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United States Department of Energy

Final
Environmental Impact Statement

REMEDIAL ACTIONS AT THE FORMER UNION CARBIDE CORPORATION URANIUM MILL SITES RIFLE, GARFIELD COUNTY, COLORADO

VOLUME II: APPENDICES

MARCH 1990

U.S. DEPARTMENT OF ENERGY

Uranium Mill Tailings Remedial Action Project

APPENDIX A

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A.1 INTRODUCTION AND INTERIM ACTIONS AT THE OLD AND NEW RIFLE SITES

A.1.1 PURPOSE

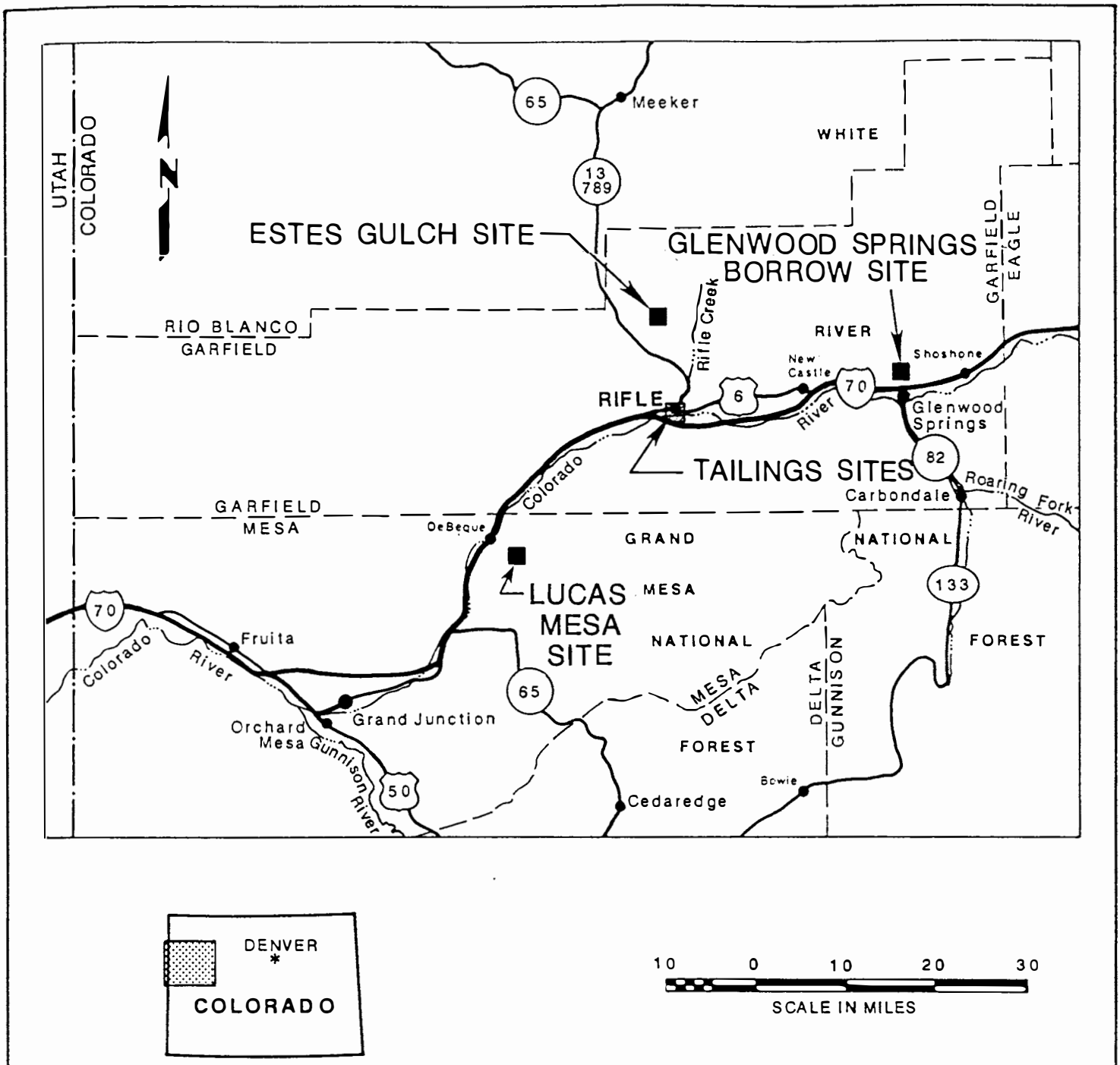
This appendix provides the information needed to understand the conceptual designs for the remedial action alternatives addressed in this environmental impact statement (EIS). It is intended to provide sufficient details for the reader to evaluate the feasibility and assess the impacts of each remedial action alternative. It is not intended to provide the detailed engineering necessary to implement the alternatives. Details of the preferred remedial action will be presented in the remedial action plan (RAP).

The remedial action alternatives addressed in this EIS include no action, stabilization at the New Rifle site, disposal at the Estes Gulch site, and disposal at the Lucas Mesa site. All alternatives include interim actions to remediate existing health and safety hazards to the Rifle community that presently exist at the Old and New Rifle processing sites. Figures A.1.1 and A.1.2 show the locations of the Rifle tailings sites, the Estes Gulch and Lucas Mesa alternate disposal sites, and the proposed borrow sites. It should be noted that the borrow sites included in this EIS were selected as the sources of the necessary borrow materials for impacts analyses purposes only. The borrow sites to be used for the remedial action will be selected during the final design.

A.1.2 DESIGN OBJECTIVES

The purpose of the remedial action is to stabilize and control the uranium mill tailings (residual radioactive wastes) and other contaminated materials in a manner which complies with the U.S. Environmental Protection Agency (EPA) standards (40 Code of Federal Regulations Part 192). Consistent with this purpose and the EPA standards, the following major design objectives have been established:

- Reduce the average radon flux from the site to levels consistent with the EPA standards.
- Design controls to be effective for up to 1000 years to the extent reasonably achievable, and, in any case, for at least 200 years.
- Ensure that existing or anticipated beneficial uses of surface and groundwaters are not adversely affected.
- Reduce contaminant levels (radium-226) in areas released for unrestricted use to levels consistent with the EPA standards.
- Minimize the land area to be occupied by the stabilized tailings.
- Provide flood protection, runoff and sediment control, and treatment of wastewater as required.



APPROXIMATE LOCATION OF MAP

FIGURE A.1.1
RIFLE SITES LOCATION

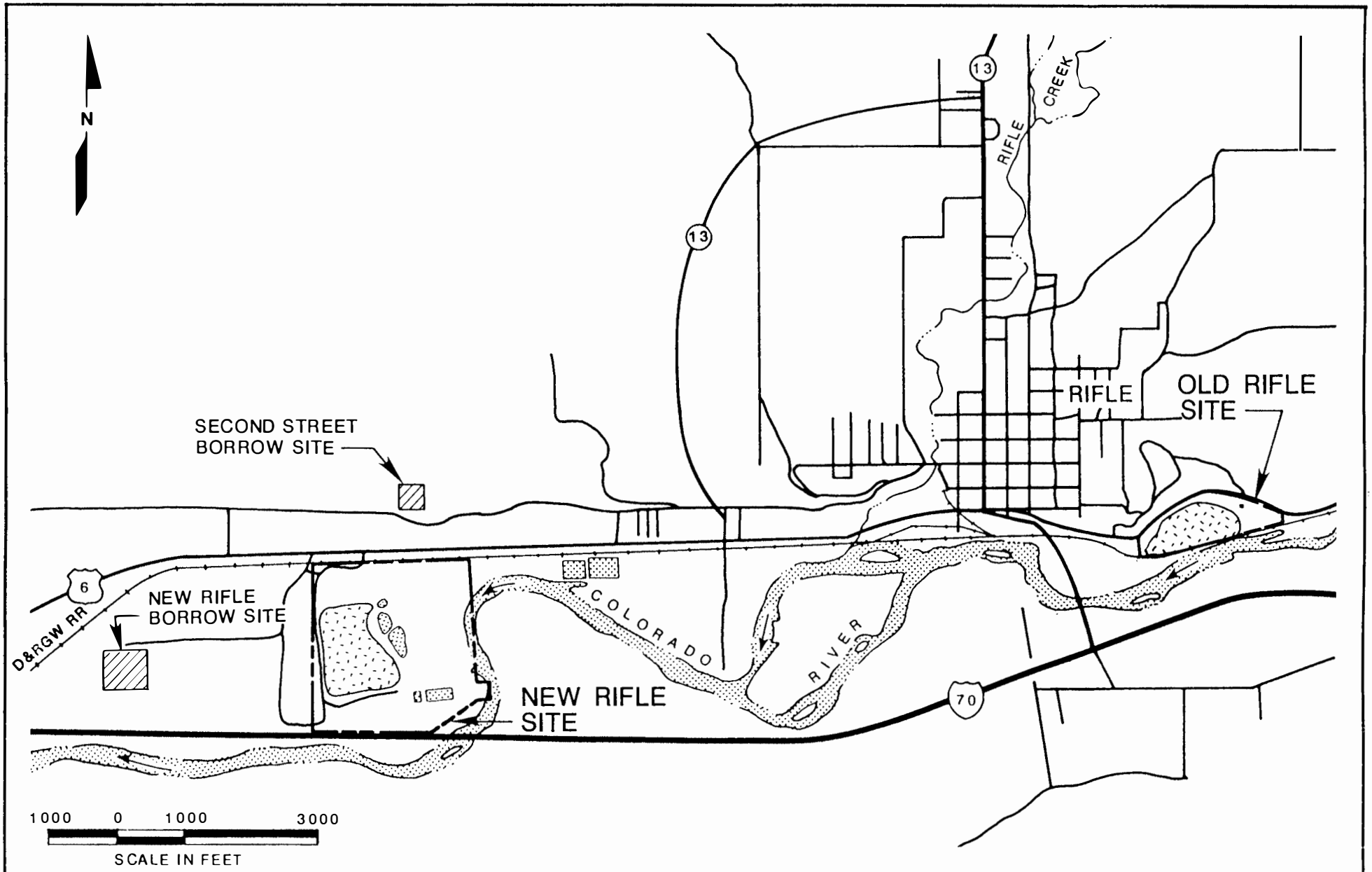


FIGURE A.1.2
OLD AND NEW RIFLE SITES

- o Prevent inadvertent human intrusion into the stabilized tailings.
- o Minimize plant root penetration and animal burrowing into the stabilized tailings.
- o Protect against releases of contaminants from the sites during construction.
- o Minimize the areas disturbed during construction and human exposure to contaminated materials.

A.1.3 INTERIM ACTIONS AT THE OLD AND NEW RIFLE SITES ONLY (NO ACTION ALTERNATIVE)

A.1.3.1 Major design features

Under this alternative, no steps would be taken toward remedial action at the tailings sites and the vicinity properties. However, this alternative does consider the completion of interim actions activities at the Old and New Rifle processing sites by August 1989 to remediate existing safety hazards to the Rifle community. The actions include such activities as establishment of temporary and construction facilities, removal of asbestos and other chemicals and materials, demolition of unstable and unsafe mill structures, and improving site security. Vanadium-contaminated materials would be transferred to a vanadium processing facility for reprocessing; all other chemicals, acids and materials would be transferred to licensed disposal sites. The major activities for this interim action are discussed in detail in Section A.1.3.3. The following activities at each site and the borrow site are required:

At the Old and New Rifle sites

- Upgrading (as necessary) of the access road from each tailings site to U.S. Highway 6.
- Sealing, removing or plugging of all existing abandoned utilities and wells.
- Installation of permanent security fences with locked gates and warning signs at each site to inhibit inadvertent human intrusion.
- Construction of wastewater retention basin(s) at each site to protect against releases of any contaminants from the sites during interim actions.

- Construction of drainage control measures at each site to direct all wastewater and storm-water runoff to the retention basin(s) during interim action.

- Installation and operation of a wastewater treatment facility (if necessary) at each site to protect against the inadvertent release of contaminants during interim actions.

- Implementation of measures to control erosion and sedimentation from disturbed areas at each site during the interim actions.

- Construction of temporary construction facilities, such as asbestos control areas, airtight asbestos barriers, decontamination enclosure systems at asbestos control area entrances and exits, construction worker facilities, and an equipment staging area.

- Asbestos removal from all mill site areas and packaging for disposal. Includes post-removal clean up of work areas and spraying of removal surfaces with an encapsulating material to prevent fibers from becoming airborne during demolition.

- Collecting and transfer of all vanadium-contaminated wastes to a vanadium processing facility for reprocessing.

- Demolition of all buildings, foundations, structures, conveyors, bins, tanks, scales, drums, existing fencing and piping; transfer of all crushed demolition debris to an approved disposal facility.

- Removal, plugging or sealing of abandoned or unnecessary utilities and test wells.

- Restoration of the disturbed areas at both sites with clean fill material and grading to promote positive drainage. Includes revegetation of those disturbed wetlands requiring restoration areas to re-establish plant species identical or similar to those that presently exist.

<u>At the New Rifle site</u>

- Identification, packaging and removal of all chemicals, oils, solvents, etc., to an appropriate licensed disposal facility.

At the Second Street and New Rifle borrow sites

- Excavation of earthen materials for uncontaminated fill and site restoration.

- Transportation by truck of the earthen materials to the Old and New Rifle tailings sites.

A.1.3.2 Permanent design features

Description of final conditions

All of the unstable mill structures at both sites would be demolished, crushed, and removed to an appropriate disposal facility. All asbestos, chemicals and materials would be packaged and transferred to a licensed disposal facility. All vanadium-contaminated materials would be transferred to a vanadium processing facility for reprocessing. Both sites would be totally restricted from use and would be enclosed by a permanent security fence with locked gates and warning signs. Those areas disturbed during the interim actions would be restored with clean fill and graded to promote positive drainage. Disturbed wetlands requiring restoration would be revegetated to re-establish plant species identical or similar to those that presently exist. The tailings piles would remain in their present locations and conditions, and the contaminated materials would be subject to dispersion by wind and water erosion and unauthorized removal by man. The contamination of groundwater beneath the tailings sites would continue for an indefinite period of time.

Decontamination and restoration

Contaminated debris resulting from the demolition of the existing buildings and structures would be packaged and transferred to the appropriate licensed disposal facility. Mixed wastes, asbestos and chemicals would be packaged and transferred to a licensed disposal facility. Vanadium-contaminated materials would be transferred to a vanadium processing facility for reprocessing.

After completion of the interim actions, all disturbed areas would be restored with clean fill and graded to promote positive drainage. Disturbed wetlands areas would be revegetated to re-establish plant species identical or similar to those that presently exist.

Site drainage

During the interium action activities, temporary site drainage control facilities would be constructed to direct all

wastewater and storm-water runoff into the retention basins. After the completion of interim action, the disturbed areas would be graded to promote positive drainage; however, the no action alternative does not include construction of permanent drainage control or PMF control facilities.

Groundwater protection

Removal of the existing chemicals, oils, solvents, cleaners and other contaminants present at the New Rifle site would remove potential sources of ground and surface water contamination. Under the no action alternative, the tailings piles would remain in their present locations and conditions; therefore, the contamination of groundwater beneath the pile, and the risk of surface water contamination, would continue for an indefinite period of time.

Site access

After the interim actions have been completed, both processing sites would be surrounded by permanent security fencing with locked gates and warning signs to discourage inadvertent human intrusion.

A.1.3.3 Major construction activities

Layout

The staging area at the Old Rifle site would be in the former mill area northeast of the pile. At the New Rifle site, the staging area would be in the former mill buildings area north of the pile. Equipment decontamination facilities would be adjacent to the staging areas at both sites. Ditches and berms surrounding the sites would direct uncontaminated flows outside of the sites away from the sites; contaminated water on the site would be directed to wastewater retention basins and treatment facilities constructed on the site. At the New Rifle site the basin would be constructed southwest of the pile, and at the Old Rifle site the basin would be constructed just east of the pile. Temporary fencing would surround both sites during the interim actions.

Site access

The temporary security fences would provide control of traffic entering and leaving the sites and prevent unauthorized traffic from entering the sites. Equipment would be decontaminated prior to leaving the sites.

Staging area facilities

During the interim actions, temporary facilities would be required for the interim action workers, supervisory, administration, security and asbestos monitoring staff. The facilities would consist of office space, washing facilities, temporary asbestos control areas, airtight asbestos barriers to separate high asbestos areas, decontamination entrance/exit enclosure systems, change rooms, laundry and portable toilets for all on-site workers. On-site equipment would be stored in the staging areas. Parking areas would also be constructed at the sites.

Utilities

Some water for dust suppression would be recycled from wastewater retention basins. Additional water for dust suppression, and for continued watering of the tailings piles as required by CDH, would be drawn from the Colorado River. Potable water, and temporary electricity, gas and phone service would be obtained from local suppliers. All existing abandoned utilities and wells will be sealed, removed or plugged. Temporary utility systems will be removed upon completion of the interim actions.

Drainage, erosion control and wastewater retention basins

During interim actions, all on-site drainage from both sites will be blocked from reaching off-site waterways. Disturbed areas on the site will be graded so that runoff will drain into the temporary wastewater retention basins. Off-site runoff would be diverted away from the site and contaminated areas and into existing surface drainge ways by diversion ditches. The wastewater retention basins will receive waters from the equipment decontamination area, disturbed area runoff, protective clothing laundry and employee washing facilities.

Wastewater treatment

Wastewater generated from the sources mentioned in Section A.2.3.5 would be directed to temporary wastewater retention basins that would provide primary settling along with flow and contaminant equalization. Some of this water would be used for dust suppression. The remainder of this water would be treated to meet applicable state of Colorado water quality standards before discharge. After completion of the interim actions, the treatment system would be decontaminated and transferred to another UMTRA Project site.

Dust control

Dust generated by site clearing, earth movement, vehicle use, temporary materials stockpiling and similar activities would be controlled and minimized by the use of water and water-based surfactants sprayed from hoses and trucks.

Dust suppression waters for contaminated areas wil be recycled in part from the temporary wastewater retention basins. The rest would be drawn from the Colorado River, particularly dust suppression waters for uncontaminated areas.

The spraying schedules will vary daily and be determined on an hour-by-hour basis in accordance with state permits. The frequency of spraying would increase when combinations of low soil moisture and high wind speed were encountered.

Special care would be taken to control dust and asbestos fibers during structure demolition and the temporary stockpiling or mixing of contaminated materials. Work areas will be cleaned to assure that asbestos fibers do not become airborne during demolition. Surfaces from which asbestos has been removed will be sprayed with an encapsulating material, and air sampling will be performed to verify that asbestos contamination levels are below regulated levels.

Borrow site

Two borrow sites have been identified for the interim actions. The Second Street borrow site is approximately 0.2 road mile north of the New Rifle site. Earthen materials for clean fill would be purchased from this existing commercial borrow site and trucked to the tailings sites. The New Rifle borrow site is along the north bank of the Colorado River approximately 0.5 road mile west of the New Rifle tailings site. Aggregate for temporary roads, the decontamination pads and other facilities would be purchased from this existing commercial borrow site.

Construction sequence

The following is a construction sequence for the interim actions at the Old and New Rifle processing sites. Initially, a site security system would be established at each site and coordinated with staging and decontamination areas. This would provide control of traffic entering and leaving each site and prevent unauthorized traffic from entering the sites.

Next, excavation and stockpiling of contaminated materials in the access roads, access control areas and decontamination control areas would commence. These areas would be backfilled

with uncontaminated materials from the borrow sites. Temporary utilities, gravel surfacing, office trailer and worker facilities would be installed, followed by construction of the temporary wastewater retention basins and drainage and erosion control measures.

Asbestos would be removed prior to the demolition of the existing mill structures. The asbestos, demolition debris and any other wastes discovered would be packaged appropriately and transferred to a licensed disposal facility. The vanadium-contaminated wastes would be transferred to a vanadium processing facility for reprocessing. All existing abandoned utilities and test wells would be removed, sealed, or plugged.

Demobilization would consist of the removal of the temporary wastewater retention basins and drainage ditches. The water remaining would be treated and discharged, while the bottom sludges would be transferred to a disposal facility. All decontamination facilities would be removed and the equipment cleaned for transferral to another UMTRA Project site. The staging areas would be dismantled. The contaminated items would be decontaminated and salvaged. All equipment would be decontaminated and inspected prior to release from the site. The final stages would involve reestablishing overall positive site drainage; grading; minimal revegetation, including those disturbed wetlands areas requiring restoration; and construction of permanent security fencing around the sites.

A.1.3.4 Radon control

Neither the no action alternative nor the interim actions consider control of radon flux at either processing site. The tailings piles and contaminated areas would be left on site, in their original position and conditions. The contaminated materials would be subject to dispersion by wind and water erosion and unauthorized removal by man. The contamination of groundwater beneath the tailings piles would continue for an indefinite period of time.

A.1.3.5 Design considerations

The major design considerations for this alternative include providing for the remediation of existing safety hazards to the Rifle community that are present at the processing sites.

When the state acquired the processing sites in 1988, the mill structures were unsafe and contained asbestos; a variety of oils, gasses, solvents, chemicals and cleaners, often in unmarked containers or in unsecured areas, were present on the

New Rifle site, and neither of the sites was guarded or considered physically secured. The condition of the sites presented a constant hazard to the groundskeeping crew, as well as any local residents who might easily gain unauthorized access to the sites.

In addition, both sites' proximity to the Colorado River, coupled with the hazardous substances present on the site, could result in the potential for additional pollution of the river or local groundwater, noncompliance with applicable water pollution regulations and a public health hazard.

Because of the unsafe conditions and the potential liability issues, the DOE approved the initiation of the interim actions in July 1988. Performance of the interim actions was determined to be necessary for purposes of health, safety, and removal of potential sources of ground and surface water contamination, independent of the selection of either an action alternative or the no action alternative.

While these activities may be considered part of the type of the site preparation work that could proceed prior to remedial action, no uranium mill tailings piles will be disturbed as a result of this activity, and these activities will in no way jeopardize or influence the National Environmental Policy Act (NEPA) process.

If the no action alternative is selected, all wastes and contaminated debris will be transferred to the appropriate, licensed disposal site.

A.1.3.6 Long-term stability

Neither the no action alternative nor the interim actions consider long-term site stability at either of the processing sites.

A.1.3.7 Groundwater protection

Neither the no action alternative nor the interim actions consider groundwater protection at either of the processing sites, beyond the removal of chemicals, solvents and other potential surface and groundwater contaminating materials at the New Rifle site. The tailings piles and contaminated windblown materials would be left in their original positions and conditions at both sites where they would be subject to dispersion by wind and water erosion and unauthorized removal by man. Contamination of groundwater beneath the sites would continue for an indefinite period of time.

A.2 STABILIZATION AT THE NEW RIFLE SITE

A.2.1 DESIGN FEATURES

Under this alternative, the tailings and contaminated materials at the Old Rifle tailings site would be transported to the New Rifle tailings site and consolidated into a single pile. While this alternative includes performance of interim actions at the Old and New Rifle sites, these activities are discussed in detail in Section A.1.3. The uranium mill tailings and contaminated materials from both sites would then be stabilized in a manner which complies with the EPA standards (Figure A.2.1). The major construction activities for this design are discussed in detail in Section A.2.3. The design would require the following activities at each site and the proposed borrow sites:

<u>At the Old and New Rifle sites</u>

- o Upgrading (as necessary) of the access roads from the sites to U.S. Highway 6.
- o Protection (or relocation) of surface or subsurface utilities at the sites during construction.
- o Construction of staging areas in the former mill areas.
- o Installation of temporary security fencing.
- o Construction of wastewater retention basins to protect against the release of contaminants from the sites during remedial action.
- o Construction of truck washing stations at the sites.
- o Construction of drainage control measures to direct all wastewater and storm water runoff to the retention basins during construction.
- o Implementation of measures to control erosion and sedimentation from disturbed areas during construction.
- o Installation and operation of wastewater treatment facilities (if necessary) to protect against the inadvertent release of contami- nants from the sites during construction.
- o Consolidation of the asbestos and demolition debris with the tailings and contaminated materials.
- o Restoration of the disturbed areas with clean fill material, grading to promote positive drainage and revegetation. Includes revegetation of disturbed and wetlands areas requiring restoration.

