells in the surficial aquifer for irrigation and livestock watering. This alternative could result in some risk to vegetation, aquatic life, and livestock as summarized in Table 3.

4.8 Wetlands

4.8.1 Affected Environment

Five wetlands areas are near the Riverton site (Plate 1). Three wetlands, consisting of 361 acres, 6.5 acres, and 0.9 acre are north (upgradient) of the site. A 179-acre wetland is south and west of the site and a 68-acre wetland is east of the site.

Koch ditch discharges into the West Side Irrigation Ditch, which crosses the wetland south and west of the site and discharges into the Little Wind River. Concentrations of sulfate in samples from that wetland have exceeded State irrigation guidelines by as much as a factor of seven. It is likely that these concentrations have caused the lack of aquatic macrophytes and also the mortality of Russian olive trees along Koch Ditch. Because the contaminant plume (Figures 5, 6, and 7) is moving southeast from the site and does not enter either wetland, it is believed that contaminants in the southwest wetland are not associated with the millsite and originate off site.

The wetland east of the site receives effluent from the North Irrigation Ditch, which flows east from the millsite through surface-water monitoring location 744 (Plate 1). Contaminant concentrations in surface-water samples from the east wetland have not exceeded agricultural, ecological, or aquatic-life standards. However, manganese concentrations in sediment samples from location 746 indicated a potential for toxicity to benthic organisms. Because this wetland is not in the flow path of the ground water contaminant plume, the elevated concentrations of manganese are not a result of ground water contamination. Continued monitoring is planned at location 746.

4.8.2 Environmental Consequences

Proposed Action

Wetland areas would not be affected by the natural-flushing alternative because the land surface would not be disturbed and because the contaminant plume is migrating southeast from the site and does not extend into the wetland areas.

No Action

Wetland areas would not be affected by the no-action alternative because the land surface would not be disturbed and because the contaminant plume is not migrating toward the wetlands.

4.9 Socioeconomic Issues and Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, states that "... each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations...." An open meeting for the public and interested stakeholders was held in Riverton on January 27, 1998, to discuss the Environmental Assessment and the Site Observational Work Plan.

Proposed Action

The proposed action would not adversely affect ground water, surface water, land or water use, ecological resources, or wetlands. The application of natural flushing and institutional controls would be protective of human health and the environment. The alternate water supply system would eliminate the potential for using contaminated ground water for drinking water. Although a population that is subject to environmental justice considerations is present at the Riverton site, no disproportionate adverse effects to that population would result from the proposed action.

No Action

The no-action alternative would not adversely affect ground water, surface water, land or water use, ecological resources, or wetlands. However, this alternative could potentially result in disproportionately high or adverse effects to minority or low-income populations. The millsite and site-related contaminants are within the Wind River Indian Reservation. Information about potential risks and the need to restrict the use of contaminated ground water would not be available to the Northern Arapaho and Shoshone Tribes. Unrestricted use of ground water from the most contaminated portion of the surficial aquifer could present a hazard to human health. Monitoring would not be conducted to evaluate effects on ecological resources. Information concerning the locations of contaminated areas, the extent of contamination, and the results of natural flushing would not be available.

5.0 Persons and Agencies Consulted

Information included in this document was compiled from other sources, such as the Surface EA (DOE 1987), the Baseline Risk Assessment (DOE 1995), the Site Observational Work Plan (DOE 1998), and the PEIS (DOE 1996). During preparation of those documents, several public meetings were held and notices were published in local, regional, and tribal newspapers and posted in several locations. Federal, State, and tribal agencies were invited to participate in the public meetings. Stakeholders were routinely consulted or given the opportunity to participate in the development of the Baseline Risk Assessment and the Site Observational Work Plan. Persons and agencies consulted included the public, the State, the Wind River Environmental Quality Commission, IHS, and the Bureau of Indian Affairs. Analytical results from ground water sampling are routinely mailed to landowners, stakeholders, and tribal agencies. Copies of all site-related documents are available at the branch library in Riverton, the Wyoming State Library, and the University of Wyoming Library. Copies of all site-related documents are forwarded to the Wind River Environmental Quality Commission. DOE will make additional copies available through the Commission. A public meeting was held on January 27, 1998, at Saint Stephen's Mission to discuss DOE's proposed action, including installation of the water supply system. DOE has also communicated regularly with the Wind River Environmental Quality Commission and met with that agency on January 27, 1998. A toll-free number is established for anyone who needs additional information. Audrey Berry of the DOE Public Affairs office in Grand Junction, Colorado, can be contacted at (800)399–5618 for more information or copies of documents and data prepared for the Riverton site. Donald Metzler, DOE Project Manager, can be contacted at (970)248–7612.

6.0 References

10 CFR 1021. "National Environmental Policy Act Implementing Procedures," *U.S. Code of Federal Regulations*, January 1, 1997.

40 CFR 192. "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *U.S. Code of Federal Regulations*, July 1, 1996.

U.S. Department of Energy, 1987. *Remedial Action at the Riverton Uranium Mill Tailings Site, Riverton Wyoming*, DOE EA–0254, June.

———, 1995. *Baseline Risk Assessment of Ground Water Contamination at the Uranium Mill Tailings Site Near Riverton, Wyoming*, Rev. 1, DOE/AL/62350–65, prepared by Jacobs Engineering Group Inc. for the U.S. Department of Energy, Environmental Restoration Division, UMTRA Project Team, Albuquerque, New Mexico, September.

U.S. Department of Energy, 1996. *Final Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project*, DOE/EIS–0198, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico, October.

———, 1998. *Final Site Observational Work Plan for the UMTRA Project Site at Riverton, Wyoming*, MACTEC Environmental Restoration Services, LLC, for the U.S. Department of Energy, Albuquerque Operations Office, Albuquerque, New Mexico, and Grand Junction Office, Grand Junction, Colorado, February.

U.S Geological Survey, 1984a, b, and c. WATSTORE Data Retrieval, May, June, and August 1984, Water Resources Division, New Mexico District Office, Albuquerque, New Mexico.

Appendix A. Glossary

Alternate concentration limits—Concentrations of constituents that may exceed the maximum concentration limits; or, limits for those constituents without maximum concentration limits. If DOE demonstrates, and the U.S. Nuclear Regulatory Commission concurs, that human health and the environment would not be adversely affected, DOE may meet an alternate concentration limit.

Maximum concentration limit—EPA's maximum concentration of certain constituents for ground water protection. Constituents with maximum concentration limits that may be present in the ground water at the Riverton site are arsenic, molybdenum, and uranium.

National Environmental Policy Act of 1969 (and subsequent amendments)—a national policy for promoting efforts to prevent or eliminate damage to the environment. This act requires Federal agencies to prepare a detailed statement that identifies and analyzes the environmental effects of a proposed action that may significantly affect the quality of the human environment. Regulations in NEPA also require that each Federal agency develop its own implementing procedures. The DOE implementing requirements for compliance with NEPA are in 10 CFR Part 1021.

Natural Flushing (also known as natural attenuation)— a process in which natural geochemical and biological processes and ground water movement decrease contaminant concentrations in the aquifer.

Residual radioactive material (RRM)—Uranium mill tailings that DOE determines to be radioactive and that have resulted from the processing of uranium ore, and other waste at a processing site that DOE determines to be radioactive and that relates to such processing. EPA has interpreted this to include sludges and captured contaminated water from processing sites.