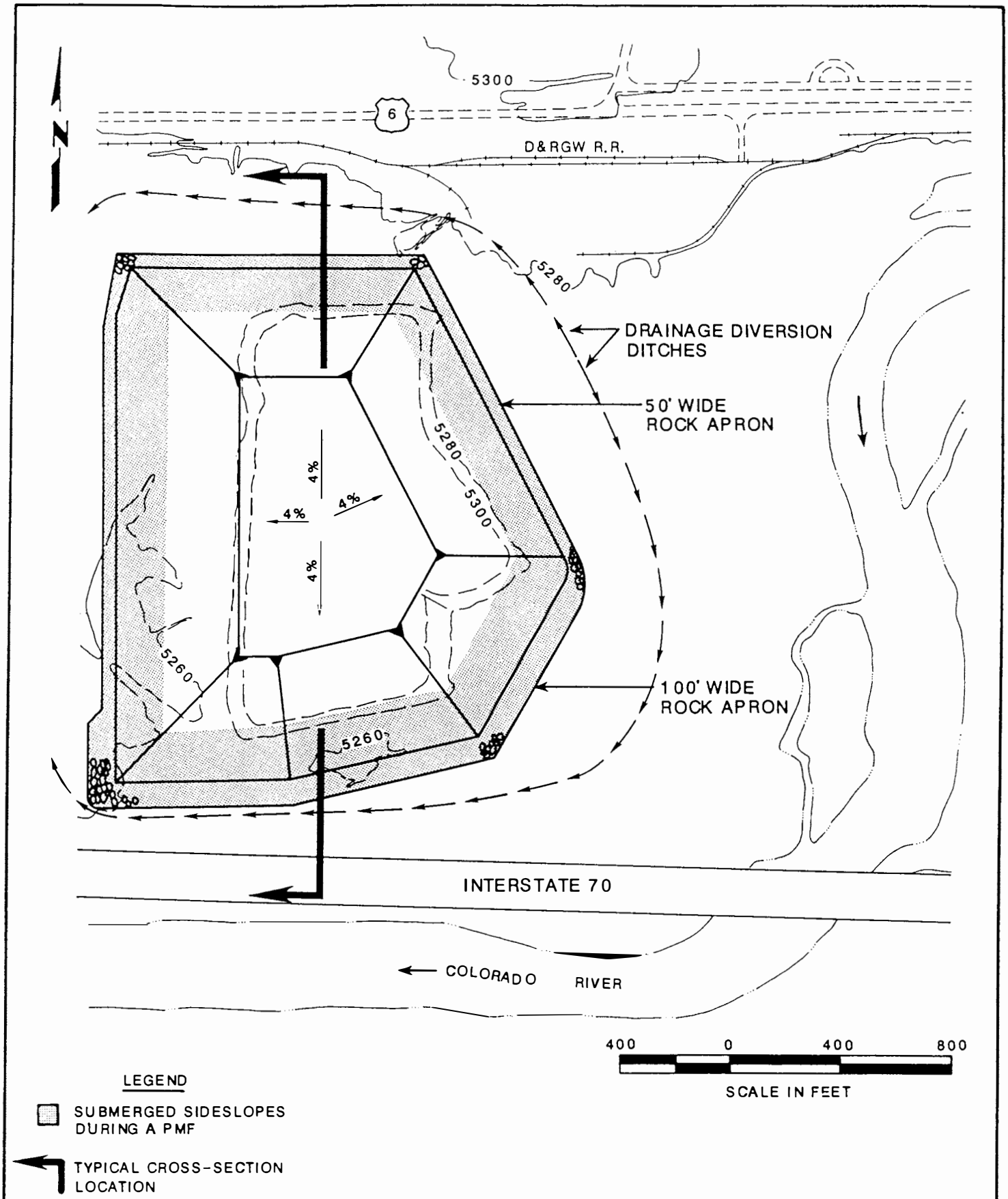


FIGURE A.2.1
FINAL CONDITIONS, NEW RIFLE SITE

At the Old Rifle site

- Dewatering of the tailings and alluvium beneath the tailings.
- Excavation and relocation (by truck) of the tailings and contaminated materials, including demolition debris collected during interim actions, and sediments from the wastewater retention basin(s) and temporary drainage ditches, to the New Rifle site.
- Release of the site for any use consistent with existing land use controls.

At the New Rifle site

- Excavation and stockpiling of tailings and contaminated materials at the site, including demolition debris from the mill buildings and structures collected during interim actions, as well as contaminated materials from the vicinity properties.
- Consolidation of all of the tailings and contaminated materials, including sediments from the wastewater retention basins and temporary drainage ditches.
- Construction of the final cover system over the tailings and contaminated materials to inhibit radon emanation, water infiltration, frost heave and solifluction, plant root penetration, wind and water erosion, penetration by burrowing animals, and prevent further groundwater contamination.
- Construction of erosion protection features (below-grade, rock apron and earthen drainage diversion ditches) around the stabilized tailings pile to protect against flooding and surface water runoff.
- Installation of permanent security fencing (with locked gates) and warning signs.

At the Second Street borrow site

- Excavation of earthen materials for the radon barrier frost protection and site restoration.
- Relocation of the earthen materials by truck to the Old and New Rifle tailings sites.

At the New Rifle borrow site

- Excavation of small rock for erosion protection.
- Relocation of the small rock by truck to the New Rifle tailings site.

At the Glenwood Springs borrow site

- Excavation of large rock for erosion protection.
- Relocation of the large rock by truck to the New Rifle tailings site.

A.2.2 PERMANENT DESIGN FEATURES

Description of final condition

The completed New Rifle site would cover approximately 172 acres and would contain the stabilized tailings pile, drainage diversion ditches, and permanent security fencing.

The stabilized tailings pile would be roughly trapezoidal with pointed sides to the east and southeast (Figure A.2.1). The pile would cover approximately 59 acres and would be about 850 feet west and 450 feet north of the Colorado River. The tailings and contaminated materials would be covered with a compacted earthen cover, or radon barrier, approximately two feet thick. The stabilized pile would have maximum sideslopes of 20 percent (five horizontal to one vertical), and the top would be gently sloped in all directions (a maximum of four percent). The entire pile would first be covered with a 2.5-foot-thick frost protection and drain layer, then a rock layer for erosion protection. A layer of graded rock approximately 1.5 feet thick (including the filter layer) would be placed on the topslopes. The 20 percent sideslopes would consist of two zones: above the maximum water surface elevation for a Probable Maximum Flood (PMF), the sides of the pile would be covered with a two-foot layer of graded rock (including the filter layer); the remainder of the pile's sideslopes would be covered with a three-foot layer of graded rock (including the filter layers). This three-foot rock layer would tie into a 10-foot-thick, below-grade, rock apron around the base of the tailings. The final stabilized pile would be an average of 47 feet and a maximum of 80 feet above the northern site boundary. A typical cross section for stabilization at the New Rifle site is shown in Figure A.2.2.

Drainage diversion ditches would be constructed around the outside of the rock apron on the north, east, and south sides of the pile. The ditch would divert surface water runoff around and away from the pile. A security fence with locked gates and warning signs would enclose the site.

After remedial action, the disturbed areas at the Old and New Rifle sites would be restored with clean fill to promote positive drainage, and the Old Rifle site would be released for any use consistent with existing land use controls. Disturbed wetlands areas requiring restoration would be revegetated to re-establish plant species identical to or similar to those that presently exist.

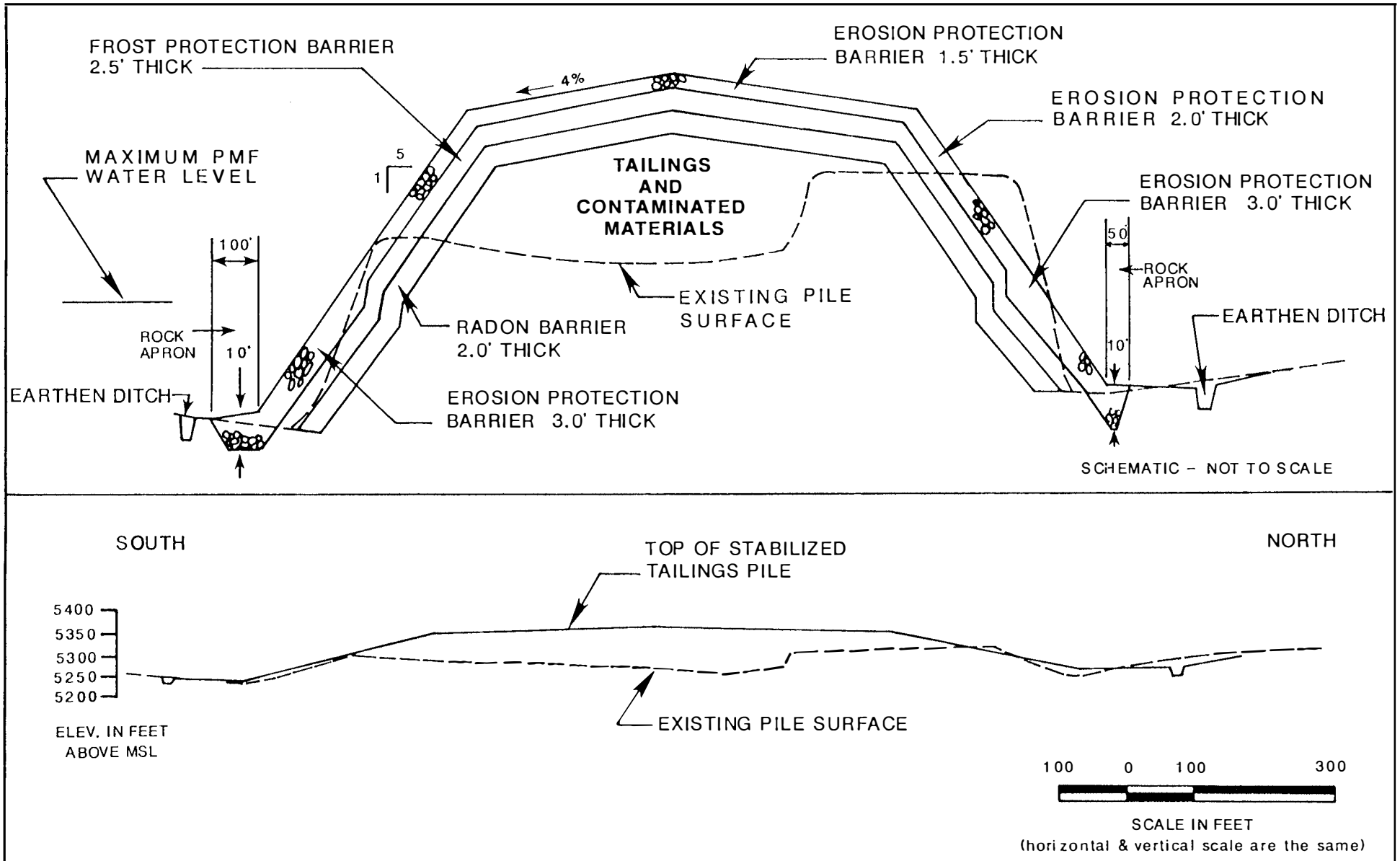


FIGURE A.2.2

TYPICAL CROSS SECTION, NEW RIFLE SITE

Decontamination and restoration

Contaminated materials excavated from the Old Rifle site, mill area, windblown areas, vicinity properties, and off-pile contaminated materials at the New Rifle site would be combined in the pile at the New Rifle site. Contaminated debris resulting from the demolition of existing buildings and structures would be consolidated into the stabilized tailings pile.

Subpile contamination below the tailings-alluvium interface at the New Rifle tailings pile averages from four to 5.6 feet. At the Old Rifle pile, the average subpile contamination is 4.9 feet. Off-pile limits of contamination for the Old and New Rifle sites are shown in Figures A.2.3 and A.2.4, respectively. Areas of excavation on and around the Old and New Rifle tailings sites would be restored with clean fill to promote positive drainage.

This alternative would require that the tailings, contaminated materials, and demolition debris from the Old Rifle site be transported to the New Rifle site first and incorporated into the stabilized pile shown in Figure A.2.1. The volumes of contaminated materials at both the Old and New Rifle sites are presented in Table A.2.1. Once placement of the tailings and contaminated materials from the Old Rifle site is complete, contaminated materials excavated from around the pile at the New Rifle site would be placed on top of the relocated Old Rifle contaminated materials.

The Old Rifle tailings and contaminated materials would be placed over the existing New Rifle tailings and compacted with suitable compaction equipment to increase strength and reduce compressibility. The total long-term settlement of these materials will be very small due to the compaction, as well as to the granular, non-plastic nature of the tailings. Settlement of the foundation will be negligible, as most of the underlying soil will be removed and any remaining in situ soils will not be saturated after placement of the contaminated materials. Therefore, the adverse effects of total and differential settlement on the integrity of the radon barrier are considered to be small and within acceptable limits. The final engineering design would specify the degree of compaction required to avoid detrimental settlement. If necessary, a monitoring program would be undertaken to ensure that differential and total settlement would not affect the integrity or longevity of the stabilized tailings pile. The pile slopes would be compacted with engineering fill consisting of the Old Rifle tailings and contaminated materials. Any unstable materials placed in the pile would be excavated and recompacted to ensure that the pile slopes would be dense throughout.

In order to minimize the risk of undercutting by scour during peak flows of the Colorado River, a 10-foot-thick, below-grade, rock apron designed to protect against the maximum depth of scour would surround the pile as shown in Figure A.2.1.

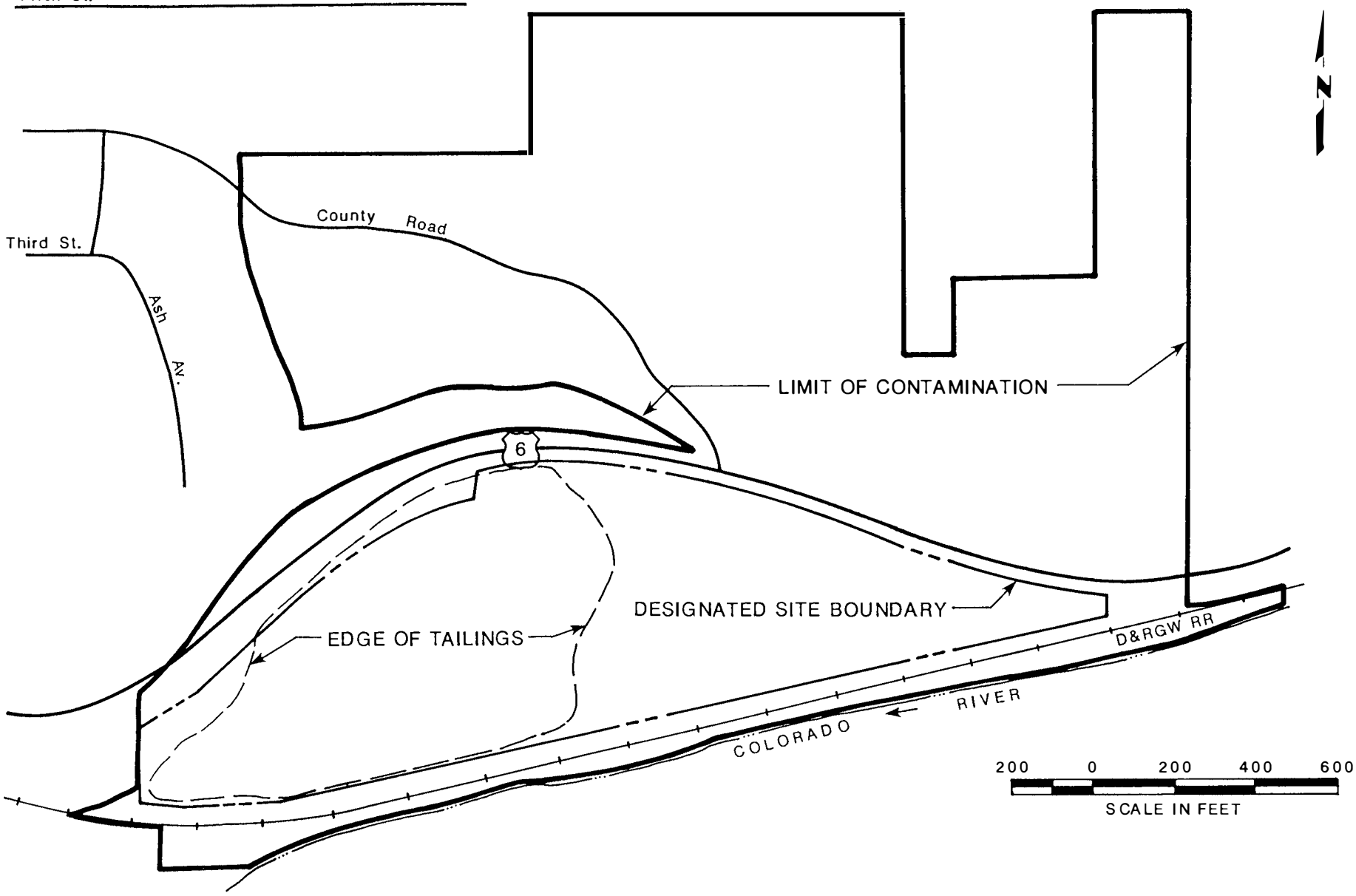


FIGURE A.2.3
OFF-PILE CONTAMINATION, OLD RIFLE SITE

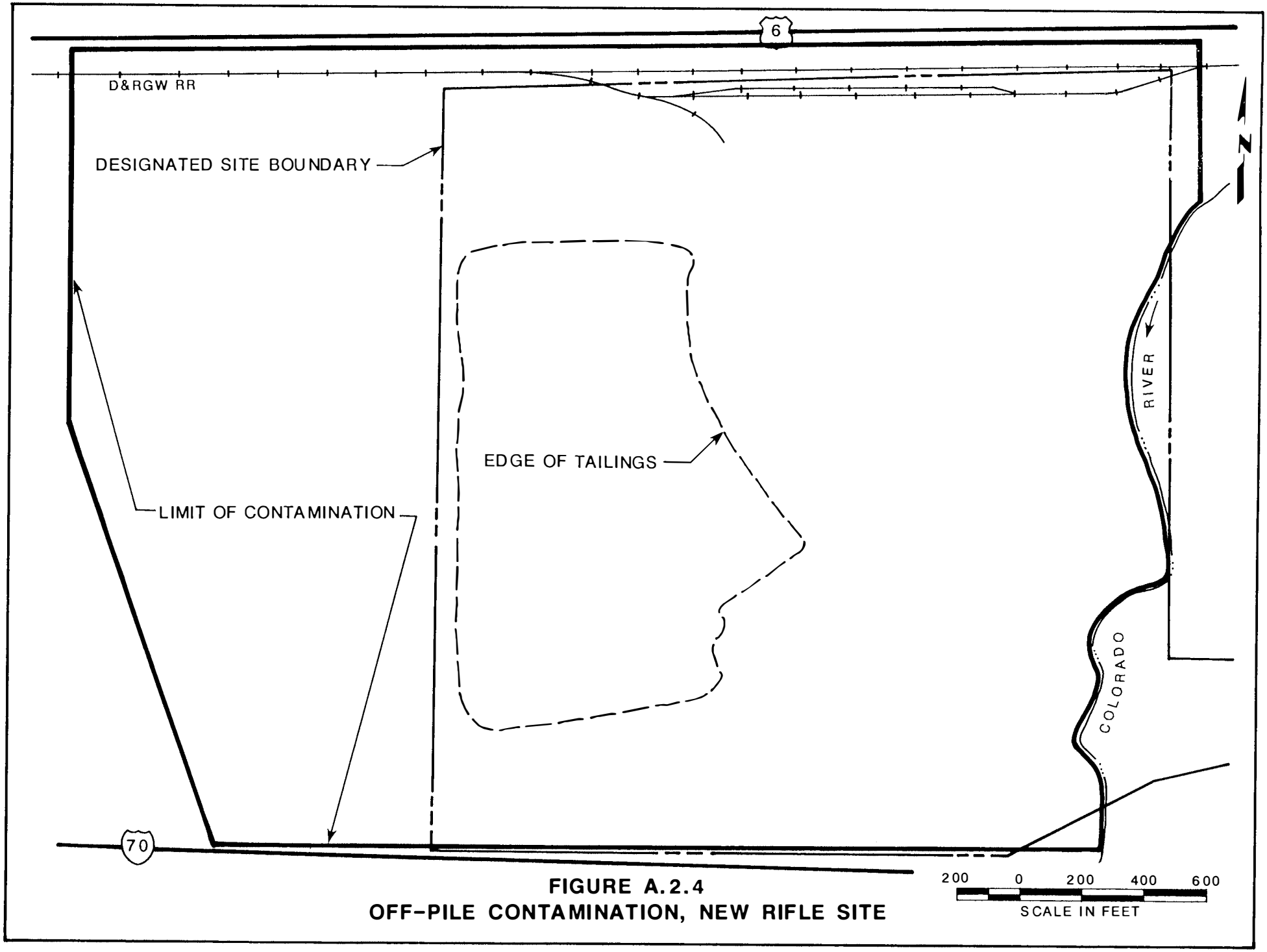


FIGURE A.2.4
OFF-PILE CONTAMINATION, NEW RIFLE SITE

Table A.2.1 Volumes of contaminated materials, Old and New Rifle sites[a]

Source of contaminated materials	Volume of contaminated materials (cubic yards)
New Rifle site	
Tailings	2,415,000
Alluvium beneath tailings	375,000
Windblown tailings and vanadium ponds	684,000
Old Rifle site	
Tailings	330,000
Alluvium beneath tailings	168,000
Windblown tailings	160,000
Vicinity properties	10,000
TOTAL	4,135,000

[a]The volume of debris from the demolition of existing mill buildings and structures at the Old and New Rifle sites is not included in this table. The buildings and structures may be decontaminated and left in place or dismantled and removed. The volume of demolition debris would be small compared to the total volume of contaminated materials involved in the remedial action.

Organic material such as wood demolition debris and grubbed vegetation would be evenly distributed throughout the newly constructed portions of the stabilized pile so that no more than five percent organics by volume would be contained in any of these areas. Demolition debris would be placed in the lower portions of the pile and surrounded with compacted tailings. The procedures for this activity would be specified to ensure that the debris is placed to avoid concentration in any area and to ensure good compaction of materials around the debris.

Limiting the pile topslopes to four percent and the sideslopes to 20 percent would provide the necessary factor of safety against slope failure and would reduce the potential effects of erosion.

Cover construction

The tailings radon emanation rate would be reduced to the EPA standards by the placement of approximately two feet of compacted earth which would serve as a radon barrier. The compaction of the earthen radon barrier would produce a cover that retains moisture and retards radon gas diffusion. The radon barrier would also inhibit plant root penetration.

The earthen radon barrier would be protected by frost protection and drain layer, and then a layer of rock and an underlying filter layer, designed to prevent exposure of the contaminated materials for up to 1000 years to the extent reasonably achievable, and, in any case, for at least 200 years. The rock and filter layers would reduce the potential for drying of the radon barrier by trapping soil moisture and resist erosion and gully formation thereby preventing the radon barrier from eroding away during any rainstorms. The rock and filter layers have been designed to withstand the occurrence of the Probable Maximum Precipitation (PMP). The rock and filter layers would also protect the pile against wind erosion and would discourage plant root penetration and intrusion by burrowing animals.

The frost protection and drain layers would reduce the potential for frost heave of the radon barrier by providing an insulating blanket of loosely compacted soil.

In addition, a below-grade, rock apron would be constructed around the entire perimeter of the pile to further protect the contaminated materials from erosion. This rock apron would be designed to withstand the effects of channel migration and scour caused by a PMF occurring in the Colorado River.

Site drainage

The drainage pattern of the New Rifle site has been designed to ensure long-term pile stability. Since the entire site would be inundated during a PMF, it would be impractical to design permanent ditches to contain the PMF flows. Therefore, the stabilized pile would be surrounded to the north, east, and south by drainage diversion ditches

designed to carry the runoff resulting from the 200-year one-hour rainfall event to ensure proper drainage of the pile and site area. The site grading would have a sufficiently shallow gradient so that flow velocities would be non-erosive as flow is directed south toward the Colorado River.

Details on flood analyses and flood protection are provided in Section A.2.6 and in Section E.1.2 of Appendix E, Hydrology.

Groundwater protection

The stabilized tailings pile would be designed to comply with EPA groundwater protection standards. The placement and sloping of the tailings and placement of the low permeability, earthen radon barrier would minimize the migration of contaminants to the groundwater systems by inhibiting the downward migration of contaminants from the tailings. Details are provided in Section A.2.7.

Site access

After remedial action is complete, the disposal site would be surrounded by permanent security fencing with locked gates and warning signs to discourage inadvertent human intrusion.

A.2.3 MAJOR CONSTRUCTION ACTIVITIES

A.2.3.1 Layout

Construction activities at both the Old and New Rifle sites would be primarily confined within the tailings pile areas except for adjacent contaminated areas.

The exact locations and sizes of all construction features such as the staging areas, decontamination facilities, drainage ditches, and wastewater retention basins would be determined during final design. The following discussion presents one possible layout and is provided to allow a better understanding of all aspects of the remedial action.

The staging area at the Old Rifle site would be in the former mill area northeast of the pile. At the New Rifle site, the staging area would also be in the former mill area northeast of the pile. Equipment decontamination facilities would be adjacent to the staging areas at both sites. Ditches and berms surrounding the sites would direct uncontaminated flows away from the sites. Contaminated water would be directed to wastewater retention basins and treatment facilities constructed on the sites. At the New Rifle site, the existing retention basins southeast of the tailings pile could be used for wastewater retention. Temporary security fences would surround the contaminated areas at both sites.

A.2.3.2 Site access

The temporary security fences would provide control of traffic entering and leaving the sites and prevent unauthorized traffic from entering the sites. Equipment would be decontaminated prior to leaving the Old and New Rifle sites.

A.2.3.3 Staging area facilities

During construction operations, temporary facilities would be required for remedial action workers as well as supervisory, engineering, administrative, security, and radiation monitoring personnel at both sites. The facilities would consist of office space, laundering facilities, showers, and change facilities for all personnel working on the sites. Portable toilets would be provided for on-site workers. Onsite equipment would be stored in the staging areas. Parking areas would also be constructed at the sites.

A.2.3.4 Utilities

All known existing utilities at the Old and New Rifle sites are shown in Figures A.2.5 and A.2.6, respectively. These utilities would be protected during construction, removed, or relocated, as necessary prior to construction.

Some water for dust suppression on contaminated areas at the Old and New Rifle sites would be obtained from the tailings and subsoil dewatering or would be recycled water from the wastewater retention basins. Most water for dust suppression on uncontaminated areas and for compaction during site restoration would be obtained from the Colorado River. Potable water, electricity, gas, and phone service would be obtained from local suppliers.

A.2.3.5 Drainage, erosion control, and wastewater retention basins

During remedial action, all drainage from both the Old and New Rifle sites would be blocked from reaching any waterways. Areas of the sites disturbed by construction activities would be graded so that runoff would drain to the wastewater retention basins. Drainage ditches would be lined with erosion resistant materials if sediment buildup in the wastewater retention basins becomes a problem. In addition, the ditches would be designed and maintained to carry the 10-year one-hour storm event for the area tributary to the channel. Runoff from land outside of affected areas would be diverted away from the site by diversion ditches designed and maintained to carry the runoff from the 10-year one-hour storm event.

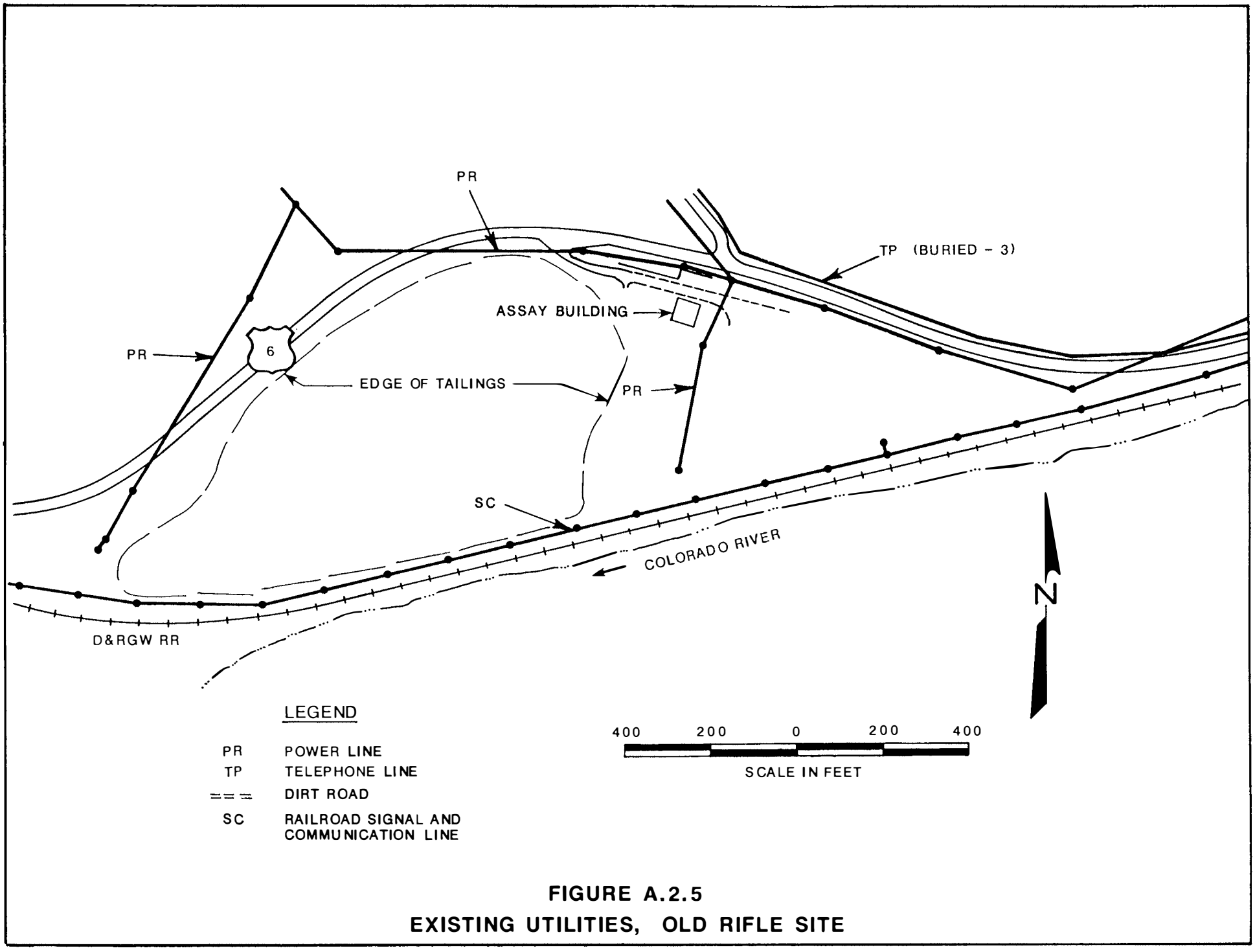


FIGURE A.2.5
EXISTING UTILITIES, OLD RIFLE SITE

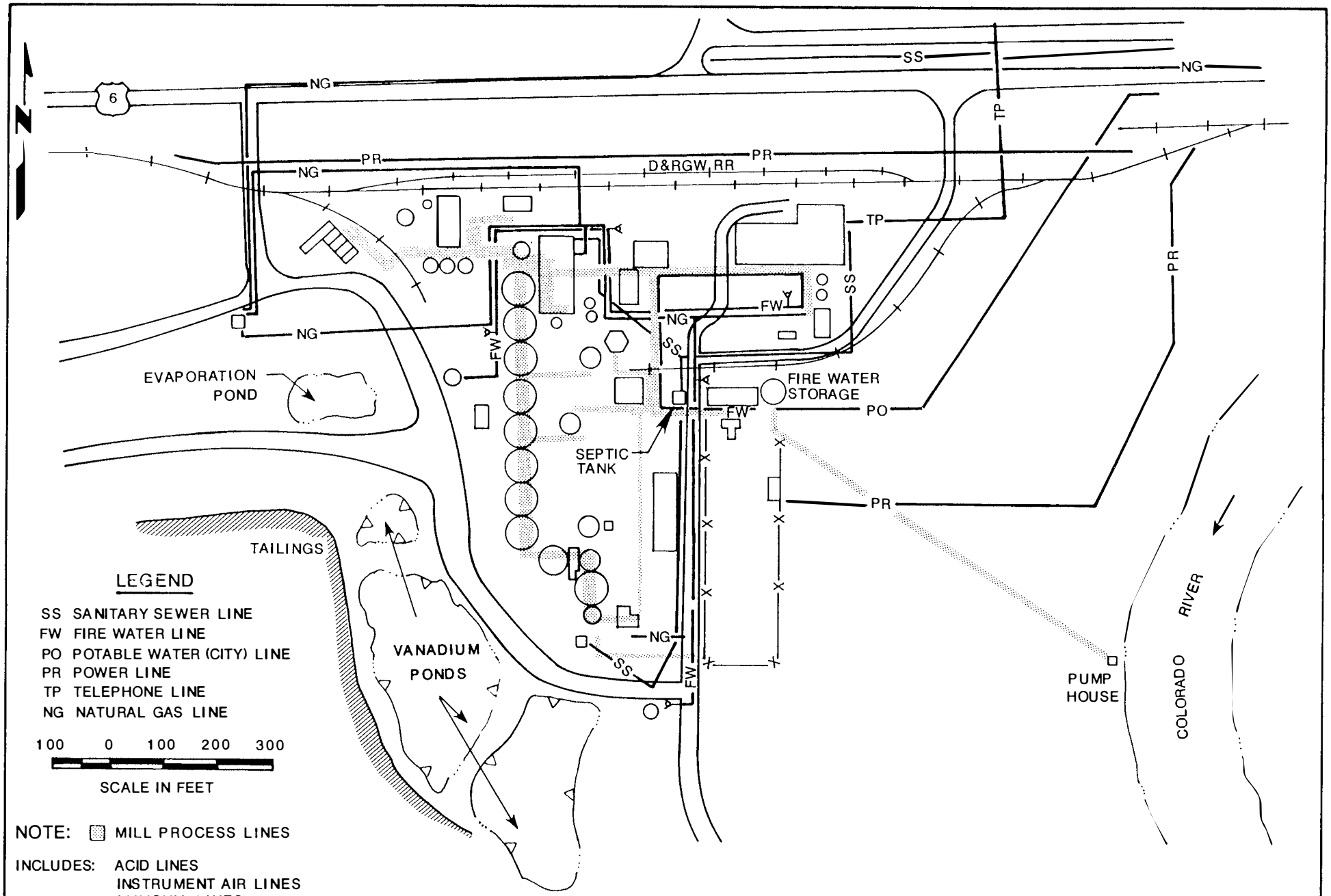


FIGURE A.2.6
EXISTING UTILITIES, NEW RIFLE SITE

The wastewater retention basins would receive waters from:

- o Decontamination activities including equipment and truck washing.
- o Runoff from contaminated materials.
- o Laundry wastewater from washing protective clothing.
- o Shower and washbasin wastewater.
- o Site dewatering (if contaminated).

The retention basins at the sites would be designed to retain the runoff from a 10-year 24-hour storm as well as the wash water from the decontamination operations and site dewatering. The retention basins would have sufficient capacities to hold all sediment inflow over the entire life of the remedial action without any need for removal. The emergency outlets from the basins would be designed to safely discharge the 25-year storm peak runoff while maintaining a minimum of one foot of freeboard. The final locations and designs of the retention basins would be determined during final design.

A.2.3.6 Wastewater treatment

Wastewater generated from sources mentioned in Section A.2.3.5 would be directed to wastewater retention basins which would provide primary settling along with flow and contaminant equalization. Some of this water would be used for dust control on contaminated areas. The remainder of the water would be treated to meet applicable state of Colorado water quality standards before discharge.

Performance specifications for the treatment systems would be determined in the final design. After completion of the remedial action, the treatment systems would be either decontaminated and salvaged or buried in the stabilized tailings pile.

A.2.3.7 Dewatering

Groundwater at the Old Rifle site rises into the tailings. To facilitate handling, some of the tailings would require dewatering.

Dewatering would be accomplished by installing either well points or drainage ditches with sump pumps in the excavations to lower the groundwater level until it is at an elevation below the excavation depth. The dewatered material would then be excavated. Contaminated water would be used as dust

suppression water on contaminated areas, pumped to the wastewater retention basin(s), or treated prior to discharge.

At the New Rifle site, the need for dewatering of tailings or soils during excavation is not anticipated. In most cases the shallowest recorded groundwater levels are deeper than planned excavation depths. However, if required, dewatering would be accomplished as discussed previously for the Old Rifle site.

A.2.3.8 Dust control

Dust generated by excavation, earth movement, vehicle use, temporary materials stockpiling, and similar activities would be controlled and minimized by the use of water and water-based surfactants sprayed from hoses or trucks. Special care would be taken to control dust created by building decontamination or demolition and the temporary stockpiling or mixing of contaminated materials.

Some of the sources for dust suppression water on contaminated areas would include recycled water from the wastewater retention basins and water from tailings and subsoil dewatering. Uncontaminated water would be used for the decontaminated areas. Most of the water needed for dust suppression and compaction would be obtained from the Colorado River.

The schedules for spraying the haul roads, the piles, and other contaminated areas would vary daily and would be determined on an hour-by-hour basis in accordance with applicable state permits. The frequency of spraying would increase when combinations of low soil moisture and high wind speed were encountered.

A.2.3.9 Borrow sites

Three separate borrow sites have been identified for stabilization at the New Rifle site. The Second Street borrow site is approximately 0.2 road mile north of the New Rifle tailings site (Figure A.1.2). Earthen materials for the radon barrier frost protection layers, and clean fill would be purchased from this existing, commercial borrow site and trucked to the tailings sites. The New Rifle borrow site is along the north bank of the Colorado River approximately 0.5 road mile west of the New Rifle tailings site (see Figure A.1.2). Small rock ($D_{50} \leq$ eight inches) for the erosion protection barrier and filter layer would be purchased from this existing, commercial borrow site and trucked to the New Rifle site.

The only borrow material not locally available would be the large rock required for the erosion protection barrier and

rock apron. This material is available at the Glenwood Springs borrow site approximately 31 miles east of the New Rifle tailings site (see Figure A.1.1). The large rock would be mined at this existing, commercial borrow site and trucked to the New Rifle site.

A.2.3.10 Construction sequence

The following construction sequence is proposed as a possible sequence for the remedial action. As with the layout (Section A.2.3.1), the final design would contain greater detail, and the construction subcontractor would be allowed the flexibility of executing work as desired, given certain constraints. Therefore, the actual construction sequence and methods of construction may differ from the following.

Initially, a site security system would be established at each site and coordinated with staging and vehicle decontamination areas. This would provide control of traffic entering and leaving each site and prevent unauthorized traffic from entering either site.

The next major item of site preparation would consist of constructing wastewater retention basins at the sites. Materials excavated from each basin would be stockpiled for later use as fill in site restoration. Site preparation would also include construction of drainage and erosion control measures.

Wastewater treatment facilities at both sites would be installed to treat contaminated water and to protect against contaminant releases during construction. Asbestos removal and demolition of existing buildings and structures would have already been performed during interim actions.

Upon completion of the site preparation, removal of the tailings and contaminated materials at the Old Rifle site would begin. Once the Old Rifle tailings and contaminated materials were evenly consolidated over the New Rifle tailings, the New Rifle off-pile contaminated materials would be added to the pile.

Uncontaminated earthen material from the Second Street borrow site would be added to the pile after all tailings and contaminated materials were in place. Drainage ditches would be excavated around the stabilized tailings pile. The final stages would involve reestablishing overall site drainage, grading, monitoring for settlement, placement of the rock erosion protection barrier and the rock apron, backfilling of disturbed areas for positive drainage, and the construction of permanent security fencing around the site.

Demobilization would consist of the removal of the remaining wastewater retention basin(s) and temporary drainage ditches. The water would be treated and discharged while the bottom sludges and dikes would be disposed of in the pile. All decontamination facilities would be removed and the equipment cleaned for salvage. The staging areas would be dismantled with the contaminated items either cleaned and salvaged or buried. All equipment would be decontaminated and inspected prior to release from the sites.

Figure A.2.7 shows a construction schedule for stabilization at the New Rifle site.

A.2.4 RADON CONTROL

Control of radon flux from the stabilized tailings pile would be accomplished by placing a compacted earthen radon barrier over the consolidated tailings and contaminated materials.

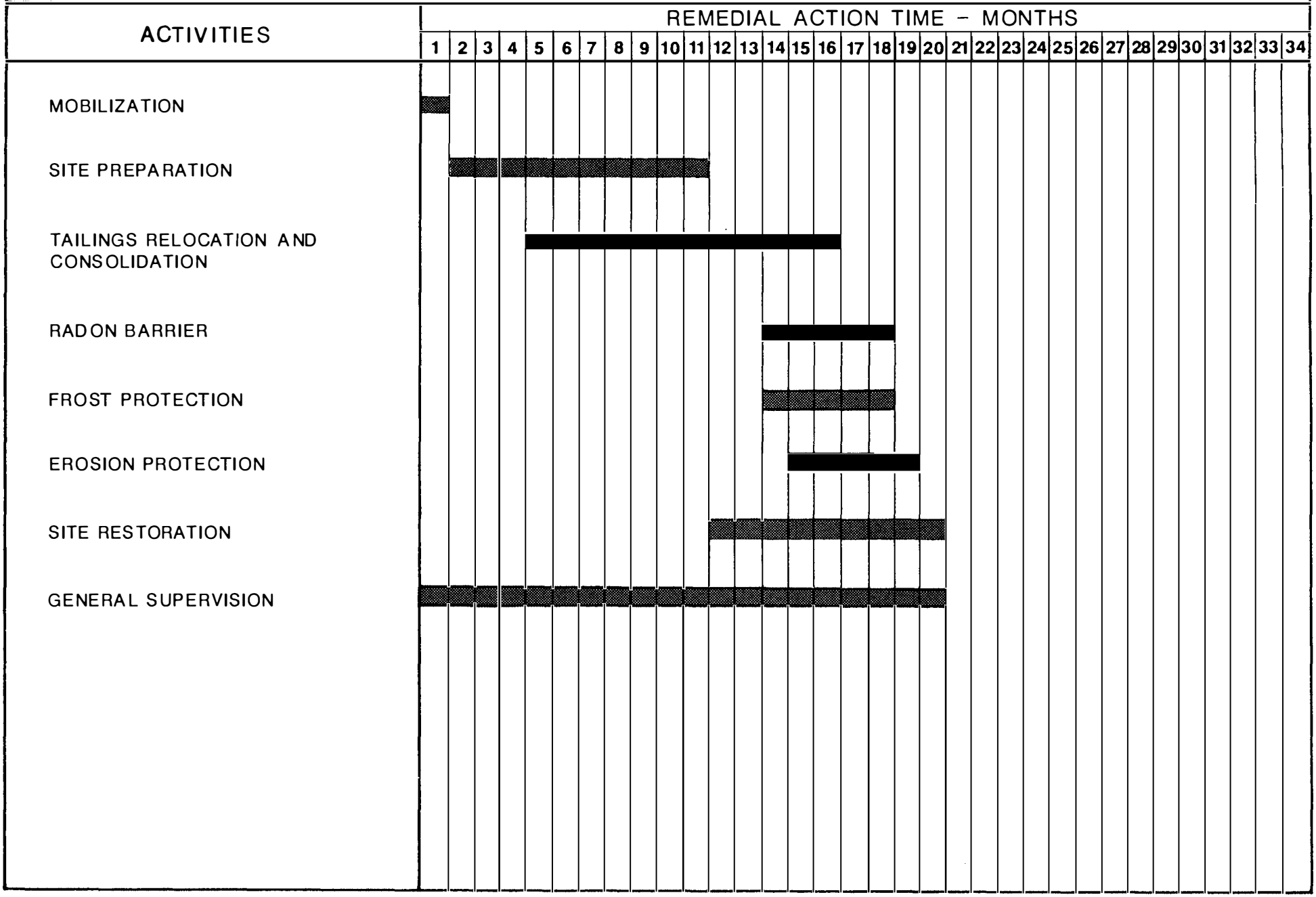
Data on the distribution of radium-226 in the tailings, on the properties of the earthen borrow materials, and on the estimated depth of the windblown tailings were analyzed in order to develop an estimated radon barrier thickness.

The thickness of the radon barrier required to limit radon flux to 20 picoCuries per square meter per second (pCi/m^2s) was calculated using the computer code RAECOM (NRC, 1984). The mathematical model implemented in RAECOM describes one-dimensional, steady-state radon diffusion through a two-phase, multi-layer system of porous media, representing the tailings pile and its radon barrier. Multiple layers of tailings and radon barrier are allowed in the model, with differences in physical, radiological, and diffusional properties represented by seven, layer-specific, input parameters. The seven values required for each layer of the tailings pile system modeled by RAECOM are:

- Thickness of layer (centimeters).
- Bulk density (grams per cubic centimeter).
- Porosity (fractional).
- Long-term moisture content (percent dry weight basis).
- Emanating fraction of radon (fractional).
- Radon diffusion coefficient (square centimeters per second).
- Radium-226 concentration (picocuries per gram).

In addition to the parameters describing the layers of the stabilized pile, RAECOM requires the input of the total number of layers in the pile and the layer to be optimized in meeting the specific radon flux limit (20 pCi/m^2s) at the surface. Also, the radon boundary conditions at the top and bottom of the pile must be specified. The bottom condition is always an incoming flux equal to zero pCi/m^2s for tailings piles. The top condition is the observed ambient radon concentration (picocuries per liter) in air near the site.

FIGURE A.2.7 REMEDIAL ACTION SCHEDULE, STABILIZATION AT THE NEW RIFLE SITE



The actual thickness of the radon barrier may vary depending on additional borrow site evaluation and analyses to be performed during final design and remedial action. Plant root penetration, intrusion by burrowing animals, and constructibility are also considerations in determining radon barrier thickness. For purposes of this EIS, the radon barrier required to meet the EPA standards would be constructed of approximately two feet of material available at the Second Street borrow site. Using this thickness and including the frost protection barrier and the erosion protection barrier, radon flux after remedial action was calculated to be less than 20 pCi/m^2s. The data and analyses are available in the DOE UMTRA Project Office, Albuquerque, New Mexico.

A.2.5 DESIGN CONSIDERATIONS

A number of alternative designs were investigated in order to ensure long-term stability of the tailings pile. Major concerns related to disposal at the New Rifle site include: proximity to the Colorado River, vulnerability to channel shifts of the river, high groundwater table, large quantity of contaminated material involved, and constraints imposed by the limited areal extent of the site. Since the pile would be located near the city of Rifle, efforts were also made to reduce visual impacts from the stabilized tailings pile.

The groundwater under the New Rifle tailings pile is contaminated as indicated by measured concentrations of sulfate and uranium in monitor wells. The placement and sloping of the tailings and the placement of the low-permeability earthen radon barrier would substantially reduce further groundwater contamination.

The sideslopes of the pile were analyzed in order to determine a slope that would provide the necessary factor of safety against slope instability, reduce the potential effects of erosion, and maximize the volume contained within the limited area. Limiting the pile sideslopes to 20 percent would ensure pile stability as well as provide sufficient volume within the pile, despite the limited width of the site.

The upstream (eastern) side of the pile would be pointed in order to divert flow around rather than directly toward the pile. This would result in lower flow velocities, thereby reducing the size of the rock for erosion protection. Grouted riprap or other cementitious materials were eliminated from consideration as flood protection because the excessive maintenance that would be required during the design life does not meet the intent of the EPA standards.

A.2.6 LONG-TERM STABILITY

Water erosion

Severe rainfall events have the potential to develop rills and gullies on the steeper (20 percent) sideslopes of the stabilized

tailings pile and erode some or all of the radon barrier in small, undefinable areas. One such potential rainfall event is commonly referred to as the Probable Maximum Precipitation (PMP). The PMP is defined as the maximum precipitation that could occur from the most severe combination of meteorological conditions that are reasonably possible in a region. For the New Rifle site, the local one-hour PMP storm was calculated to be 7.6 inches. Based on this one-hour intensity, a maximum 2.5-minute intensity was calculated based on the time of concentration for flow off the pile. This intensity was then converted to an equivalent one-hour rainfall intensity of 50.2 inches per hour. The PMP would generate sheet flow rates ranging from 0.7 to 1.7 cubic feet per second per foot (cfs/ft) of slope width on the pile.

To protect the pile from the impact of a PMP, the stabilized tailings pile would have a 1.5-foot-thick layer of rock (including the filter layer) on the topslopes and a two- to three-foot-thick layer of rock (including the filter layer) on the sideslopes as part of the cover system. Rock sizes required to withstand sheet erosion on the pile top and sideslopes during a PMP event are shown in Table A.2.2.

To further reduce the potential for erosion by surface water runoff, additional control features were incorporated into the design to reduce surface runoff velocities. The slopes of the stabilized tailings pile would be limited to five horizontal to one vertical (20 percent). The top of the pile would be gently sloped (a maximum of four percent) to promote drainage.

Table A.2.2 Rock erosion protection, New Rifle site

Location	Rock size[a] (inches)	Thickness of rock[b] (inches)	Design flow (cfs/ft)
Topslopes	$D_{50} \geq 1.5$	18	0.7
Toeslope	$D_{50} \geq 7.0$	24	1.7
Toeslope submerged during a PMF	$D_{50} \geq 16$	36	1.7
Rock apron	$D_{50} \geq 40$	120	1.7

[a]"D" corresponds to required rock diameter; D_{50} is the diameter of 50 percent of the rock by weight.
[b]Thicknesses include filter layers except for the rock apron where a filter layer would not be necessary.

In addition to erosion from sheet flow, the lower sides of the stabilized pile must resist the erosive forces of a PMF. Below the PMF maximum flood elevation, the 20-percent sideslopes would be covered with a three-foot-thick layer of rock (including the filter layer). This three-foot-thick rock layer would tie into a 10-foot-thick rock apron around the base of the tailings. Rock sizes required to withstand the PMF are also shown in Table A.2.2.

It is anticipated that a filter layer would be required on the top and sideslopes of the pile to prevent piping and erosion of the finer-grained radon barrier. The gradations of the filter layer would be determined during the final design when the grain size distribution of the radon and rock erosion protection barriers were finalized. The following criteria would be used in the final design:

$$\frac{D_{15}\ \text{filter}}{D_{85}\ \text{base}} < 5$$

The acceptability of the rock would be determined well in advance of the time when the rock would be required for placement. The selected rock must meet specific testing criteria for long-term durability.

Wind erosion

High wind velocities could damage the radon barrier of the stabilized tailings pile if left exposed. The same rock and filter layers used to protect the pile from water erosion would provide sufficient protection from the effects of potentially erosive wind velocities.

Flood protection

The New Rifle site is on the north bank of the Colorado River about 2.5 miles downstream of the Old Rifle site. The tailings lie within a meander of the Colorado River that exhibits an island-braided pattern. The Colorado River is within 1000 feet east and 600 feet south of the existing tailings pile. The mill and ore storage areas lie between the pile and the river to the east. The main channel of the Colorado River has been artificially channeled northward by blocking alternative river channels upstream of the site. This has caused the river to swing north and erode the northern portion of a dike that protects the tailings pile and mill area.

The watershed upstream of the site is 6950 square miles of steeply sloped terrain. Elevations in the watershed range from 5260 feet at Rifle to more than 14,000 feet in the highest headwater areas.

Because of the location of the stabilized tailings pile with respect to the Colorado River, flooding would present a risk to the long-term stability of the pile. In order to design adequate protection against flooding for the stabilized tailings pile, a flood analysis of

the site was performed using the HEC-1 and HEC-2 (COE, 1982, 1981) computer models. This analysis evaluated the PMF using the PMP estimate for a severe summer storm on the Colorado River watershed above Rifle.

The flood analysis resulted in calculation of a peak flood flow in the Colorado River of 795,200 cubic feet per second (cfs). Due to natural topography, the PMF floodplain narrows near the site from a floodplain of over 4400 feet wide approximately 1000 feet upstream of the tailings pile to a floodplain of less than 2300 feet wide approximately three miles downstream of the tailings pile. All sides of the pile would be exposed to channel flow as shown in Figure A.2.8. The peak water surface elevation would vary from 5290 feet to 5301 feet along the pile, and mean channel velocities would range from approximately 16 to 26 feet per second (fps). Floodplain constrictions at the site would cause unstable (i.e., turbulent) flow conditions to occur in the form of near critical flow (i.e., flow that causes erosion or scour). The river would attempt to moderate the steep energy gradient and stabilize the flow by scouring alluvium. Using methods outlined for the Bureau of Reclamation by Pemberton and Lara (1984), the depth of zero sediment transport (depth of maximum scour) would be 32 feet below the channel bottom. Maximum water surface and scour elevations for the PMF event are shown in Figure A.2.9.

To protect the stabilized tailings pile from the maximum flood conditions described above, the sideslopes of the pile below the maximum water surface elevation for a PMF would be covered with a three-foot-thick layer of graded rock (including the filter layer). This rock layer would tie into a ten-foot-thick, below-grade, rock apron around the base of the tailings pile. The rock protection requirements for this design are shown in Table A.2.2. The calculations supporting this design are on file at the DOE Project Office in Albuquerque, New Mexico.

Geomorphology (river meander)

The New Rifle tailings site is in a meander path of the Colorado River and overlies 20 to 29 feet of alluvial material. Particle sizes of the alluvium at the site vary from minor amounts of silt sized particles to gravelly sands to cobbly gravels. The floodplain at the New Rifle site has been narrowed both naturally, due to geologic features, and artificially, due to construction of Interstate-70, the Denver and Rio Grande Western Railroad, and the tailings pile. These constrictions could cause unstable flow conditions, accelerated velocities, and scouring of alluvium at the site during major flood events. Given these site conditions, the river could cut through the site if not properly controlled. A detailed description of the geomorphic setting at the New Rifle site is provided in Section D.3 of Appendix D, Soils, Geology, and Seismicity.

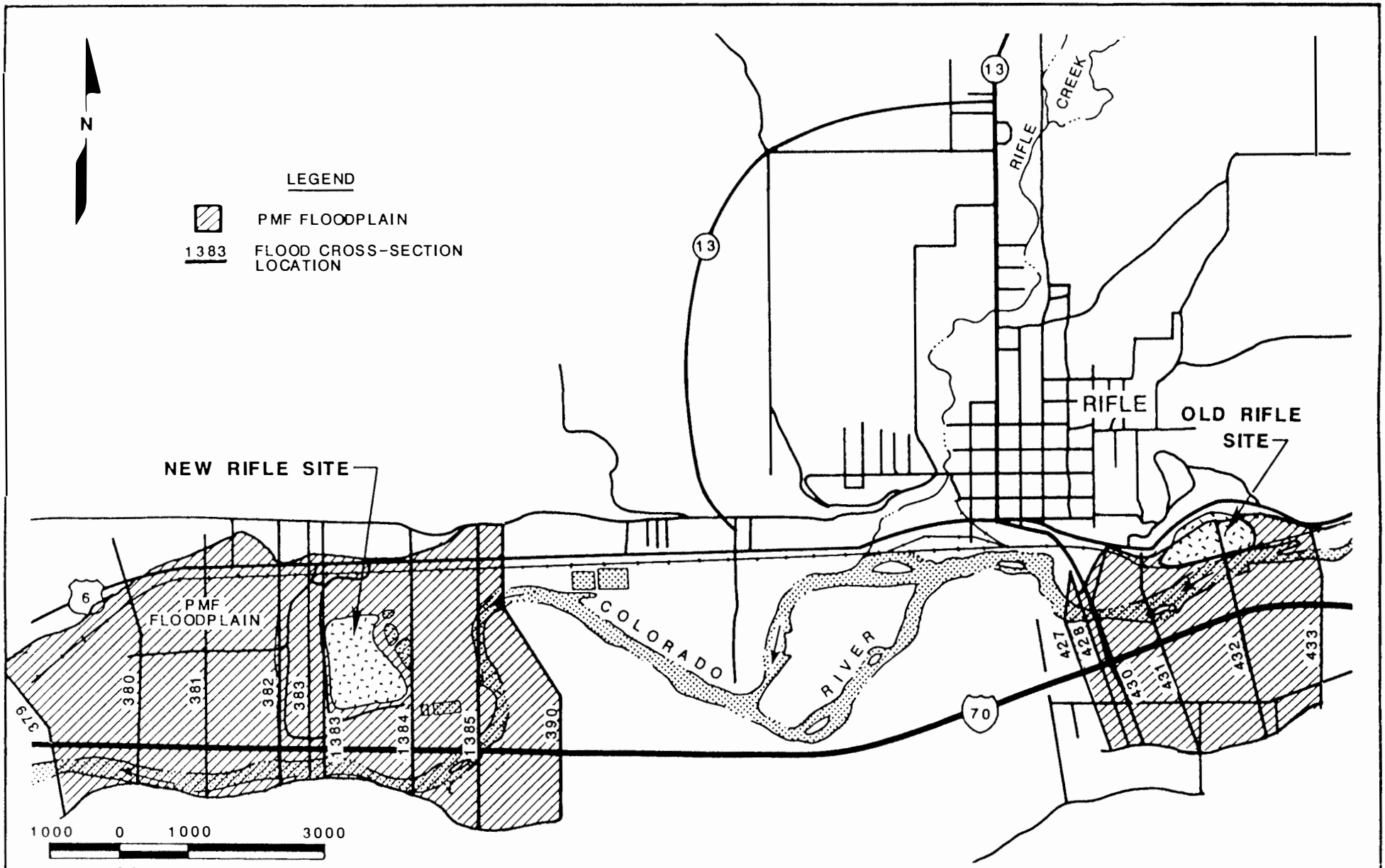


FIGURE A.2.8

PMF FLOODPLAIN, OLD AND NEW RIFLE SITES

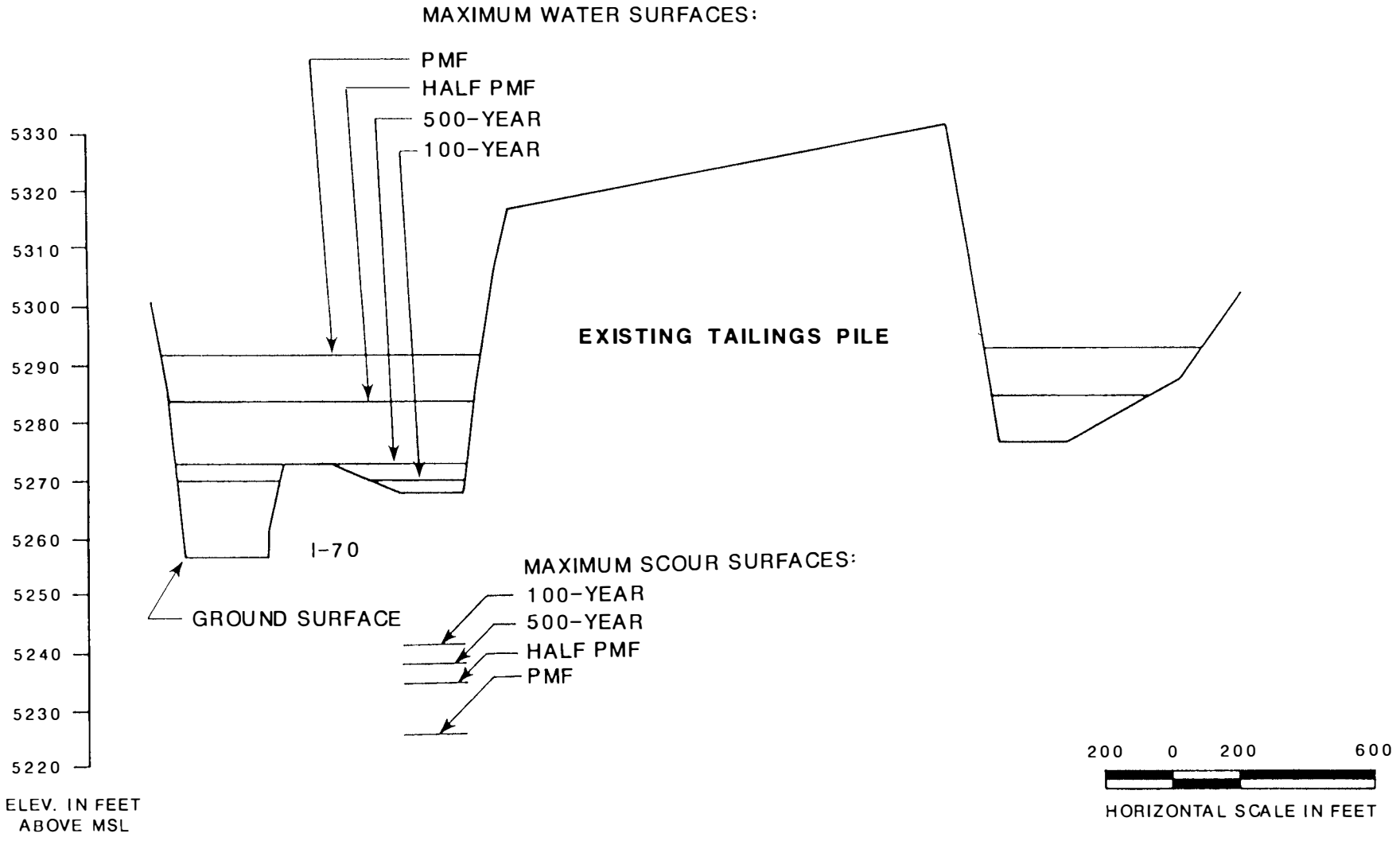


FIGURE A.2.9

FLOOD CROSS SECTION 1383, NEW RIFLE SITE

The rock apron described in the previous section has been designed to protect the pile from the potential impacts related to channel meander and scour, and to protect against the calculated depth of scour during river meander. The calculations supporting this design are on file at the DOE Project Office in Albuquerque, New Mexico. These calculations compute water surface profiles and flood velocities with revised boundary geometry to model the sensitivity of geomorphic changes.

Slope stability/seismic risk

Slope failure due to instability under static and seismic loading could affect the integrity of the tailings pile if not properly stabilized.

Stability analyses were performed for each loading condition to estimate factors of safety against slope failure. In particular, the seismic loading conditions were evaluated by applying the peak horizontal acceleration resulting at the site from a design earthquake (one which produces the largest on-site acceleration). The evaluation estimated that the design earthquake would generate an on-site effective peak horizontal bedrock acceleration of 0.21g. Details on the seismic analysis for the New Rifle site are provided in Section D.4 of Appendix D, Soils, Geology, and Seismicity.

The factors of safety against slope failure under both static and seismic loading for the stabilized tailings pile exceed generally accepted limits of 1.5 (Sowers, 1979) and 1.0 (DOA, 1970), respectively. The static and seismic safety factors calculated for the pile are 3.1 and 1.8, respectively. The effects of flooding on stability were included in this analysis.

Groundwater at the site is below the tailings-soil interface. Due to the dense nature of the cohesionless foundation soils, liquefaction is not a potential hazard given the design earthquake acceleration.

Settlement and cover cracking

Differential settlement of the stabilized tailings pile has the potential hazard of cracking the cover system due to horizontal strains and, thus, could affect the integrity of the pile. Differential settlement could also increase the potential for gully erosion due to concentrations of surface runoff. However, the tailings and contaminated materials would be compacted to increase strength and reduce compressibility. The total long-term settlement of these materials will be very small due to the compaction, as well as to the granular, non-plastic nature of the tailings. Settlement of the foundation will be negligible, as most of the underlying soil will be removed and any remaining in-situ soils will not be saturated after placement of the contaminated materials. Therefore, the adverse effects of total and differential settlement on the integrity of the radon barrier are considered to be small and within acceptable limits. The final engineering design would

specify the degree of compaction required to avoid detrimental settlement.

Due to the difficulty in controlling differential settlement of the consolidated tailings, settlement monitoring devices would be installed to measure the total settlement of the tailings and underlying soils caused by consolidation. Upon the completion of 90 percent of all of the settlement, the earthen radon barrier would be placed over the tailings, and the settlement would be monitored again. Final grading and compaction of the radon barrier would be performed only after sufficient settlement had occurred to prevent cracking of the barrier and concentration of surface runoff flows.

Frost heave/solifluction

Frost heave and solifluction are processes that pose a hazard to the long-term performance of any structure constructed to isolate the tailings at the site. Climatic conditions at the site favor the occurrence of these processes during the winter.

Frost heave and associated frost creep or frost sloughing are processes which can occur under the climatic conditions at the tailings site. The latter two occur in fine-grained sediments on slopes (Linell and Lobacz, 1980) and can be mitigated by using an aggregate (rock) cover.

Frost heave is the expansion toward the surface from the freeze-thaw cycle and generally has the largest movement from the summer-winter cycle of freeze-thaw. The process requires that adequate soil moisture be present to form ice lenses at boundaries in fine-grained soil which act as a barrier to water penetration.

The susceptibility of the radon barrier to freeze-thaw effects has been studied. The remedial action design includes a 2.0-foot-thick frost protection layer of loosely compacted soils, excavated from the Second Street borrow site, to be placed above the radon barrier and 0.5 foot of sufficiently porous surface aggregate, or drain layer, in conjunction with a continuous slope, to allow drainage across the pile surface. This would restrict water buildup over the radon barrier, thereby ensuring its integrity.

Solifluction is the action of slow flowage in saturated soils in periglacial regions (Ritter, 1978). Only the surface layer is affected, and very low slopes can flow if saturated. The remedial action design includes the use of a permeable aggregate (rock) layer over the fine-grained, earthen radon barrier, in conjunction with a continuous slope to allow drainage across the pile surface, thus removing the saturation prerequisite for this process and mitigating the hazard.

Plant root penetration, burrowing animals, and human intrusion

The stabilized tailings would be covered with a two-foot-thick layer of compacted, low-permeability, earthen materials and a 2.5-foot-thick frost protection and drain layer. These layers would then be covered with a layer of rock erosion protection material (including the filter layer).

These layers of compacted earth and rock would inhibit plant root penetration into the tailings and contaminated materials. The rock and frost protection layers would also discourage intrusion by burrowing animals and would inhibit inadvertent human intrusion. The final tailings pile would be surrounded by a security fence with locked gates and warning signs.

A.2.7 GROUNDWATER PROTECTION

Depending on seasonal variations in the depth to groundwater, approximately 20 feet of saturated alluvium comprise the shallow groundwater system that discharges to the Colorado River. The Wasatch Formation underlies the alluvium and comprises the deeper bedrock groundwater system. The direction of groundwater flow in both groundwater systems is westward. Localized groundwater mounding occurs in the alluvium at the Old Rifle site due to a drainage ditch discharging near the tailings. This has created downward potentiometric gradients, driving contaminants down into the Wasatch Formation. At the New Rifle site, hydraulic heads in the alluvium are also higher than those in the underlying Wasatch Formation. Therefore, water flows from the alluvium downward into the Wasatch Formation, and any contaminants present in the alluvium at the New Rifle site may be transported to the Wasatch Formation. Seepage from the Old and New Rifle tailings piles has impacted the groundwater in both groundwater systems; however, contamination of the groundwater has had no effect on the existing use of the water in the vicinities of the Rifle tailings sites.

The design for stabilization of the tailings pile at the New Rifle site incorporates a two-foot-thick, compacted, low permeability, earthen radon barrier and 2.5 feet of frost protection and drain layers that would be constructed over the tailings pile. The stabilized tailings pile would be sloped to reduce the standing time of water on the surface of the radon barrier. The infiltration flux through the barrier would be approximately 10^{-9} cm/s, minimizing seepage though tailings.

At the Old and New Rifle sites, natural flushing would reduce concentrations of conservative contaminant species to background levels in the alluvium within 10 years after the tailings have been removed at the Old Rifle site, and within 50 years at the New Rifle site. However, natural flushing of non-conservative (geochemically reactive) species could require considerably more time and require active aquifer restoration. Natural flushing in the underlying Wasatch Formation within 100 years would be negligible because of the formation's low hydraulic conductivity.

Contaminant concentrations at the New Rifle site would eventually naturally flush to meet MCLs at the toe of the pile. However, stabilization at New Rifle would result in periods of potential exceedance of the proposed groundwater protection standards related to flooding of the Colorado River. If natural flushing with proper institutional controls is not sufficient to reduce all contaminant concentrations to MCLs or background within 100 years, or if periodic flooding causes periodic exceedance of MCLs or background levels, then design modifications, active aquifer restoration, active restoration in combination with natural flushing, or ACLs would be required to ensure compliance.

Under the UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

A.3 DISPOSAL AT THE ESTES GULCH SITE

A.3.1 INTRODUCTION

This section provides the information necessary to understand the proposed conceptual design for the relocation of the tailings from the Old and New Rifle tailings sites at Rifle, Colorado, to a disposal site identified as Estes Gulch (Figure A.3.1). The Estes Gulch site is approximately seven road miles north of the Old Rifle tailings site and approximately nine road miles north of the New Rifle tailings site. While this alternative includes performance of interim actions at the Old and New Rifle sites, these activities are discussed in detail in Section A.1.3.

A.3.2 DESIGN FEATURES

The remedial action would stabilize the uranium mill tailings and contaminated materials at the Estes Gulch site in compliance with the EPA standards. The principal feature of the design concept is the removal of all tailings and contaminated materials from both the Old and New Rifle sites and consolidation of these materials into a contoured pile at the Estes Gulch site. Major construction activities for this relocation alternative are discussed in detail in Section A.3.4. The design would require the following activities at the tailings, alternate disposal, and proposed borrow sites:

<u>At the Old and New Rifle sites</u>

- Upgrading (as necessary) of the access roads from the sites to U.S. Highway 6.
- Construction of staging areas in the former mill areas.
- Installation of temporary security fencing.
- Protection, relocation, or removal of surface or subsurface utilities at the sites during construction.
- Construction of wastewater retention basins and treatment plants to protect against the release of contaminants from the sites during remedial action.
- Construction of truck washing stations at the sites.
- Construction of drainage control measures to direct all wastewater and storm water runoff to the retention basins during construction.
- Implementation of measures to control erosion and sedimentation from disturbed areas during construction.

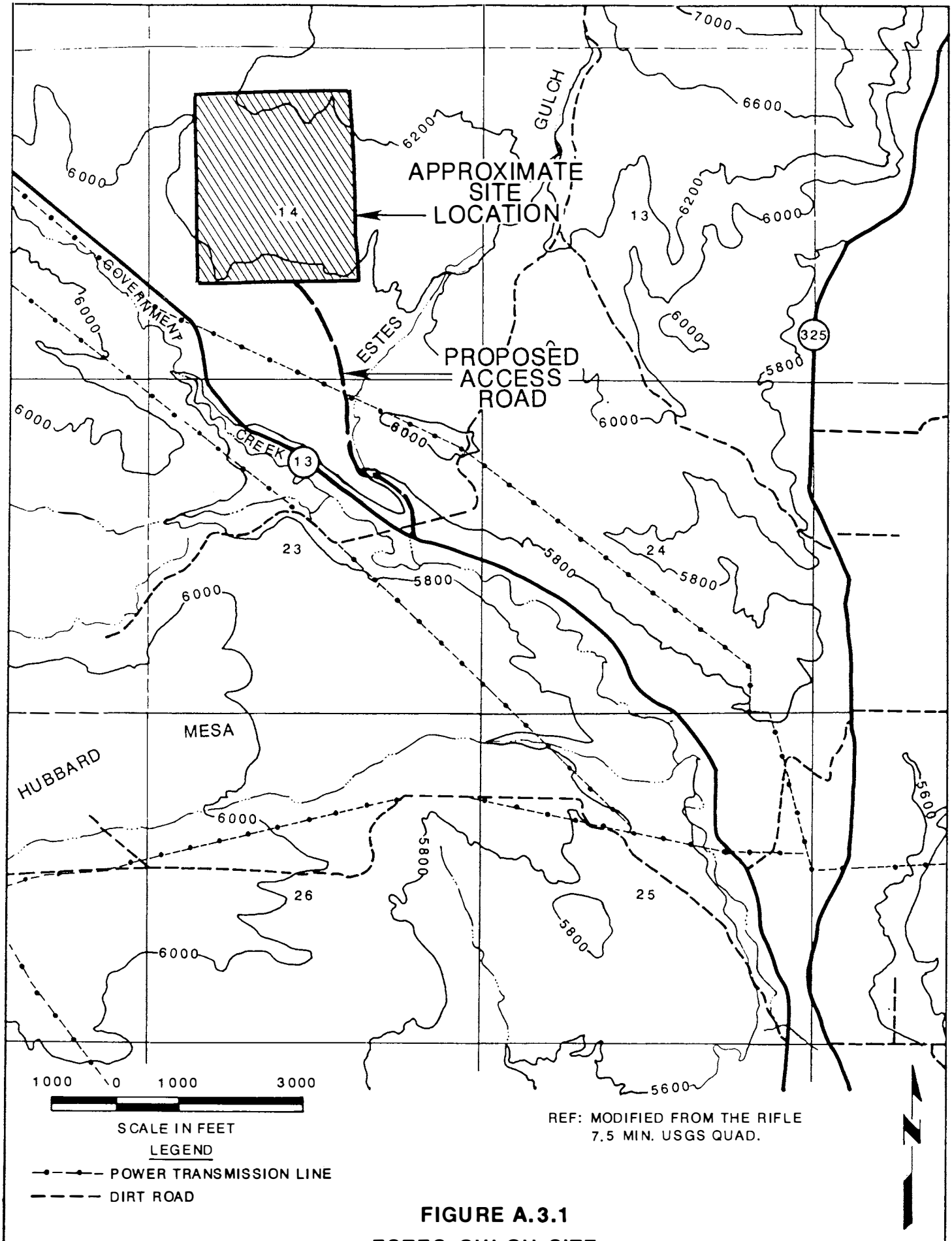


FIGURE A.3.1
ESTES GULCH SITE

- o Installation and operation of wastewater treatment facilities (if necessary) to protect against the inadvertent release of contaminants from the sites during construction.

- o Consolidation of the demolition debris and non-hazardous materials with the tailings and contaminated materials.

- o Dewatering of the tailings and alluvium beneath the tailings at the Old Rifle site.

- o Excavation and stockpiling of the tailings and contaminated materials at the sites, including demolition debris from the mill buildings and structures collected during interim action, as well as contaminated materials from the vicinity properties.

- o Relocation (by truck) of all of the tailings and contaminated materials, including sediments from the wastewater retention basins and temporary drainage ditches, from the tailings sites to the Estes Gulch site.

- o Restoration of the disturbed areas with clean fill material, grading to promote positive drainage, and revegetation. Includes revegetation of those disturbed wetlands areas requiring restoration.

- o Release of the sites for any uses consistent with existing land use controls.

At the Estes Gulch site

- o Construction of: a paved 12-foot wide, 7500-foot long climbing lane on the east side of Highway 13 between Highway 325 and the Estes Gulch site turnoff; an 800-foot long, 12-foot wide gravel surfaced truck turnout, and an intersection facility on Highway 13 at the Estes Gulch turnoff.

- o Construction of a one-mile access road from State Highway 13 to the site.

- o Construction of a 10-acre staging area at the site.

- o Installation of temporary security fencing.

- o Construction of a wastewater retention basin(s) and treatment plants to protect against the release of contaminants from the site during remedial action.

- o Construction of a truck washing station.

- o Construction of drainage control measures to direct all wastewater and storm water runoff to the retention basin(s) during construction.

- Implementation of measures to control erosion and sedimentation from disturbed areas during construction.

- Excavation of the partially below-grade disposal area with stockpiling of the excavated earthen material.

- Placement of the tailings and contaminated materials, including sediments from the wastewater retention basin(s) and temporary drainage ditches at the site, in the disposal area, with materials of an acceptably low contamination level to be placed in an adjacent trench.

- Construction of the final cover system over the tailings and contaminated materials to inhibit radon emanation, water infiltration, plant root penetration, wind and water erosion, freeze-thaw action, and penetration by burrowing animals.

- Construction of various erosion protection features (rock aprons, grading, rock-filled key trenches, rock-lined drainage diversion ditches) around the stabilized tailings pile to protect against the headward advancement of adjacent surface drainages and surface water runoff.

- Installation of concrete posts with warning signs around the stabilized tailings pile.

- Reclamation, including revegetation as required, of all areas disturbed at the site during remedial action.

At the Second Street borrow site

- Excavation of earthen materials for site restoration.

- Relocation of the earthen materials by truck to the Old and New Rifle sites.

At the New Rifle borrow site

- Excavation of gravel and small rock for access road construction and erosion protection.

- Relocation of the gravel and small rock by truck to the Estes Gulch site.

At the Glenwood Springs borrow site

- Excavation of large rock for erosion protection.

- Relocation of the large rock by truck to the Estes Gulch site.

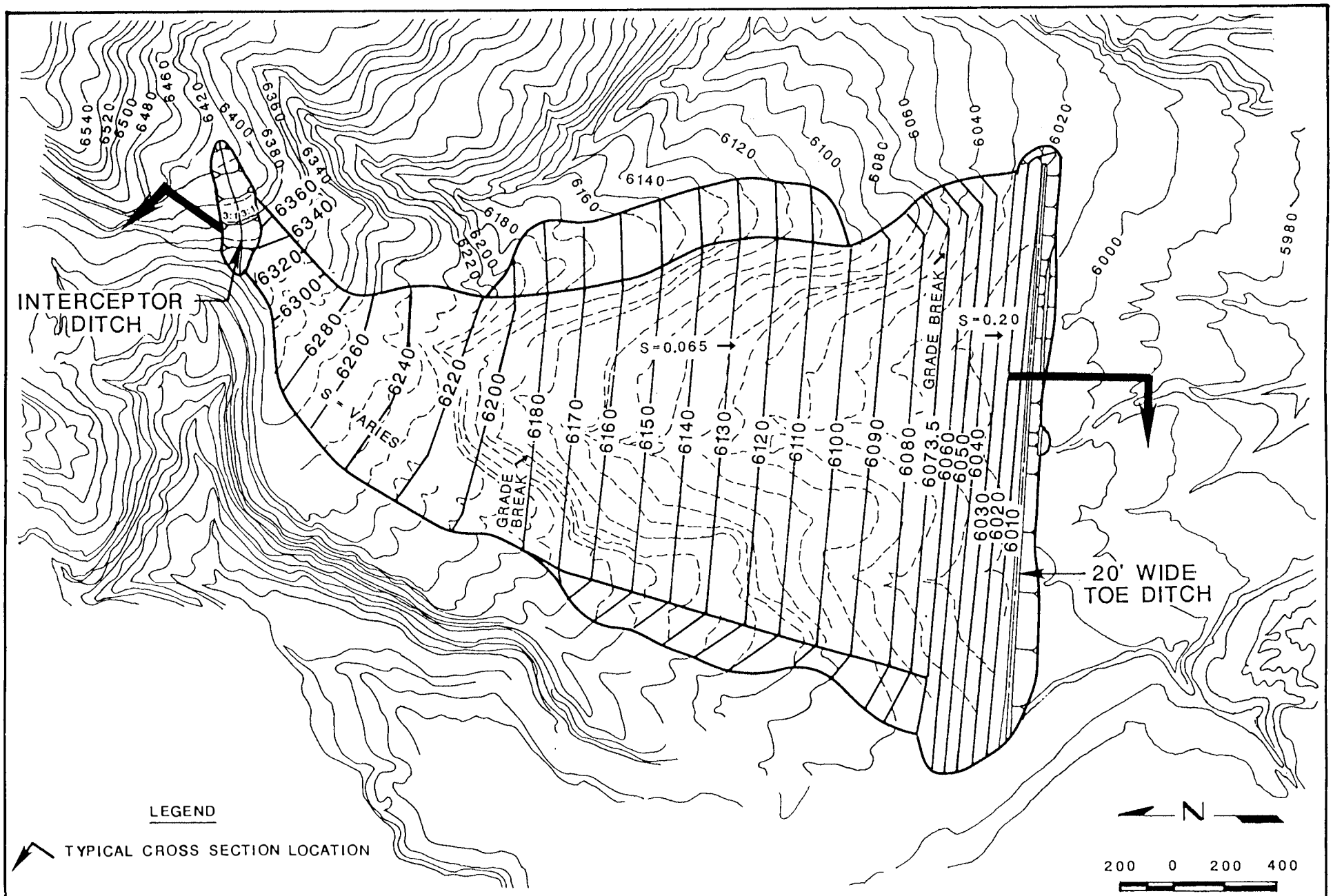


FIGURE A.3.2

FINAL CONDITIONS
ESTES GULCH SITE

A.3.3 PERMANENT DESIGN FEATURES

Description of final condition

The stabilized tailings pile would be sized to contain approximately 4.135 million cubic yards of tailings and contaminated materials and would cover approximately 71 acres of the disposal site (Figure A.3.2). The entire site would cover approximately 81 acres. The stabilized pile would be constructed in Section 14, T5S, R93W.

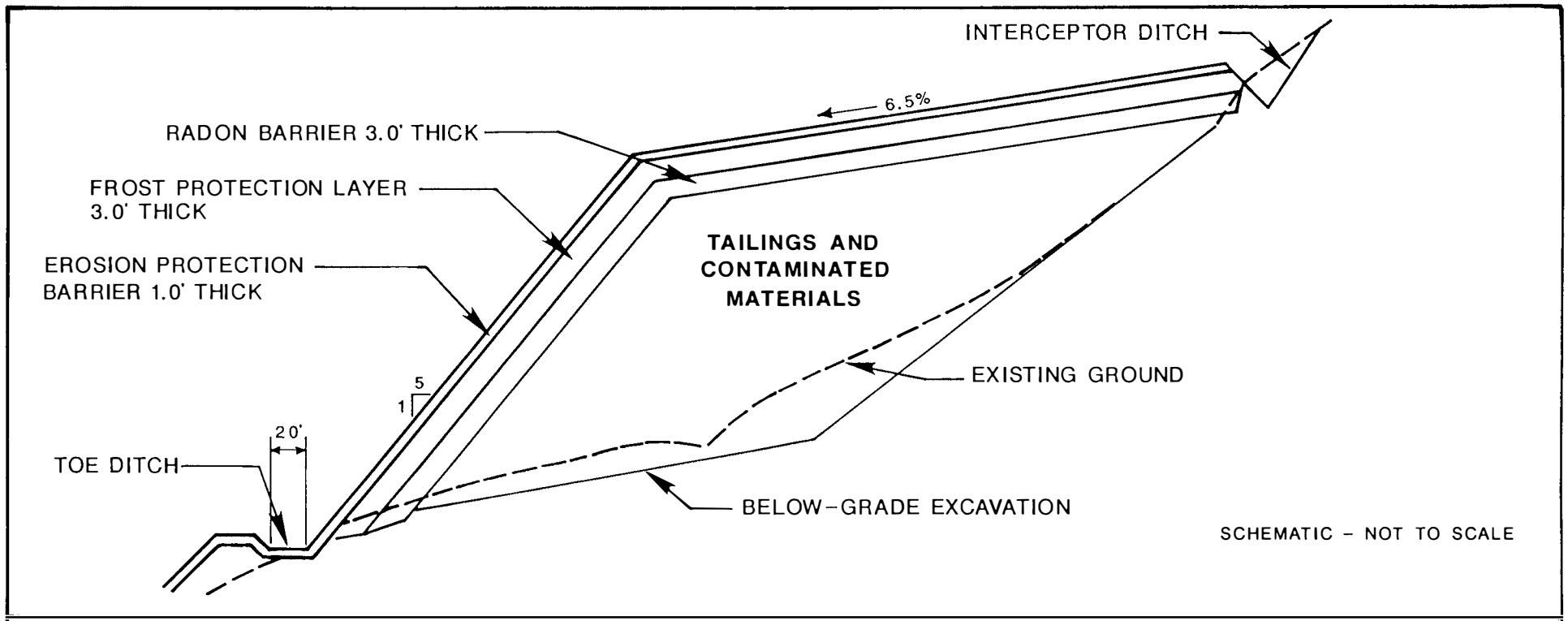
The tailings and contaminated materials would be covered with approximately 3.0 feet of compacted earth (radon barrier) and 3.5 feet of loosely compacted earth (frost protection and drain layers) (Figure A.3.3) obtained from the surface materials excavated from the disposal area, in addition to a 1.5-foot-thick layer (including the filter layer) of graded rock to provide erosion protection. The top surface of the pile would be nearly flush with the east and west ridges and with the existing terrain slope of about 6.5 percent. The slope at the toe of the pile would be a maximum of 20 percent (five horizontal to one vertical). The terrain adjacent to the embankment would be graded to promote sheet flow and rock-filled key trenches would be provided along the embankment and existing terrain interface. A rock-lined toe ditch would be constructed along the south end of the pile to collect surface water runoff and divert it westward to Government Creek. As it would also be founded in bedrock, it would provide protection for the pile from any headward advancement of gullies to the south and west. The upland drainage area to the north would be graded and riprapped, and together with an interceptor ditch, would divert runoff away from the pile.

Monuments with warning signs would be installed at set intervals designating the disposal site as Federally owned property.

After completion of the stabilized tailings pile at the disposal site and decontamination of the tailings sites, the disturbed areas at each site would be restored to promote positive drainage and revegetated as required. Those disturbed wetlands areas requiring restoration would be revegetated to re-establish plant species identical or similar to those that presently exist.

Decontamination and restoration

The mill areas, tailings piles, and the windblown tailings at the Old and New Rifle sites and the vicinity properties would be decontaminated by excavation of the tailings and contaminated materials and consolidation of these materials into the stabilized pile at the Estes Gulch site. Contaminated debris from demolition of existing buildings and structures would be consolidated into the stabilized tailings pile. Contamination exists at the Old and New Rifle sites as described in Section A.2.2 and shown in Figures A.2.3 and A.2.4.



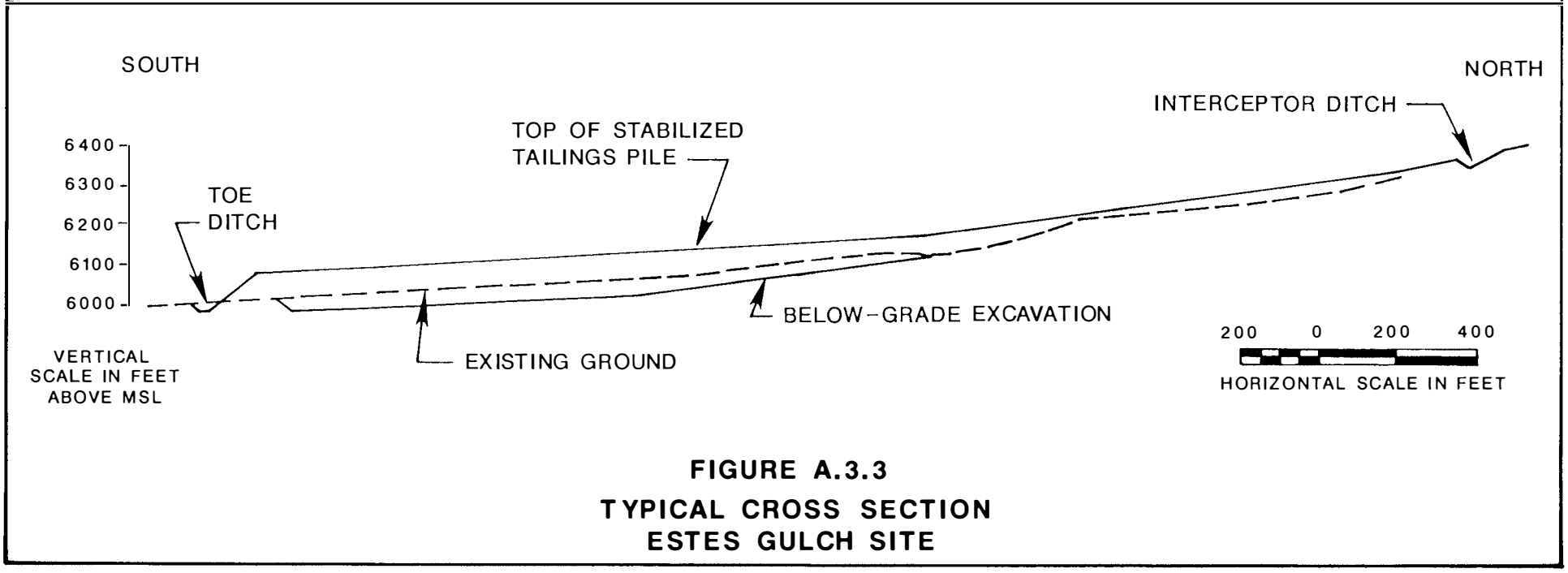


FIGURE A.3.3
TYPICAL CROSS SECTION
ESTES GULCH SITE

After removal of all contaminated materials, the areas of excavation at and around the Old and New Rifle sites would be restored with clean fill to promote positive drainage. Those disturbed wetlands areas requiring restoration would be revegetated to re-establish plant species identical or similar to those that presently exist.

Tailings pile construction

This alternative would require that the tailings pile at Estes Gulch be constructed in layers. The first layer would contain the tailings and demolition debris (demolition debris, if properly decontaminated, may be placed elsewhere than in the stabilized pile) from the New Rifle site. Once placement of this material was complete, the contaminated materials from the Old Rifle site would be transported to Estes Gulch and placed in the pile. The last layer of contaminated material would consist of the windblown tailings at the New Rifle site and contaminated materials from the vicinity properties. The cover system would then be placed to provide long-term stability and minimize radon emanation and groundwater contamination.

The below-grade excavation of the disposal area would extend to an average depth of 20 feet. The earthen materials for the radon barrier would be obtained from this excavation. The base of the excavation would be scarified, moisture conditioned, and recompacted.

Relocated tailings would be placed in lifts and compacted on top of the compacted base. The tailings and contaminated materials would be compacted to increase strength and reduce compressibility. The total long-term settlement of these materials will be very small due to the compaction, as well as to the granular, non-plastic nature of the tailings. Settlement of the foundation will be negligible, as most of the underlying soil will be removed and any remaining in-situ soils will not be saturated after placement of the contaminated materials. Therefore, the adverse effects of total and differential settlement on the integrity of the radon barrier are considered to be small and within acceptable limits. The final engineering design would specify the degree of compaction required to avoid detrimental settlement. Because the tailings would be mixed during excavation and again during unloading, spreading, and compacting at the Estes Gulch disposal site, it is not expected that any extensive lenses of slimes would exist in the compacted tailings. Consequently, appreciable differential and total settlement would not occur, and the long-term integrity of the pile would not be adversely affected by the normal consolidation and settlement of the tailings.

Organic material such as wood demolition debris and grubbed vegetation would be evenly distributed throughout the tailings pile so that no more than five percent organics by volume are contained in any area of the pile. Demolition debris would be placed in the lower portions of the pile and surrounded with compacted tailings. The procedures for this activity would be specified to ensure that the debris is placed to avoid concentration in any area and to ensure good compaction of the tailings around the debris.

Making the top of the pile flush with the adjacent ridges, and limiting the pile topslope to 6.5 percent and the toeslope to 20 percent, would provide the necessary factor of safety against slope failure and would reduce the potential effects of erosion.

Cover construction

The tailings radon flux rate would be reduced to the EPA standard by the placement of an approximately 3.0-foot-thick compacted earthen layer that would serve as a radon barrier. This radon barrier would be protected from freeze/thaw effects with a 3.0-foot-thick frost protection layer overlying a 0.5-foot-thick layer of drain material. This system will underlie a 1.5-foot-thick layer of rock (including the filter layer) on the topslope and on the toeslope designed to protect the radon barrier and consequently prevent exposure of the tailings and contaminated materials for 1000 years. The compaction of the radon barrier would produce an earthen cover that retains moisture and retards radon gas diffusion. The rock, frost protection, and filter layers would reduce the potential for drying of the compacted earthen cover by trapping soil moisture.

The rock and filter layers would be placed over the radon barrier and would resist erosion and gully formation thereby protecting the barrier from being eroded during rainstorms. The rock and filter layers would be designed to withstand the occurrence of the PMP and would also protect the pile from wind erosion and discourage plant root penetration and intrusion by burrowing animals.

Site drainage

The placement of the pile in conformance with the drainage pattern of the Estes Gulch area and the surrounding general site grading have been designed to ensure long-term pile stability. Surface runoff from the pile as well as runoff from surrounding areas would be directed away from the pile by grading to promote sheet flow that would be designed to carry the rainfall runoff resulting from the one-hour PMP storm event.

The pile has been designed to prevent gully encroachment and undercutting of the embankment. The drainage diversion ditches and slopes to the east and west have been eliminated by making the pile's top surface flush with the adjacent ridge lines. Rock-filled, 15-foot wide key trenches along the pile's eastern and western boundaries, together with limited grading of the adjacent areas, will reduce erosion and promote sheet flow away from the top of the pile. An unlined interceptor ditch would be constructed on a portion of the upland drainage area to divert runoff from the uppermost portions. The remaining watershed area between the ditch and the pile would be graded and riprap would be added to effectively eliminate all existing and future gullying and to shed part of the runoff away from the top of the pile.

The pile would be protected from the headward advancement of gullies to the south and west by the construction of a toe ditch that is founded in bedrock, armored with 5.7 inch mean diameter rock and tied into the pile's erosion protection barrier. Surface water generated on the top of the pile would be collected in this toe ditch and discharged westerly into natural terrain, and eventually into Government Creek.

Groundwater protection

The stabilized tailings pile would be designed to minimize groundwater contamination. The preparation of the subbase, placement and sloping of the tailings, and placement of the low permeability, earthen radon barrier would serve to minimize the migration of contaminants to the groundwater system. Details are provided in Section A.3.8.

Site access

After remedial action is complete, the site would be marked with monuments with warning signs to discourage human intrusion.

A.3.4 MAJOR CONSTRUCTION ACTIVITIES

A.3.4.1 Layout

Construction activities would take place at the Old and New Rifle tailings sites, the disposal site, and along the access road.

The exact locations and sizes of all construction features such as the staging areas, decontamination facilities, temporary drainage ditches, and wastewater retention basins would be determined during final design. The following discussion presents one possible layout and is provided to facilitate better understanding of all aspects of the remedial action.

At the tailings sites, the staging areas would be in the former mill areas. Equipment decontamination facilities would be adjacent to the staging areas. Ditches and berms surrounding the sites would direct uncontaminated flows away from the sites. Contaminated water would be directed to wastewater retention basins and treatment facilities constructed on the sites. Temporary security fencing would surround the areas at the Old and New Rifle sites.

At the Estes Gulch site, the staging area would be south of the proposed pile location. An equipment decontamination facility would be south of the disposal area excavation. Drainage ditches would surround the site and collect all runoff from the site. Flow in these ditches would be channeled

to a wastewater retention basin(s) south of the pile area. Temporary security fencing would enclose the entire site.

A.3.4.2 Site access

Equipment would be decontaminated prior to leaving the Old and New Rifle sites and the disposal area at the Estes Gulch site. Temporary security fences would control traffic entering and leaving any site and prevent unauthorized traffic from entering controlled areas.

Traffic would enter and leave the Estes Gulch site via an access road constructed south of the tailings pile area. A detailed description of the transportation route is presented in Section A.3.4.5.

A.3.4.3 Staging area facilities

During construction operations, temporary facilities would be required for remedial action workers as well as supervisory, engineering, administrative, security, and radiation monitoring personnel at both the tailings sites and the disposal site. The facilities would consist of office space and showers and change facilities for all personnel working on the sites and would include provisions for laundering contaminated clothing. Portable toilets would be provided for on-site workers. On-site equipment would be stored in the staging areas. Parking areas would be constructed at all sites.

A.3.4.4 Utilities

All known existing utilities at the Old and New Rifle sites and the Estes Gulch site would be protected during construction, removed or relocated, as necessary, prior to construction.

Some water for dust suppression on contaminated areas at both tailings sites would be obtained from the tailings and subsoil dewatering or would be recycled water from the wastewater retention basin(s). Most water for dust suppression on uncontaminated areas, and for compaction during site restoration and construction water, would be obtained from the Rifle Gap Reservoir. Figures A.2.5 and A.2.6 show all known existing utilities at the Old and New Rifle sites, respectively. Potable water, electricity, gas, and phone service at the Old and New Rifle sites would be obtained from local suppliers.

At the Estes Gulch site, electricity would be available from the Colorado-Ute Electrical Association or the Western

Area Power Association, and telephone service would be available from Mountain Bell. Use of these utilities would require extension of existing lines; if this were not cost-effective, electricity could be supplied by portable generators at the site and telephone service by radio telephone. All known existing utilities in the vicinity of the Estes Gulch site are shown in Figure A.3.4.

There is no developed water supply at the Estes Gulch site. Water was found at a depth of 273 feet; however, based on production rates from existing wells in the vicinity of the site, it is unlikely that a sufficient quantity of water for equipment decontamination, compaction, and dust control at the site could be produced from an on-site well. Water would be hauled from Rifle Gap Reservoir, utilizing City of Rifle water rights. Potable water could be obtained from a city water line located at the New Rifle site or hauled from the nearest commercial source.

A.3.4.5 Tailings transportation

Under this alternative, the tailings and contaminated materials would be transported by 18-cubic-yard capacity trucks (10-cubic-yard capacity trucks with eight-cubic-yard capacity pups, i.e., trailers) equipped with gate seals to prevent leakage. The trucks would be loaded at the former tailings sites and the loads would be covered with tarpaulins. Trucks would be decontaminated prior to leaving the Old and New Rifle sites and would haul the tailings and contaminated materials directly to the Estes Gulch site.

After leaving the Old and New Rifle tailings sites, trucks would proceed west approximately 1.5 miles and one mile, respectively, on U.S. Highway 6 to the State Highway 13 bypass. The truck route would then extend north on State Highway 13 approximately six miles. The trucks would then leave State Highway 13 on the newly constructed Estes Gulch access road for one mile to the Estes Gulch site. Trucks would use the same routes to return to the tailings sites.

To accomodate the increased number of tailings transport trucks and decrease the impacts to local traffic and road conditions, portions of Highway 13 would be improved. These improvements include construction of a paved 12-foot-wide, 7500-foot-long climbing lane on the east side of Highway 13 between Highway 325 and the Estes Gulch site turnoff; an 800-foot-long, 12-foot-wide gravel surfaced truck turnout; and an intersection facility on Highway 13 at the Estes Gulch turnoff for trucks entering and leaving the highway. Specific construction and improvement details would be determined during the preparation of the final engineering designs. Access road construction could add an additional $486,000 to the overall project costs.

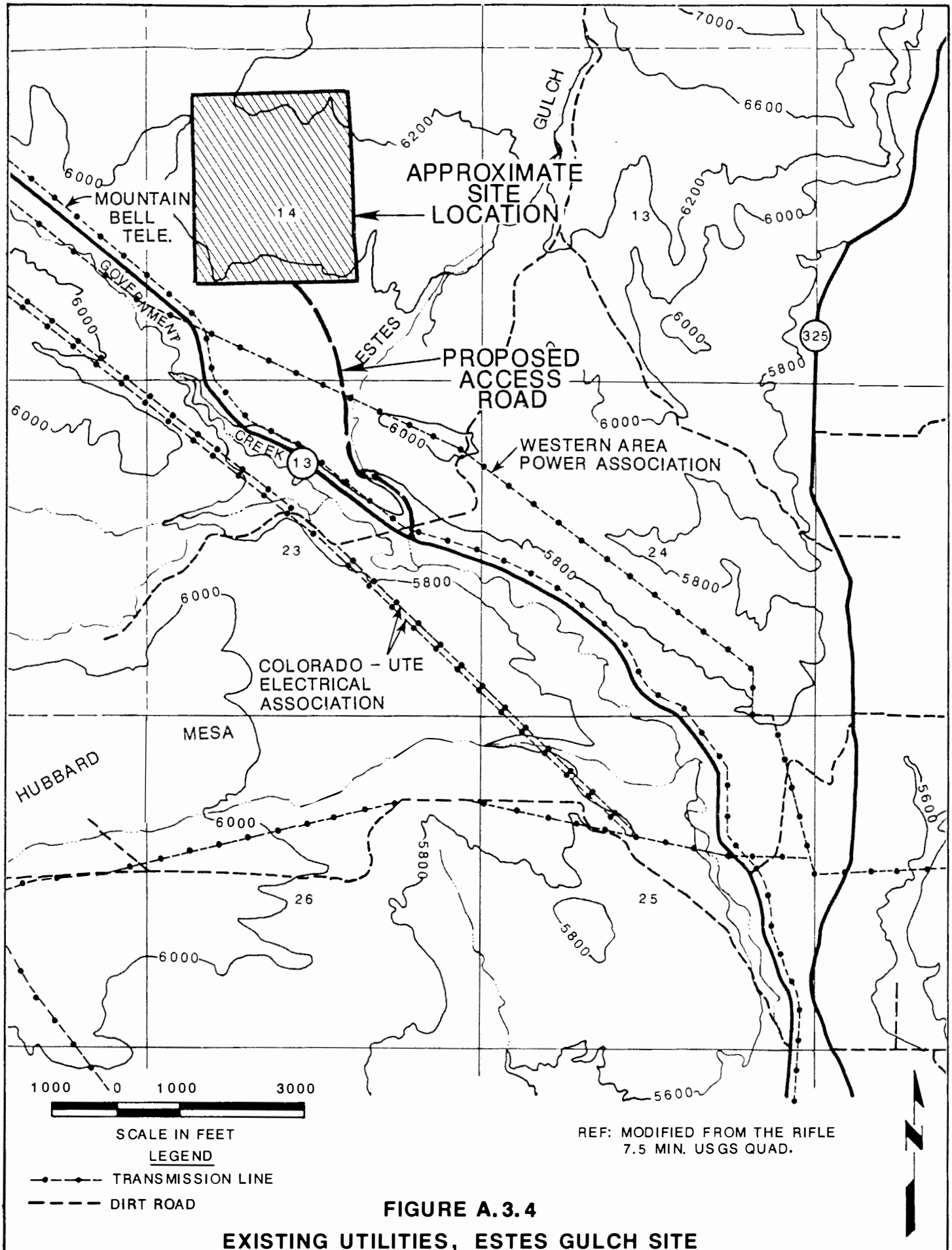


FIGURE A.3.4

EXISTING UTILITIES, ESTES GULCH SITE

A.3.4.6 Drainage, erosion control, and wastewater retention basins

During remedial action, drainage from all sites would be effectively diverted from any waterways. Areas disturbed by construction activities would be graded to direct runoff into the wastewater retention basins. Drainage ditches would be lined with erosion-resistant materials if sediment buildup in the wastewater retention basins becomes a problem. Runoff from land outside of affected areas would be diverted away from the sites by diversion ditches designed and maintained to prevent overflow.

The wastewater retention basins would be designed to meet the retention and discharge capacities described for stabilization at the New Rifle site (Section A.2.3.5).

A.3.4.7 Wastewater treatment

Wastewater generated from sources mentioned in Section A.2.3.5 would be directed to wastewater retention basins, which would provide primary settling along with flow and contaminant equalization. Some of this water would be utilized for dust control on contaminated areas. The remainder of the water at the tailings sites would be treated to meet applicable state of Colorado water quality standards before discharge.

A.3.4.8 Dewatering

Additional data gathered indicates that excavation dewatering volumes at both the Old and New Rifle sites will be higher than originally estimated. This is because the volumes of contaminated materials below groundwater levels is more than originally anticipated. To facilitate handling, some of the tailings would require dewatering. Dewatering would be accomplished as described for stabilization at the New Rifle site (Section A.2.3.7). Water treatment plants would be installed at all three Rifle sites.

Dewatering would not be necessary at the Estes Gulch site.

A.3.4.9 Dust control

Dust generated by excavation, earth movement, vehicle use, temporary materials stockpiling, and similar activities would be controlled and minimized by the use of water and water-based surfactants sprayed from hoses or trucks. Special care would be taken to control dust created by building and structure decontamination or demolition and the temporary stockpiling or mixing of contaminated materials.

Some of the sources for dust-suppression water on contaminated areas would include recycled water from the wastewater retention basins or water from tailings and subsoil dewatering. Uncontaminated water would be used for dust control on uncontaminated areas. Most of the water needs for dust suppression and compaction would be obtained from the water rights held by the City of Rifle at the nearby Rifle Gap Reservoir, approximately six to seven miles northeast of the Estes Gulch site.

The schedules for spraying the roads and pile areas may vary daily and would be determined on an hour-by-hour basis in accordance with applicable state permits. The frequency of spraying would increase when combinations of low soil moisture and high wind speed were encountered.

A.3.4.10 Borrow sites

Three separate borrow sites have been identified for the disposal at Estes Gulch alternative. The first is immediately north of the New Rifle tailings site and is referred to as the Second Street borrow site (see Figure A.1.2). Earthen materials for clean backfill for restoration of the tailings sites would be purchased at this existing, commercial borrow site and trucked to the tailings sites.

The New Rifle borrow site is along the north bank of the Colorado River immediately west of the New Rifle tailings site (see Figure A.1.2). Gravel for access road construction and small rock for erosion protection and the filter layer ($D_{50} \leq$ eight inches) would be purchased at this existing, commercial borrow site and trucked to the Estes Gulch site.

The Glenwood Springs borrow site is approximately two road miles north of Glenwood Springs and approximately 38 road miles east-southeast of the Estes Gulch site (see Figure A.1.1). Large rocks for erosion protection ($D_{50} \geq$ eight inches) would be purchased at this existing, commercial borrow site and hauled to the Estes Gulch site.

All earthen materials for the radon barrier and frost protection layer would be obtained from excavation of the partially below-grade disposal area at the Estes Gulch site.

A.3.4.11 Restoration of the Old and New Rifle sites

Following the removal of all contaminated materials, the Old and New Rifle sites would be restored with clean fill to promote positive drainage. Earthen material for site restoration would consist of random fill obtained from the Second Street borrow site and would be transported by truck to

the sites. Those disturbed wetlands areas requiring restoration would be revegetated to re-establish plant species identical or similar to those that presently exist.

A.3.4.12 Construction sequence

The following construction sequence is proposed as a possible sequence for the remedial action. As with the layout (Section A.3.4.1), the final design would contain more detail and the construction subcontractor would be allowed the flexibility of executing work as choosen, given certain constraints. Therefore, the actual construction sequence may differ from the following.

Initially, construction and any necessary upgrading of the access roads to the tailings and disposal sites would begin. Concurrent with these activities, a site security system would be established at each site and coordinated with staging and vehicle decontamination areas. This would provide control of traffic entering and leaving each site and prevent unauthorized traffic from entering either site.

The next major item of site preparation would be constructing a wastewater retention basin(s) at each site. Materials excavated from each basin would be stockpiled for later use as fill. Site preparation would also include construction of drainage and erosion control measures.

Wastewater treatment facilities would be installed and operated at the Old and New Rifle sites to treat contaminated water and to protect against contaminant release during construction.

Once the initial site preparation at the Estes Gulch site is completed, preparation of the disposal area would begin. This would involve the excavation and stockpiling of surface materials to allow for the partially below-grade disposal of the tailings.

The asbestos removal and building demolition process would have already been performed during interim actions. Dewatering activities would also begin at this time. Tailings would be excavated and moved and contaminated materials (as necessary) would be excavated from the windblown areas and consolidated into the disposal area. However, the movement of tailings and contaminated materials would not begin until a sufficient area had been opened and prepared at the disposal cell.

The radon barrier and frost protection and drain layers, composed of uncontaminated earthen materials, would be added to the relocated pile after the tailings and contaminated materials were in place. The uncontaminated earthen materials

would be obtained from the surface materials excavated from the disposal area and compacted to project specifications. Drainage ditches would be excavated around the stabilized tailings pile. The final stages would involve reestablishing overall site drainage, grading, monitoring for settlement, placement of rock over the stabilized tailings, and revegetation of disturbed areas as required.

Restoration at the tailings sites would involve the placement of clean fill in the excavated areas to promote positive drainage. The clean fill would be obtained from the Second Street borrow site. Disturbed wetlands areas would be revegetated to re-establish plant species identical or similar to those that presently exist.

Demobilization would consist of the removal of the remaining wastewater retention basins and temporary drainage ditches. The water would be treated and discharged while the bottom sediments and dikes would be transported to the Estes Gulch site for disposal in the stabilized pile. All decontamination areas would be removed and the equipment cleaned for salvage. The staging areas would be dismantled with the contaminated items either cleaned or buried. All contractor equipment would be decontaminated and inspected prior to release from the contaminated areas.

Figure A.3.5 shows a construction schedule for disposal at the Estes Gulch site.

A.3.5 RADON CONTROL

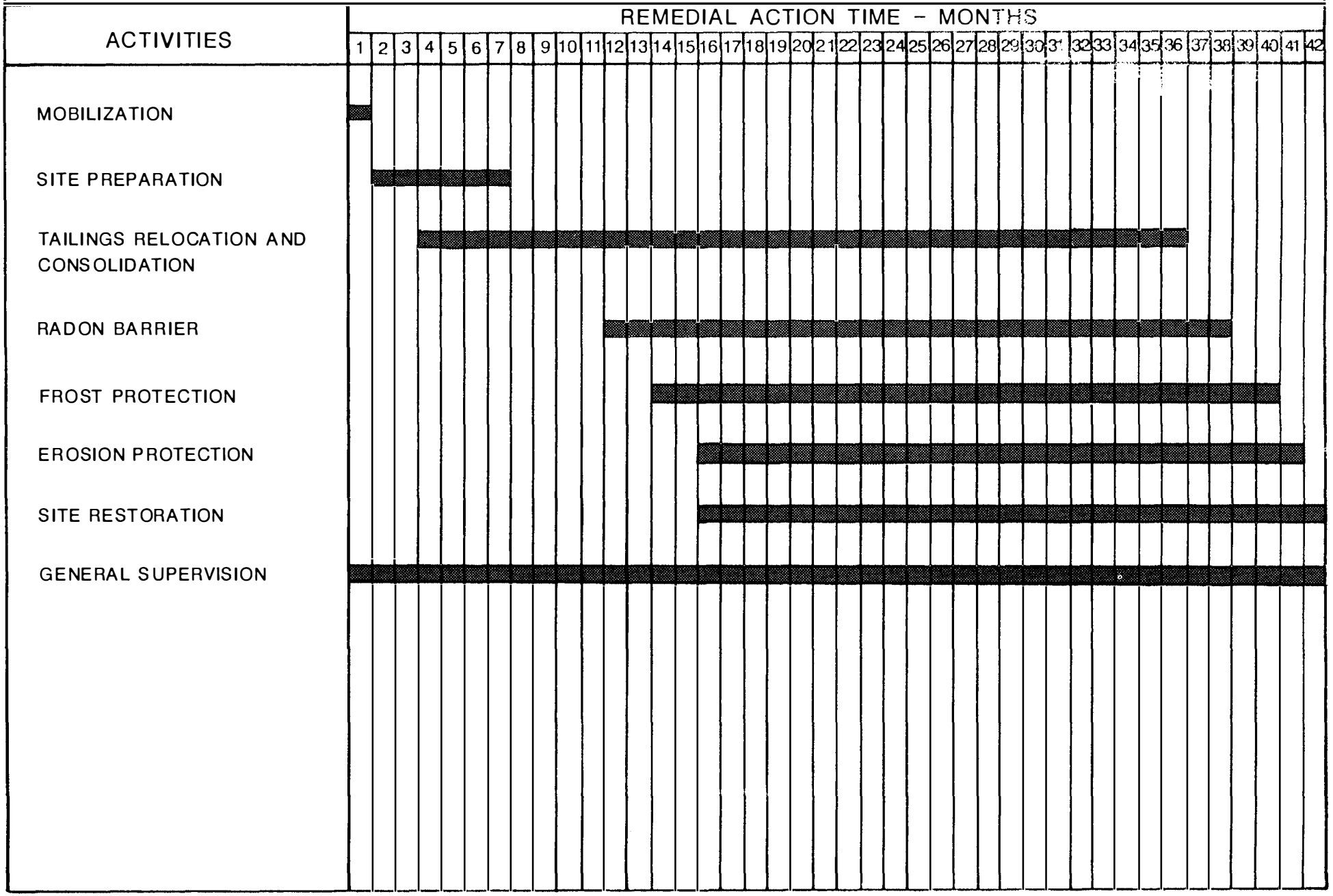
Control of radon flux from the stabilized tailings pile would be accomplished by placing a compacted, 3.0-foot-thick, earthen radon barrier over the tailings and contaminated materials.

As with stabilization at the New Rifle site, data on the distribution of radium-226 in the tailings, on the properties of the surficial materials at the disposal site, and on the estimated depth of the windblown tailings were analyzed and used in the computer code RAECOM to develop an estimate of radon barrier thickness. Using this thickness, radon flux after remedial action would be less than the EPA standard of 20 pCi/m^2s. The erosion protection barrier and the frost protection layer were not considered in the calculations and would provide some additional reduction in radon flux. The data and analyses are available in the DOE UMTRA Project Office, Albuquerque, New Mexico. The actual thickness of the radon barrier could vary depending on additional analyses to be performed during final design and remedial action.

A.3.6 DESIGN CONSIDERATIONS

The Estes Gulch site is in a remote, moderately flat area. There are no perennially flowing waters or shallow groundwater levels in the

FIGURE A.3.5 **REMEDIAL ACTION SCHEDULE, DISPOSAL AT THE ESTES GULCH SITE**



site area. Therefore, many of the design concerns associated with stabilization at the New Rifle site are not relevant for this option. Since tailings and contaminated materials would be relocated from a metropolitan area, the issues associated with tailings transportation are of concern. Also, the location and configuration of the pile were evaluated in order to minimize the quantity and size of erosion protection required and to take advantage of any shallow gradients in the site area.

The proposed layout was determined by considering the geomorphology of the site. The pile was set back against the head of a hollow in order to minimize the drainage area impacting the site. The pile was also set back to minimize the impacts of gully erosion on the site. The pile would be designed to prohibit headcutting into the pile for the design life of at least 1000 years.

The toeslope of the pile would be limited to five horizontal to one vertical (20 percent), and the top of the pile would be gently sloped to approximately 6.5 percent, and flush with the adjacent natural topography. By placing the pile back into the head of a hollow, this configuration would contain the large quantity of materials involved and minimize visual impacts from the pile. Also, by placing the tailings in the head of a hollow, the amount of rock required to cover the pile is minimized. The two ridges east and west of the pile protect the pile from the adjacent drainages.

A.3.7 LONG-TERM STABILITY

Water erosion

Severe rainfall events have the potential to develop rills and gullies on the steeper (20 percent) toeslope of the stabilized tailings pile and erode some or all of the radon barrier in small, undefinable areas. For the Estes Gulch site, the local one-hour PMP storm was calculated to be 7.6 inches. Based on this one-hour intensity, a maximum 2.5-minute intensity was calculated based on the time of concentration for flow off the pile. The intensity was then converted to an equivalent one-hour rainfall intensity of 50.2 inches per hour. This PMP would generate sheet flow rates ranging from 1.3 to 2.2 cfs/ft on the pile. Rock sizes required to withstand sheet erosion on the pile top and toeslope during a PMP event are shown in Table A.3.1.

To further reduce the potential for water erosion by surface runoff, additional control features were incorporated into the design to reduce surface runoff velocities. The toeslope of the stabilized tailings pile would be limited to five horizontal to one vertical (20 percent). The top of the pile would be gently sloped (a maximum of 7.1 percent) and would be flush with the adjacent terrain to promote drainage.

It is anticipated that a filter layer would be required on the pile top and toeslope to prevent piping and erosion of the finer-grained

Table A.3.1 Rock erosion protection, Estes Gulch site

Location	Rock size[a] (inches)	Thickness of rock[b] (inches)	Design flow (cfs/ft)
Topslope	$D_{50} \geq 3.5$	18	1.3
Toeslope	$D_{50} \geq 5.7$	18	2.2

[a]"D" corresponds to required rock diameter; D_{50} is the diameter of 50 percent of the rock by weight.
[b]Thicknesses of rock include filter layers.

radon barrier. The gradations of the filter layer would be determined during final design using the criteria described for stabilization at the New Rifle site.

Wind erosion

High wind velocities could damage the radon barrier of the stabilized tailings pile if the barrier were left exposed. The same rock and filter layers used to protect the pile from water erosion would provide sufficient protection from the effects of potentially erosive wind velocities.

Frost protection

Freeze-thaw cycles occurring throughout the year can cause cracking within the radon barrier. These cracks significantly increase the hydraulic conductivity of the radon barrier. Without a frost protection layer to protect from the freeze/thaw-related cracking, water in contact with the surface of the pile would percolate through the pile and exit through its base. This contaminated water would then build up beneath the pile and/or come to the surface in Estes Gulch.

The susceptibility of the radon barrier to freeze-thaw effects has been studied. A freeze-thaw protection layer, consisting of 3.0 feet of loosely compacted soils excavated from the Estes Gulch disposal site, and 0.5 foot of drainage material would be installed above the radon barrier to protect it against freeze-thaw effects. This frost protection layer would thereby ensure the integrity of the radon barrier.

Flood protection

The stabilized tailings pile would be surrounded by various drainage control measures designed to protect the pile from the discharge resulting from the occurrence of a PMP on the upstream watershed.

Rock-filled key trenches would reduce erosion of the ground adjacent to the pile. Limited grading of the adjacent terrain would promote sheet flow away from the pile and prevent gully formation. An interceptor ditch would divert runoff in the northern watershed away from the pile, and the intervening watershed area would be graded and riprap added. The rock-armored toe ditch would collect surface water from the top of the pile, discharging it westerly onto natural terrain, and eventually into Government Creek. It would be designed to prevent headcutting into the stabilized pile. The rock size required for the cover is provided in Table A.3.1.

The Estes Gulch site is at the head of a hollow and has virtually no drainage area above it. Drainage on the Estes Gulch site flows into an ephemeral creek in Estes Gulch approximately 0.5 mile southeast and 150 feet below the site. This creek joins Government Creek approximately one mile and 280 feet below the site. The Colorado River, at its closest point, is approximately six miles away and 730 feet below the site. No data on historical floods exist for the Estes Gulch site; because of its distance from and elevation above any major flows, the site would not be subject to river flooding.

Additional details on surface water hydrology at the Estes Gulch site are provided in Section E.1.1 of Appendix E, Hydrology.

Geomorphology

Gully erosion and arroyo encroachment have the potential to impact the site if not protected. The gullies which are present at the site are deeply incised, indicating recent downcutting. Also, numerous piping features indicate that at least some of the site soils are susceptible to erosion. The pile would be placed back into the head of hollow in order to minimize upland drainage and to maximize the distance from the deeply incised gullies south of the pile. A below-grade, rock-lined toe ditch would be placed at the southern toe of the pile to prevent headcutting into the stabilized pile. The two ridges flanking the sides of the pile and the designed erosion protection would protect the pile from future gully erosion for at least the 1000-year life of the pile.

A more extensive geomorphic evaluation of the Estes Gulch site is included in Section D.3 of Appendix D, Soils, Geology, and Seismicity.

Slope stability/seismic risk

Slope failure due to slope instability under static and seismic loading could affect the integrity of the stabilized tailings pile unless properly designed.

Stability analyses were performed for each loading condition to estimate factors of safety against slope failure. In particular, the seismic loading conditions were evaluated by applying the on-site horizontal acceleration resulting from a design earthquake. The evaluation estimated that the design earthquake would generate an on-site

effective peak horizontal bedrock acceleration of 0.21g. Details on the seismic analysis are included in Section D.4 of Appendix D, Soils, Geology, and Seismicity.

The factors of safety against slope failure under both static and seismic loading for the designed slope meet or exceed the generally accepted limits of 1.5 and 1.1, respectively. The static and seismic safety factors calculated for disposal at the Estes Gulch site are 3.1 and 1.8, respectively.

At the Estes Gulch site, the tailings would be placed as a dense, engineered fill. The foundation soils are hard and dry, and groundwater is deep into the underlying bedrock. For these reasons, and because the pile will be covered with a low permeability layer, there would be no potential for seismically-induced liquefaction at the site.

Settlement and cover cracking

As previously discussed in Section A.3.3 under "Tailings pile construction," differential and total settlement should not adversely affect the long-term integrity of the pile.

Frost heave/solifluction

The processes of frost heave and solifluction, which are discussed in detail in Section A.2.6, could pose a hazard to the long-term performance of any structure constructed to isolate the tailings. However, as with stabilization at the New Rifle site, the remedial action design includes the use of a 3.5-foot-thick frost protection layer composed of a 3.0-foot-thick layer of loosely compacted earthen materials excavated from the Estes Gulch Site, underlain by a 0.5 foot layer of drainage material. The frost protection layer will be placed over the radon barrier's sufficiently impermeable earthen materials to restrict ice lens formation. The underlying 0.5-foot-thick drain and overlying 1.5-foot-thick rock erosion barrier layers, composed of sufficiently porous aggregate layers, in conjunction with a continuous slope, would allow drainage across the pile surface. This system would provide an insulating blanket effect as well as restrict water buildup over the radon barrier. It eliminates the potential for frost heave (ice lens formation) and the prerequisite for solifluction (saturation).

Plant root penetration, burrowing animals, and human intrusion

The tailings pile at the Estes Gulch site would be covered with the radon barrier, a 3.0-foot-thick layer of compacted, low permeability, earthen material. The radon barrier is covered by a 3.5-foot-thick frost protection and drain layer. This layer would then be covered with a 1.5-foot-thick layer (including the filter layer) of rock erosion protection.

These layers of rock and compacted earth would inhibit plant root penetration into the contaminated material. The rock erosion protection barrier and frost protection layer would also discourage intrusion by burrowing animals and inadvertent human intrusion. The final tailings pile would also be surrounded by monuments with warning signs to discourage human intrusion.

A.3.8 GROUNDWATER PROTECTION

Groundwater beneath the Estes Gulch disposal site occurs in the variegated claystones, siltstones, shales, and fine-grained sandstones of the Wasatch Formation below depths of 270 feet. The underlying strata are nearly impermeable, with an average hydraulic conductivity of 2×10^{-8} cm/s, based on constant head permeability tests conducted on four monitor wells at Estes Gulch. Consequently, to prevent ponding of groundwater on the low permeability bedrock of the Wasatch Formation (the "bathtub effect"), a radon barrier with a hydraulic conductivity lower than that of the underlying rock will be constructed. The radon barrier will be designed with a saturated hydraulic conductivity of 10^{-8} cm/s to prevent the bathtub effect. Additional groundwater protection would be provided by the slope of the pile, which will enhance runoff and thus reduce infiltration.

Non-design features which will protect groundwater beneath the site include the low permeability of the Wasatch Formation, the impervious characteristics of the fracture zones in the bedrock, and the steep dip of the underlying beds. Based on an average hydraulic conductivity of 2×10^{-8} cm/s and a porosity of 20 percent (measured from 4 core samples), groundwater flow velocities beneath the site are less than 0.1 ft/year. Consequently, during the 1000 year design life of the pile, contamination will travel no more than 100 feet, the minimal distance from the edge of the tailings to the toe of the pile. Thus, the proposed EPA groundwater protection standards will be met at the toe of the pile.

Because of its low hydraulic conductivity, the Wasatch Formation beneath the disposal site cannot be considered an aquifer. Based on preliminary calculations with the Theis Equation, the formation beneath the disposal site cannot yield 150 gpd. All of the calculations are on file at the UMTRA Project office in Albuquerque, New Mexico.

Although minor faults and random fracture zones were encountered during core drilling beneath the site, constant head packer permeability tests indicate that these zones close with depth, and do not contribute significantly to the hydraulic conductivity of the Wasatch Formation. For this reason, they are not a contaminant transport route.

Finally, the beds of the Wasatch Formation dip approximately 65 to 75 degrees to the southwest, preventing any contaminants from traveling south towards Government Creek.

If the proposed groundwater protection standards are exceeded for any hazardous constituent at the toe of the pile, disposal cell cover modifications, supplemental standards, or ACLs would be implemented to ensure compliance.

Under the UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

A.4 DISPOSAL AT THE LUCAS MESA SITE

A.4.1 INTRODUCTION

This section provides the information necessary to understand the proposed conceptual design for the relocation of the tailings from the Old and New Rifle tailings sites at Rifle, Colorado, to a disposal site identified as Lucas Mesa (Figure A.4.1). The Lucas Mesa site is approximately 35 road miles southwest of the Old Rifle tailings site and approximately 33 road miles southwest of the New Rifle tailings site. While this alternative includes interim actions at the Old and New Rifle sites, these activities are discussed in detail in Section A.1.3.

A.4.2 DESIGN FEATURES

The remedial action would stabilize the uranium mill tailings and contaminated materials at the Lucas Mesa site in compliance with the EPA standards. The principal feature of the design concept is the removal of all tailings and contaminated materials from both the Old and New Rifle sites and consolidation of these materials into a contoured pile at the Lucas Mesa site. Major construction activities for this relocation alternative are discussed in detail in Section A.4.4. The design would require the following activities at the tailings, alternate disposal, and proposed borrow sites:

<u>At the Old and New Rifle sites</u>

- Upgrading (as necessary) of the access roads from the sites to U.S. Highway 6.
- Construction of staging areas in the former mill areas.
- Installation of temporary security fencing.
- Protection (or relocation) of surface or subsurface utilities at the sites during construction.
- Construction of wastewater retention basins and treatment plants to protect against the release of contaminants from the sites during remedial action.
- Construction of truck washing stations at the sites.
- Construction of drainage control measures to direct all wastewater and storm water runoff to the retention basins during construction.
- Implementation of measures to control erosion and sedimentation from disturbed areas during construction.

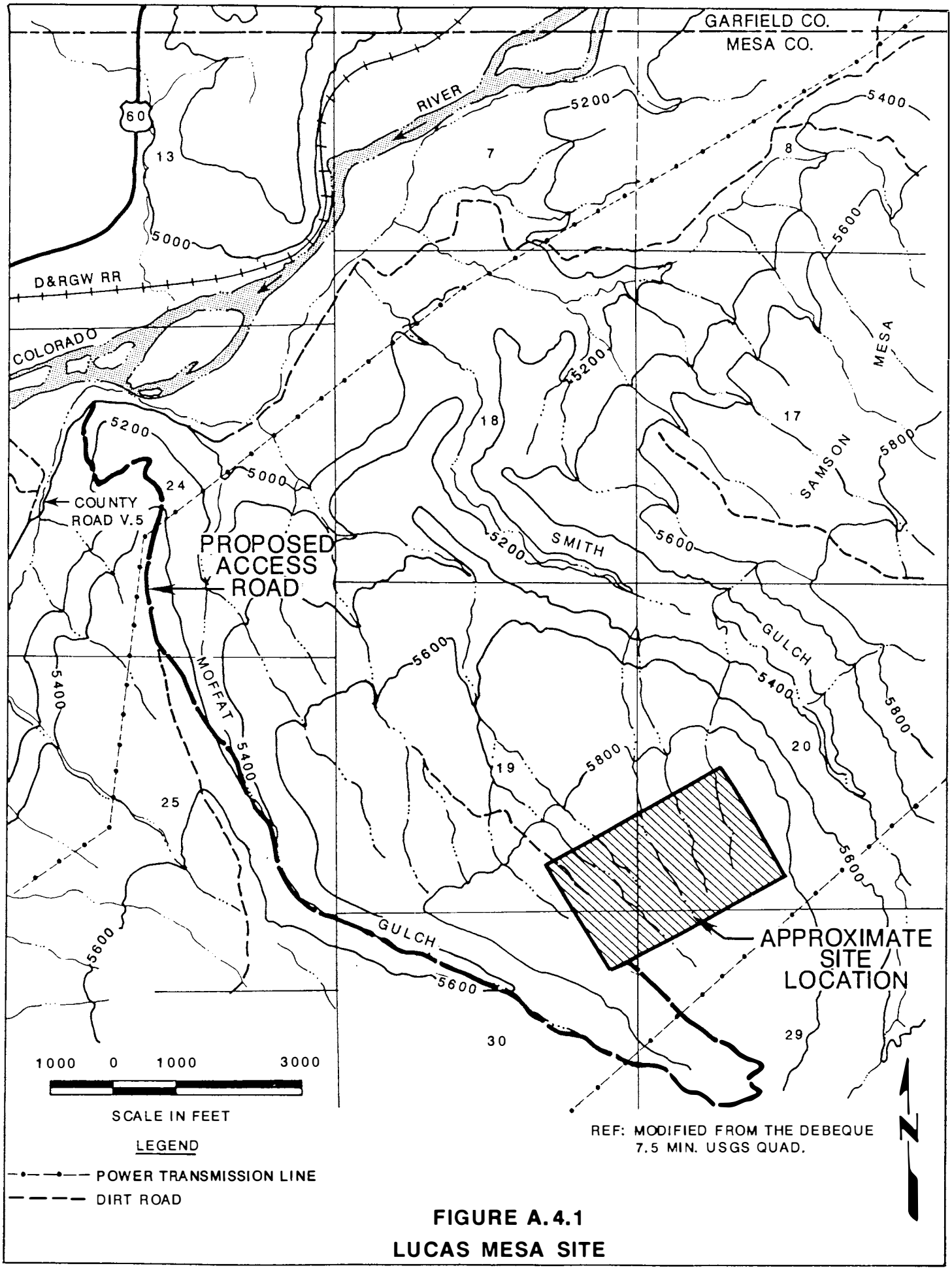


FIGURE A.4.1

LUCAS MESA SITE

- Installation and operation of wastewater treatment facilities (if necessary) to protect against the inadvertent release of contaminants from the sites during construction.

- Consolidation of the asbestos and demolition debris with the tailings and contaminated materials.

- Dewatering of the tailings and alluvium beneath the tailings at the Old Rifle site.

- Excavation and stockpiling of the tailings and contaminated materials at the sites, including demolition debris from the mill buildings and structures collected during interim action, as well as contaminated materials from the vicinity properties.

- Relocation (by truck) of all of the tailings and contaminated materials, including sediments from the wastewater retention basins and temporary drainage ditches, from the sites to the Lucas Mesa site.

- Restoration of the disturbed areas with clean fill material, grading to promote positive drainage, and revegetation. Includes revegetation of those disturbed wetlands requiring restoration.

- Release of the sites for any uses consistent with existing land use controls.

At the Lucas Mesa site

- Upgrading County Road V.5 at DeBeque and construction of a one lane, four-mile access road from County Road V.5 to the site; potential construction of a five-mile return loop from the site to County Road V.5.

- Installation of temporary security fencing.

- Construction of a wastewater retention basin(s) to protect against the release of contaminants from the sites during remedial action.

- Construction of a truck washing station.

- Construction of drainage control measures to direct all wastewater and storm water runoff to the retention basin(s) during construction.

- Implementation of measures to control erosion and sedimentation from disturbed areas during construction.

- Excavation of the partially below-grade disposal area with stockpiling of the excavated earthen materials.

- Placement of the tailings and contaminated materials, including sediments from the wastewater retention basin(s) and temporary drainage ditches at the site, in the disposal area.

- Construction of the final cover system over the tailings and contaminated materials to inhibit radon emanation, water infiltration, plant root penetration, wind and water erosion, freeze-thaw action, and penetration by burrowing animals.

- Construction of erosion protection features (a below-grade, rock apron, and rock-lined drainage diversion ditches) around the stabilized tailings pile to protect against the headward advancement of adjacent surface drainages and surface water runoff.

- Installation of concrete posts with warning signs around the stabilized tailings pile to discourage inadvertent human intrusion.

- Reclamation, including revegetation as required, of all areas disturbed at the site during remedial action.

At the Second Street borrow site

- Excavation of earthen materials for site restoration.

- Relocation of the earthen materials by truck to the Old and New Rifle sites.

At the New Rifle borrow site

- Excavation of gravel and small rock for access road construction and erosion protection.

- Relocation of the gravel and small rock by truck to the Lucas Mesa site.

At the Glenwood Springs borrow site

- Excavation of large rock for erosion protection.

- Relocation of the large rock by truck to the Lucas Mesa site.

A.4.3 PERMANENT DESIGN FEATURES

Description of final condition

The stabilized tailings pile would be sized to contain approximately 3.52 million cubic yards of tailings and contaminated materials and would cover approximately 77 acres of the disposal site (Figure A.4.2).

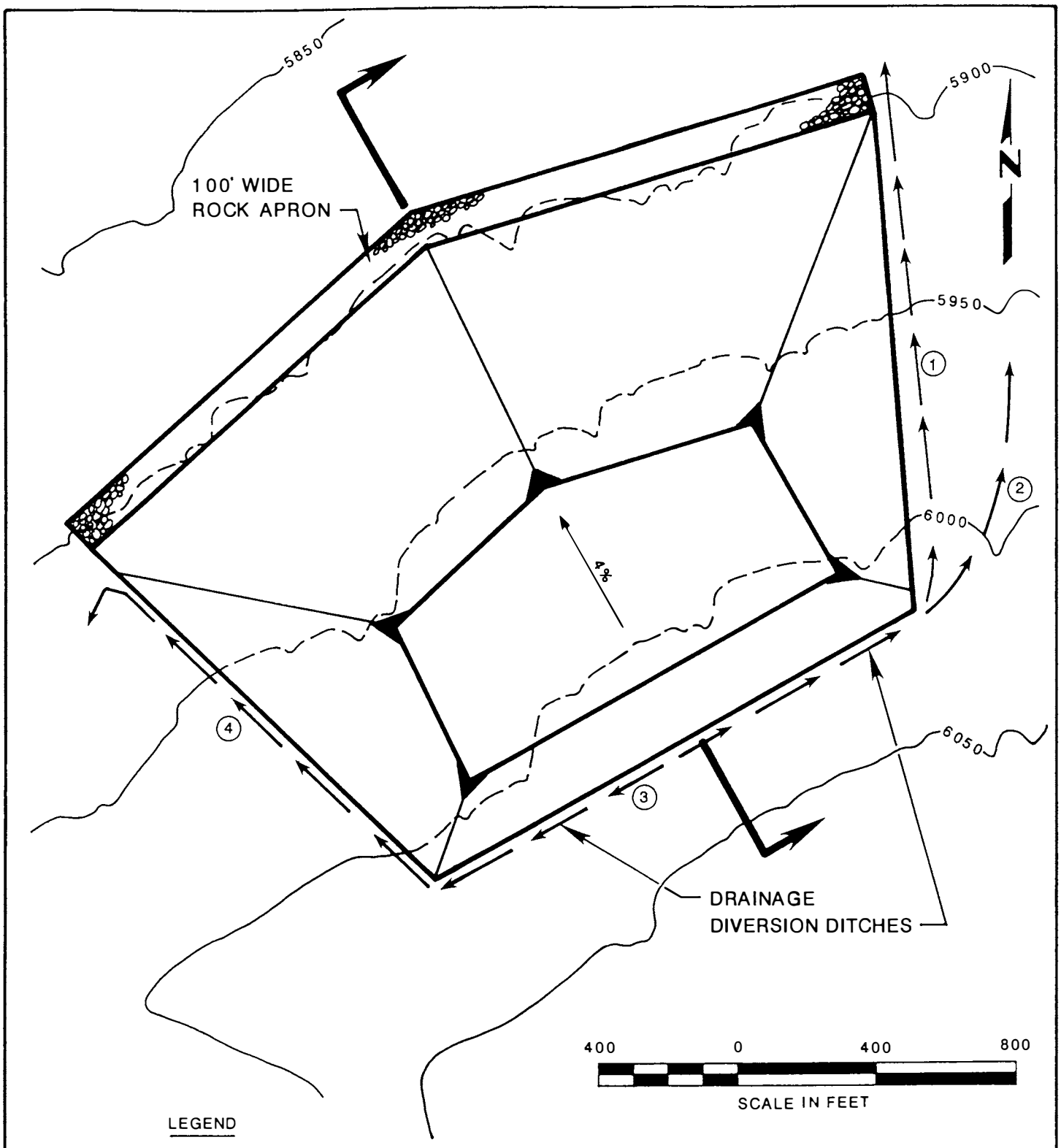


FIGURE A.4.2
FINAL CONDITIONS, LUCAS MESA SITE

The entire site would cover approximately 83 acres. The stabilized tailings pile would be constructed in portions of Sections 19, 20, 29, and 30, T8S, R96W. The stabilized pile would be approximately seven road miles east of DeBeque.

The tailings and contaminated materials would be covered with approximately four feet of compacted earth amended with 10 percent bentonite and a 4.0-foot-thick frost protection layer (Figure A.4.3). The earthen material and bentonite would be obtained from the surface materials excavated from the disposal area and from a commercial source, respectively. The stabilized tailings pile would have maximum sideslopes of 20 percent (five horizontal to one vertical) and maximum topslopes of four percent. The entire pile would be covered with a 1.5-foot-thick layer (including the filter layer) of graded rock on the topslopes and a two-foot-thick layer (including the filter layer) on the sideslopes for erosion protection. The final stabilized pile would be an average of 36 feet and a maximum of 160 feet above the surrounding terrain.

Drainage ditches adjacent to the pile would direct on-site flows around and away from the pile. The west ditch adjacent to the pile would intercept a portion of the drainage area above the site. The flow from the remaining drainage area would be intercepted by the far east ditch and would be directed into the natural drainage pattern east of the site. A below-grade rock apron would be placed at the northern toe of the pile. This apron would be designed to prevent headcutting into the stabilized pile. Monuments with warning signs would be installed at set intervals designating the disposal site as Federally owned property.

After completion of the stabilized tailings pile at the disposal site and decontamination of the former tailings sites, the disturbed areas at each site would be restored to promote positive drainage and revegetated as required.

Decontamination and restoration

The mill areas, tailings piles, and the windblown tailings at the Old and New Rifle sites and the vicinity properties would be decontaminated by excavation of the tailings and contaminated materials and consolidation of these materials into the stabilized pile at the Lucas Mesa site. Contaminated debris resulting from demolition of existing buildings and structures would be consolidated into the stabilized tailings pile. Contamination exists at the Old and New Rifle sites as described in Section A.2.2 and shown in Figures A.2.3 and A.2.4.

After removal of all contaminated materials, the areas of excavation at and around the Old and New Rifle sites would be restored with clean fill to promote positive drainage.

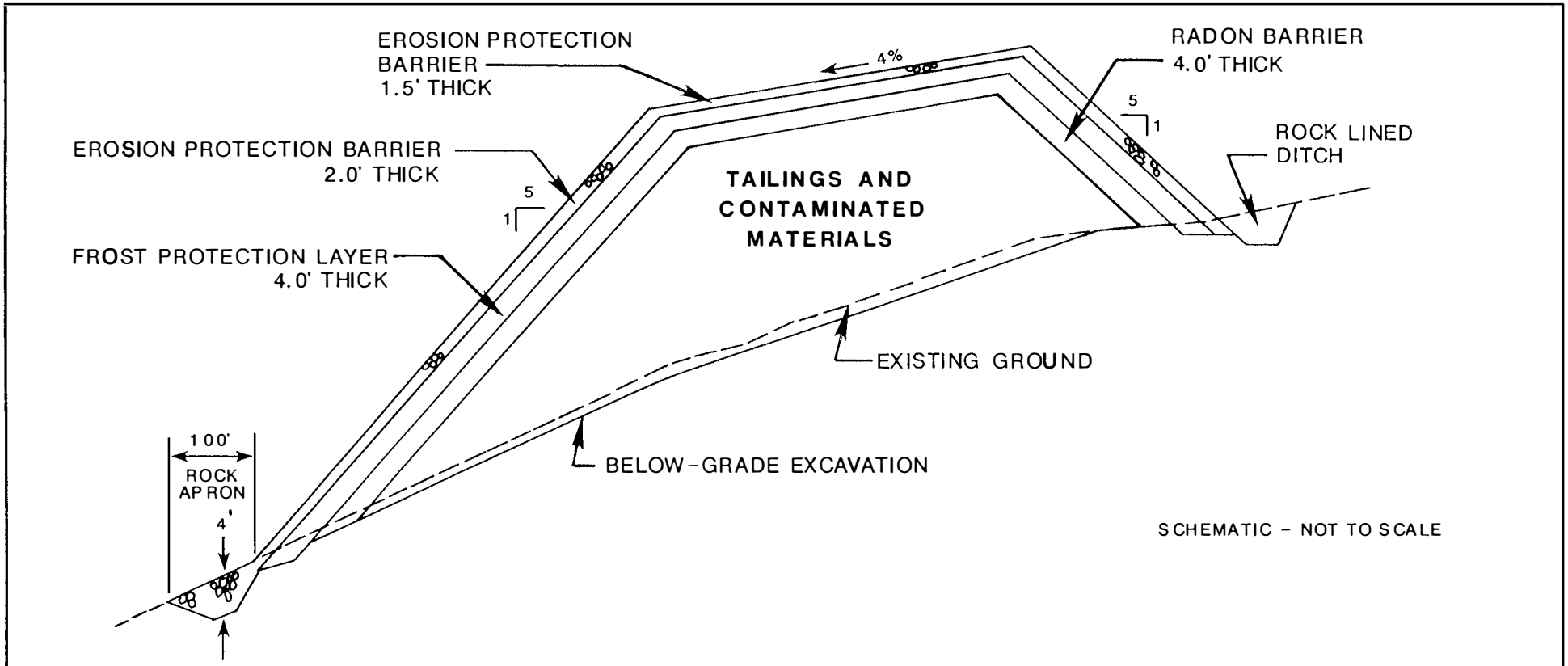


FIGURE A.4.3

TYPICAL CROSS SECTION, LUCAS MESA SITE

Tailings pile construction

This alternative would require that the tailings pile at Lucas Mesa be constructed in layers. The first layer would contain the tailings and demolition debris (demolition debris, if properly decontaminated, may be placed elsewhere than in the stabilized pile) from the New Rifle site. Once placement of this material was complete, the contaminated materials from the Old Rifle site would be transported to Lucas Mesa and placed in the pile. The last layer of contaminated materials would consist of the windblown tailings at the New Rifle site and contaminated materials from the vicinity properties. The cover system would then be placed to provide long-term stability and minimize radon emanation and groundwater contamination. The pile would be located to most effectively use the natural topography of the area in order to reduce the potential effects of erosion.

The below-grade excavation of the disposal area would extend to an average depth of 15 feet. The earthen materials for the radon barrier would be obtained from this excavation. The base of the excavation would be scarified, moisture conditioned, and recompacted.

Relocated tailings would be placed in lifts and compacted on top of the compacted base. Because the tailings would be mixed during excavation and again during unloading, spreading, and compacting at the Lucas Mesa disposal site, it is not expected that any extensive lenses of slimes would exist in the compacted tailings. Consequently, appreciable differential and total settlement would not occur, and the long-term integrity of the pile would not be adversely affected by the normal consolidation and settlement of the tailings.

Organic material such as wood demolition debris and grubbed vegetation would be evenly distributed throughout the tailings pile so that no more than five percent organics by volume are contained in any area of the pile. Demolition debris would be placed in the lower portions of the pile and surrounded with compacted tailings. The procedures for this activity would be specified to ensure that the debris is placed to avoid concentration in any area and to ensure good compaction of tailings around the debris.

Limiting the pile topslopes to four percent and the sideslopes to 20 percent would provide the necessary factor of safety against slope failure and would reduce the potential effects of erosion.

Cover construction

The tailings radon flux rate would be reduced to the EPA standards by the placement of an approximately four-foot-thick, compacted, earthen layer amended with 10 percent bentonite that would serve as a radon barrier. The radon barrier would be protected from freezing and thawing by the placement of a 4.0-foot-thick layer of earthen material. The

radon barrier and frost protection layer would be protected by a 1.5-foot-thick layer of rock (including the filter layer) on the topslopes and a two-foot-thick layer of rock (including the filter layer) on the sideslopes designed to protect the radon barrier and consequently prevent exposure of tailings and contaminated materials for 1000 years. The compaction of the radon barrier would produce an earthen cover that retains moisture and retards radon gas diffusion. The rock and filter layer would reduce the potential for drying of the compacted earthen cover by trapping soil moisture.

The rock and filter layer would be placed over the frost protection layer and would resist erosion and gully formation thereby protecting the layer from being eroded during rainstorms. The rock and filter layer would be designed to withstand the occurrence of the PMP and would also protect the pile from wind erosion and discourage plant root penetration and intrusion by burrowing animals.

Site drainage

The placement of the pile in conformance with the drainage pattern of the Lucas Mesa area and the surrounding general site grading have been designed to ensure long-term pile stability. Surface runoff from the pile as well as runoff from surrounding areas would be directed away from and around the pile by drainage diversion ditches designed to carry the rainfall runoff resulting from the one-hour PMP storm event.

Drainage diversion ditches adjacent to the pile would direct on-site flows around and away from the pile. The west ditch adjacent to the pile would intercept a portion of the drainage area above the site. The flow from the remaining drainage area would be intercepted by the far east ditch and would be directed into the natural drainage pattern east of the site. The ditches would be lined with erosion-resistant material. A below-grade, rock apron would be placed at the northern toe of the pile. This apron would be designed to prevent headcutting into the stabilized pile.

Groundwater protection

The stabilized tailings pile would be designed to minimize groundwater contamination. The preparation of the subbase, placement and sloping of the tailings, and placement of the low permeability, earthen radon barrier would serve to minimize the migration of contaminants to the groundwater system. Details are provided in Section A.4.8.

Site access

After remedial action is complete, the site would be marked with monuments with warning signs to discourage inadvertent human intrusion.

A.4.4 MAJOR CONSTRUCTION ACTIVITIES

A.4.4.1 Layout

Construction activities would take place at the Old and New Rifle tailings sites, the disposal site, and along the access road.

The exact locations and sizes of all construction features such as the staging areas, decontamination facilities, temporary drainage ditches, and wastewater retention basins would be determined during final design. The following discussion presents one possible layout and is provided to facilitate a better understanding of all aspects of the remedial action.

At the tailings sites, the staging areas would be in the former mill areas. Equipment decontamination facilities would be adjacent to the staging areas. Ditches and berms surrounding the tailings sites would direct uncontaminated flows away from the sites. Contaminated water would be directed to wastewater retention basins and treatment facilities constructed on the sites. Temporary security fencing would surround the areas at the Old and New Rifle sites.

At the Lucas Mesa site, the staging area would be south of the proposed pile location. An equipment decontamination facility would be south of the disposal area excavation. Drainage ditches would surround the site and collect all runoff on the site. Flow in these ditches would be channeled to a wastewater retention basin(s) north of the pile area. Temporary security fencing would enclose the entire site.

A.4.4.2 Site access

Equipment would be decontaminated prior to leaving the Old and New Rifle sites and the disposal area at the Lucas Mesa site. Temporary security fencing would provide control of traffic entering and leaving the site and prevent unauthorized traffic from entering controlled areas.

Traffic would enter and leave the Lucas Mesa site via an access road constructed south of the tailings pile area. A detailed description of the transportation route is presented in Section A.4.4.5.

A.4.4.3 Staging area facilities

During construction operations, temporary facilities would be required for remedial action workers as well as

supervisory, engineering, administrative, security, and radiation monitoring personnel at both the tailings sites and the disposal site. The facilities would consist of office space, showers, and change facilities for all personnel working on the sites, and would include provisions for laundering contaminated clothing. Portable toilets would be provided for on-site workers. On-site equipment would be stored in the staging areas. Parking areas would be constructed at all sites.

A.4.4.4 Utilities

All known existing utilities at the Old and New Rifle sites and the Lucas Mesa site would be protected during construction, removed, or relocated as necessary prior to construction.

Water for dust suppression on contaminated areas at both tailings sites would be recycled water from the wastewater retention basins, or drawn from the Colorado River. Water for dust suppression on uncontaminated areas and for compaction during site restoration would also be obtained from the Colorado River. Potable water, electricity, gas, and phone service at the Old and New Rifle sites would be obtained from local suppliers. Figures A.2.5 and A.2.6 show all known existing utilities at the Old and New Rifle sites, respectively.

At the Lucas Mesa site, electricity would be available from the Colorado-Ute Electrical Association, and telephone service is available from Mountain Bell. Use of these utilities would require extension of existing lines; if this were not cost-effective, electricity could be supplied by portable generators at the site and telephone service by radio telephone. All known existing utilities in the vicinity of Lucas Mesa are shown in Figure A.4.4.

There is no developed water supply at the Lucas Mesa site. The site was drilled to a depth of 205 feet, and no water was found. However, water for equipment decontamination, compaction, and dust control at the site would be hauled approximately four miles from the Colorado River. Potable water would be obtained from the nearest commercial source at DeBeque.

A livestock watering system is located within the disposal site area and will need to be relocated prior to remedial action. The system is the property of the Bureau of Land Management and consists of two water-catchment basins, underground pipes, and stock watering tanks (Figure A.4.4).

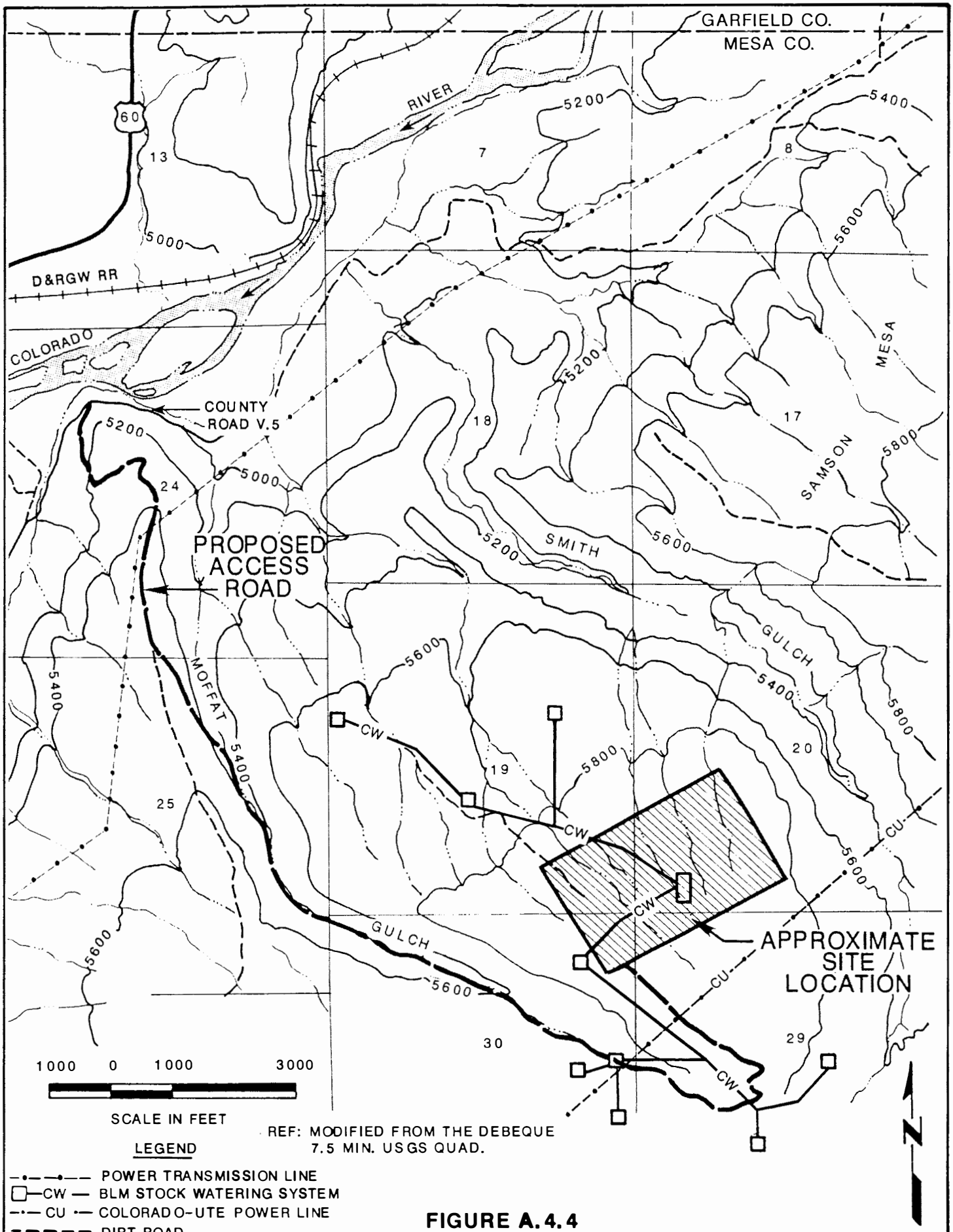


FIGURE A.4.4
EXISTING UTILITIES, LUCAS MESA SITE

A.4.4.5 Tailings transportation

Under this alternative, the tailings and contaminated materials would be transported by 18-cubic-yard-capacity trucks (10-cubic-yard-capacity trucks with eight-cubic-yard capacity pups) equipped with gate seals to prevent leakage. The trucks would be loaded at the former tailings sites, and the load would be covered with tarpaulins. Trucks would be decontaminated prior to leaving the Old and New Rifle sites and would haul the tailings and contaminated materials directly to the excavation at the Lucas Mesa site.

After leaving the Old and New Rifle tailings sites, trucks would proceed west approximately one mile and two miles, respectively, on U.S. Highway 6 and State Highway 13. The truck route would then extend south on State Highway 13 approximately one mile to Interstate 70 (I-70). The trucks would then proceed southwest on I-70 approximately 27 miles to County Road V.5 at DeBeque and then northeast approximately three miles to the newly constructed access road for four miles to the Lucas Mesa site. Trucks would use the same route to return to the tailings site.

Selection of this alternative would require the construction of an improved one-lane, four-mile long access road along the west side of Lucas Mesa. Steep terrain (10% slopes) and relative instability of the surface material limits access road construction to a one-lane gravel road, 15 feet wide. Returning truck traffic would either alternate with arriving truck traffic, or return via a five-mile return loop. The exact return route would be determined during the final design. Access road construction constraints could add an additional $400,000 to the overall project costs. Selection of a one-way, alternating access road alternative would add an additional six months to the overall construction schedule; selection of a five-mile return loop would add an additional seven months to the project schedule and an additional $100,000 to the overall project costs.

A.4.4.6 Drainage, erosion control, and wastewater retention basins

During remedial action, drainage from all sites would be effectively diverted from any waterways. Areas disturbed by construction activities would be graded to direct runoff into the wastewater retention basins. Drainage ditches would be lined with erosion-resistant materials if sediment buildup in the wastewater retention basins becomes a problem. Runoff from land outside of affected areas would be diverted away from the site by diversion ditches designed and maintained to prevent overflow.

The wastewater retention basins would be designed to meet the retention and discharge capacities described for stabilization at the New Rifle site (see Section A.2.3.5).

A.4.4.7 Wastewater treatment

Wastewater generated from sources mentioned in Section A.2.3.5 would be directed to wastewater retention basins which would provide primary settling along with flow and contaminant equalization. Some of this water would be utilized for dust control on contaminated areas. The remainder of the water at the tailings sites would be treated to meet applicable State of Colorado water quality standards before discharge.

A.4.4.8 Dewatering

Groundwater at the Old Rifle site rises into the tailings. To facilitate handling, some of the tailings would require dewatering. Dewatering would be accomplished as described for stabilization at the New Rifle site (Section A.2.3.7).

At the New Rifle site, the need for dewatering of tailings or soils during excavation is not anticipated. In most cases the shallowest recorded groundwater levels are deeper than planned excavation depths. However, if required, dewatering would be accomplished by installing either well points or drainage ditches with sump pumps as discussed in Section A.2.3.7.

Dewatering would not be necessary at the Lucas Mesa site.

A.4.4.9 Dust control

Dust generated by excavation, earth movement, vehicle use, temporary materials stockpiling, and similar activities would be controlled and minimized by the use of water and water-based surfactants sprayed from hoses or trucks. Special care would be taken to control dust created by building and structure demolition and the temporary stockpiling or mixing of contaminated materials.

The sources for dust-suppression water on contaminated areas include recycled water from the wastewater retention basins or water from the Colorado River. Uncontaminated water would be used for dust control on uncontaminated areas.

The schedules for spraying the roads and pile areas may vary daily and would be determined on an hour-by-hour basis in

accordance with applicable state permits. The frequency of spraying would increase when combinations of low soil moisture and high wind speed were encountered.

A.4.4.10 Borrow sites

Three separate borrow sites have been identified for the disposal at Lucas Mesa alternative. The first is immediately north of the New Rifle tailings site and is referred to as the Second Street borrow site (see Figure A.1.2). Earthen materials for clean backfill for restoration of the tailings sites would be purchased at this existing, commercial borrow site and trucked to the tailings sites.

The New Rifle borrow site is along the north bank of the Colorado River immediately west of the New Rifle tailings site (see Figure A.1.2). Gravel for access road construction and small rock for erosion protection and the filter layers ($D_{50} \leq$ eight inches) would be purchased at this existing, commercial borrow site and trucked to the Lucas Mesa site.

The Glenwood Springs borrow site is approximately two road miles north of Glenwood Springs and approximately 64 road miles northeast of the Lucas Mesa site (see Figure A.1.1). Large rocks for erosion protection ($D_{50} \geq$ eight inches) would be purchased at this existing, commercial borrow site and trucked to the Lucas Mesa site.

All earthen materials for the radon barrier and frost protection layer would be obtained from excavation of the partially below-grade disposal area at the Lucas Mesa site.

A.4.4.11 Restoration of the Old and New Rifle sites

Following the removal of all contaminated materials, the Old and New Rifle sites would be restored with clean fill to promote positive drainage. Earthen materials for site restoration would consist of random fill obtained from the Second Street borrow site. These materials would be transported by truck to the sites. Those disturbed wetlands areas requiring restoration would be revegetated to re-establish plant species identical or similar to those that presently exist.

A.4.4.12 Construction sequence

The following construction sequence is proposed as a possible sequence for the remedial action. As with the layout (Section A.4.4.1), the final design would contain more

detail, and the construction subcontractor would be allowed the flexibility of executing his work as he chooses, given certain constraints. Therefore, the actual construction sequence may differ from the following.

Initially, the access roads to the tailings and disposal sites would be constructed and upgraded as necessary. Then a site security system would be established at each site and coordinated with staging and vehicle decontamination areas. This would provide control of traffic entering and leaving each site and prevent unauthorized traffic from entering either site.

The next major item of site preparation would consist of constructing a wastewater retention basin(s) at each site. Materials excavated from each basin would be stockpiled for later use as fill. Site preparation would also include construction of drainage and erosion control measures.

Wastewater treatment facilities would be installed and operated at the Old and New Rifle sites to treat contaminated water and to protect against contaminant release during construction.

Once the initial site preparation at the Lucas Mesa site was completed, preparation of the disposal cell would begin. This would involve the excavation and stockpiling of surface materials to allow for the partially below-grade disposal of the tailings.

The asbestos removal and building demolition process would have already been performed during interim actions. Dewatering activities would also begin at this time. Tailings would be excavated and moved and contaminated materials (as necessary) would be excavated from the windblown areas and consolidated into the disposal area. However, the movement of tailings and contaminated materials would not begin until a sufficient area had been opened and prepared at the disposal area.

Uncontaminated earthen materials, amended with 10 percent bentonite, would be added to the relocated pile after the tailings and contaminated materials were in place. The uncontaminated earthen materials would be obtained from the surface materials excavated from the disposal area and compacted to project specifications. Drainage ditches would be excavated around the stabilized tailings pile. The final stages would involve reestablishing overall site drainage, grading, monitoring for settlement, placement of rock over the stabilized tailings, and revegetation of disturbed areas as required.

Restoration at the tailings sites would involve the placement of clean fill in the excavated areas to promote positive drainage. The clean fill would be obtained from the Second Street borrow site. Those disturbed wetlands areas requiring restoration would be revegetated with plant species identical or similar to those that presently exist.

Demobilization would consist of the removal of the remaining wastewater retention basins and temporary drainage ditches. The water would be treated and discharged while the bottom sediments and dikes would be transported to the Lucas Mesa site for disposal in the stabilized pile. All decontamination areas would be removed and the equipment cleaned for salvage. The staging areas would be dismantled with the contaminated items either cleaned or buried. All contractor equipment would be decontaminated and inspected prior to release from the contaminated areas.

Figure A.4.5 shows a construction schedule for disposal at the Lucas Mesa site.

A.4.5 RADON CONTROL

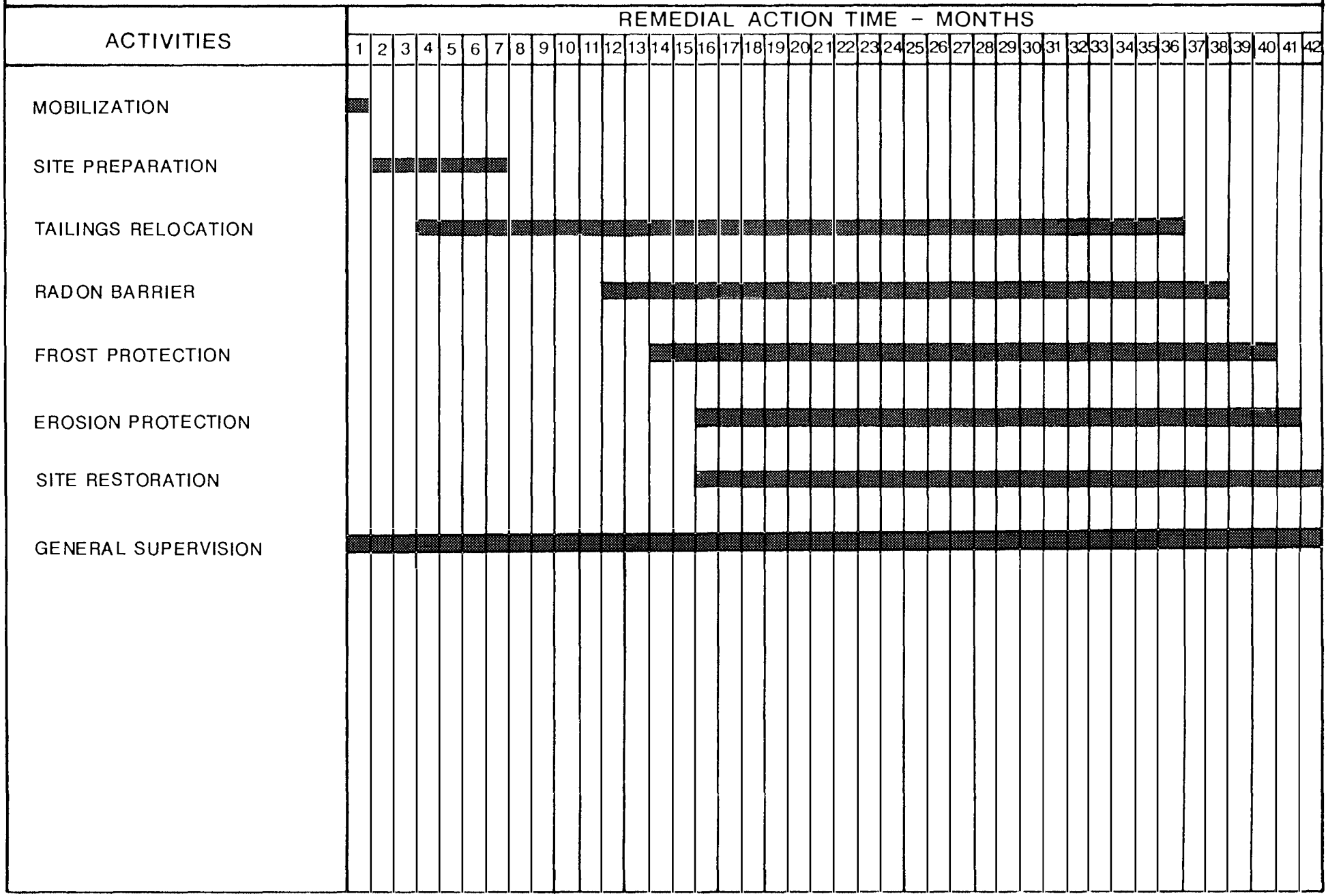
Control of radon flux from the stabilized tailings pile would be accomplished by placing a compacted, four-foot-thick radon barrier over the tailings and contaminated materials.

As with stabilization at the New Rifle site, data on the distribution of radium-226 in the tailings, on the properties of the surficial materials at the site, and on the estimated depth of the windblown tailings pile were analyzed and used in the computer code RAECOM in order to develop an estimate of radon barrier thickness. Using this thickness, radon flux after remedial action would be less than the EPA standard of 20 pCi/m^2s. The erosion protection barrier and the frost protection layer were not considered in the calculations and would provide some additional reduction in radon flux. The data and analyses are available in the DOE UMTRA Project Office, Albuquerque, New Mexico. The actual thickness of the radon barrier could vary depending on additional analyses to be performed during final design and remedial action.

A.4.6 DESIGN CONSIDERATIONS

The Lucas Mesa site is located in a remote, moderately flat area. There are no perennially flowing waters or shallow groundwater levels in the site area. Therefore, many of the design concerns associated with stabilization at the New Rifle site are not relevant for this alternative. Since tailings and contaminated materials would be relocated from a metropolitan area, the issues associated with tailings transportation are a major concern. Also, the location and configuration of the pile were evaluated in order to minimize the quantity and size of rock

FIGURE A.4.5 REMEDIAL ACTION SCHEDULE, DISPOSAL AT THE LUCAS MESA SITE



erosion protection required and to take advantage of the shallow gradients in the site area.

The proposed layout was determined by considering the geomorphology of the site. The pile was set near the top of the drainage area in order to minimize the drainage area impacting the site. The pile was also set back to minimize the impacts of gully erosion on the site. The pile would be designed to prohibit headcutting into the pile for the design life of at least 1000 years.

The sideslopes of the pile would be limited to five horizontal to one vertical (20 percent), and the top of the pile would be gently sloped (four percent maximum). By placing the tailings near the top of the drainage divide, the size of rock required for the drainage diversion ditches is minimized.

A.4.7 LONG-TERM STABILITY

Water erosion

Severe rainfall events have the potential to develop rills and gullies on the steeper (20 percent) sideslopes of the stabilized tailings pile and erode some or all of the radon barrier in small, undefinable areas. For the Lucas Mesa site, the local one-hour PMP storm was calculated to be 7.6 inches. Based on this one-hour intensity, a maximum 2.5-minute intensity was calculated based on the time of concentration for flow off the pile. The intensity was then converted to an equivalent one-hour rainfall intensity of 50.2 inches per hour. This PMP would generate sheet flow rates ranging from 0.7 to 1.3 cfs/ft on the pile. Rock sizes required to withstand sheet erosion on the pile top and toeslope during a PMP event are shown in Table A.4.1.

Table A.4.1 Rock erosion protection, Lucas Mesa site

Location	Rock size[a] (inches)	Thickness of rock[b] (inches)	Design flow (cfs/ft)
Topslopes	$D_{50} \geq 2.0$	18	0.7
Sideslopes	$D_{50} \geq 7.0$	24	1.3
Rock apron	$D_{50} \geq 7.0$	48	--

[a]"D" corresponds to required rock diameter; D_{50} is the diameter of 50 percent of the rock by weight.
[b]Thicknesses of rock include filter layers except for the rock apron where a filter layer would not be necessary.

To further reduce the potential for water erosion by surface runoff, additional control features were incorporated into the design to reduce surface runoff velocities. The toeslope of the stabilized tailings pile would be limited to five horizontal to one vertical (20 percent). The top of the pile would be gently sloped (a maximum of four percent) to promote drainage.

It is anticipated that a filter layer would be required on the pile top and sideslopes. The gradations of the filter layer would be determined during final design using the criteria described for stabilization at the New Rifle site.

Wind erosion

High wind velocities could damage the radon barrier of the stabilized tailings pile if the barrier were left exposed. The same rock and filter layers used to protect the pile from water erosion would provide sufficient protection from the effects of potentially erosive wind velocities.

Frost protection

Freeze-thaw cycles occurring throughout the year can cause cracking within the radon barrier. These cracks significantly increase the hydraulic conductivity of the radon barrier. Without a frost protection layer to protect from the freeze/thaw-related cracking, water in contact with the surface of the pile would percolate through the pile and exit through its base. This contaminated water would then build up beneath the pile and/or come to the surface in Lucas Mesa.

The susceptibility of the radon barrier to freeze-thaw effects has been studied. A freeze-thaw protection layer, consisting of 3.5 feet of loosely compacted soils excavated from the Lucas Mesa disposal site, and 0.5 foot of drainage material would be installed above the radon barrier to protect it against freeze-thaw effects. This frost protection layer would thereby ensure the integrity of the radon barrier.

Flood protection

The stabilized tailings pile would be surrounded by drainage diversion ditches designed to protect the pile from the discharge resulting from the occurrence of a PMP on the upstream watershed. Drainage diversion ditches adjacent to the pile would direct on-site flows around and away from the pile. The ditches would have trapezoidal cross sections with five to one (horizontal to vertical) sideslopes. A below-grade, rock apron would be placed at the northern toe of the pile. This apron would be designed to prevent headcutting into the stabilized pile. Table A.4.2 summarizes the rock sizes required for the drainage diversion ditches, and the rock size required for the rock apron is provided in Table A.4.1.

Table A.4.2 Drainage diversion ditches, Lucas Mesa site

Drainage diversion ditch[a]	Slope (feet per foot)	Drainage area (acres)	Rock size (inches)[b]	Design flow (cfs)
Ditch 1	0.09	15	$D_{50} \geq 28$	753
Ditch 2	0.02	40	$D_{50} \geq 11$	982
Ditch 3	0.02	40	$D_{50} \geq 11$	982
Ditch 4	0.08	55	$D_{50} \geq 32$	1205

[a]The locations of the drainage diversion ditches are shown on Figure A.4.2. All ditches would have trapezoidal cross-sections with five to one (horizontal to vertical) sideslopes. The bottoms of all the ditches would have a width of 20 feet.

[b]"D" corresponds to required rock diameter; D_{50} is the diameter of 50 percent of the rock by weight.

The Lucas Mesa site is at a head of a drainage divide and has virtually no drainage area above it. Drainage on the Lucas Mesa site flows into Smith Gulch to the east, Moffat Gulch to the west, and into the Bluestone Valley irrigation ditch 0.5 to two miles below the site. Smith Gulch is approximately 0.5 mile and 600 feet below the site, and Moffat Gulch is approximately 0.5 mile and 300 feet below the site. The creeks in both gulches join the Colorado River one to two miles below the site. The Colorado River, at its closest point, is approximately two miles away and 900 feet below the site. No data on historical floods exist for the Lucas Mesa site; because of the site's distance from and elevation above any major flows, the site would not be subject to river flooding.

Additional details on surface water hydrology at the Lucas Mesa site are provided in Sections E.1.1 and E.1.3 of Appendix E, Hydrology.

Geomorphology

The steeper sideslopes of Lucas Mesa are naturally armored with basalt boulders and cobbles and are resistant to erosion. Some headward migration of drainage systems into the surface of the mesa from the steeper bordering slopes is occurring, but, because of the cobbles and boulders, it is not strongly developed and does not result in significant drainage areas. The dominant erosion pattern occurs by sheet wash and wind as evidenced by bare soil areas at the site. The pile would be placed near the head of the drainage divide to minimize upland drainages, and a below-grade, rock apron would be placed at the northern toe of the pile to prevent headcutting into the stabilized pile.

A more extensive geomorphic evaluation of the Lucas Mesa site is included in Section D.3 of Appendix D, Soils, Geology, and Seismicity.

Slope stability/seismic risk

Slope failure due to slope instability under static and seismic loading could affect the integrity of the stabilized tailings pile.

Stability analyses were performed for each loading condition to estimate factors of safety against slope failure. In particular, the seismic loading conditions were evaluated by applying the on-site horizontal acceleration resulting from a design earthquake. The evaluation estimated that the design earthquake would generate an on-site effective peak horizontal bedrock acceleration of 0.21g. Details on the seismic analysis are included in Section D.4 of Appendix D, Soils, Geology, and Seismicity.

The factors of safety against slope failure under both static and seismic loading for the designed slopes meet or exceed the generally accepted limits of 1.5 and 1.1, respectively. The static and seismic safety factors calculated for disposal at the Lucas Mesa site are 3.1 and 1.8, respectively.

At the Lucas Mesa site, the tailings would be placed as a dense, engineered fill. The foundation soils are hard and dry, and groundwater is deep into the underlying bedrock. For these reasons, and because the pile will be covered with a low permeability layer, there would be no potential for seismically-induced liquefaction at the site.

Settlement and cover cracking

As previously discussed in Section A.4.3 under "Tailings pile construction," differential and total settlement should not adversely affect the long-term integrity of the pile.

Frost heave/solifluction

The processes of frost heave and solifluction, which are discussed in detail in Section A.2.6, could pose a hazard to the long-term performance of any structure constructed to isolate the tailings. However, as with stabilization at the New Rifle site, the remedial action design includes the use of a 4.0-foot-thick frost protection layer composed of a 3.5-foot-thick layer of loosely compacted earthen materials excavated from the Lucas Mesa site. This is underlain by a 0.5-foot-thick layer of drainage materials. The frost protection layer is placed over the radon barrier's sufficiently impermeable earthen materials to restrict ice lens formation. The underlying 0.5-foot-thick drain and overlying porous aggregate layers, in conjunction with a continuous slope, would allow drainage across the pile surface. This system would provide an insulating blanket effect as well as restrict water buildup over the radon barrier. It eliminates the potential for frost heave (ice lens formation) and the prerequisite for solifluction (saturation).

Plant root penetration, burrowing animals, and human intrusion

The tailings pile at the Lucas Mesa site would be covered with a 4.0-foot-thick layer of compacted, low permeability, earthen material and a 4.0-foot-thick frost protection layer. This layer would then be covered with a 1.5-foot-thick layer (including the filter layer) of rock erosion protection on the topslopes and a 2.0-foot-thick layer (including the filter layer) of rock erosion protection on the sideslopes.

These layers of rock and compacted earth would inhibit plant root penetration into the contaminated materials. The rock layer would also discourage intrusion by burrowing animals and inadvertent human intrusion. The final tailings pile would also be surrounded by monuments with warning signs to discourage human intrusion.

A.4.8 GROUNDWATER PROTECTION

Groundwater at the Lucas Mesa site lies at depths in excess of 200 feet. The soils at the Lucas Mesa site are composed of an unknown thickness of unconsolidated debris-flow deposits underlain by bedrock, consisting of the Wasatch Formation. Groundwater resources at the site have not been developed. The only wells within a two-mile radius of the site are completed in the alluvium of the Colorado River floodplain.

Several features of the design for this alternative would serve to minimize the potential for contaminant migration from the tailings to the groundwater. These features include preparation of the base of the disposal site, placement and sloping of the tailings, and placement of the compacted, low permeability, earthen radon barrier amended with 10 percent bentonite on the pile, a frost protection layer, and an erosion protection layer.

The cell components would function as an integrated system to limit vertical seepage through the tailings. The radon barrier would restrict steady state vertical seepage through the tailings to 10^{-8}cm/s. The lower filter layer would eliminate the potential for standing water to remain in the radon barrier. The frost protection layer and the erosion protection layer would prevent future degradation of the radon barrier by frost heave or erosion.

The steady state seepage flux of 10^{-8} cm/s is probably within the drainage capacity of the underlying Wasatch Formation bedrock, preventing tailings seepage from perching along low hydraulic conductivity strata of the bedrock. No groundwater mounding in the underlying materials would occur into the disposal cell, because the depth to groundwater is greater than 200 feet. The seepage from the disposal cell would not cause concentration limits of these hazardous constituents to be exceeded at the POC. The cell would comply with the proposed EPA groundwater protection standards because the average linear

groundwater velocity in the Wasatch Formation is extremely low. Contaminated groundwater should travel less than 100 feet in 1000 years, which is the design-life of the disposal cell. This is approximately the distance from the perimeter of the tailings to the downgradient edge of the riprap (the POC).

At the Old and New Rifle processing sites, natural flushing would reduce concentrations of conservative contaminant species to background concentrations in the alluvium within 10 years after the tailings have been removed at the Old Rifle site, and within 50 years at the New Rifle site. However, natural flushing of nonconservative (geochemically reactive) species would require considerably more time, and aquifer restoration could be necessary. Natural flushing in the underlying Wasatch Formation would be negligible due to the low hydraulic conductivity of the formation. If it can be demonstrated that natural flushing will reduce concentrations of hazardous constituents in groundwater to background or MCLs within 100 years (as required by Subpart B of 40 CFR 192), then natural flushing with institutional controls will be used to comply with the groundwater standards. However, if natural flushing is not sufficient to reduce concentrations to MCLs or background, then active aquifer restoration, aquifer restoration in combination with natural flushing, or ACLs would be required.

Under the UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

A.5 CONSTRUCTION ESTIMATES

Estimates of equipment and personnel requirements; fuel, energy, and water consumption; major earthwork volumes; and construction costs for each remedial action alternative are summarized in Tables A.5.1 through A.5.13.

Table A.5.1 Equipment requirements, interim actions at the Old and New Rifle site

Type of equipment	Pieces of equipment per month of interim action												Total equipment-months by type
	1	2	3	4	5	6	7	8	9	10	11	12	
Backhoe	1	1	1	1	1	1	1	1	1	1	1	1	12
Bulldozer	1	1	2	2	2	2	2	2	2	2	2	1	21
Front-end loader (5-cubic yard)	1	1	2	2	2	2	2	2	2	2	2	1	21
Crane	1	2	3	3	3	3	3	3	3	3	3	2	35
Truck (18-cubic yard)	2	2	4	4	4	4	4	4	4	4	4	2	42
Water truck	1	1	1	1	1	1	1	1	1	1	1	1	12
Total pieces of equipment per month of interim action	7	8	13	13	13	13	13	13	13	13	13	8	143

Table A.5.2 Personnel requirements, interim actions at the Old and New Rifle sites[a]

Type of personnel	Number of personnel per month of interim action												Total man-months per type of personnel
	1	2	3	4	5	6	7	8	9	10	11	12	
Truck drivers	3	3	5	5	5	5	5	5	5	5	5	3	54
Equipment operators	4	5	8	8	8	8	8	8	8	8	8	5	86
Operator supervision	1	1	1	1	1	1	1	1	4	1	1	1	15
Field services and general supervision	17	17	17	17	17	17	17	17	17	17	17	17	204
Other	5	5	8	9	9	9	9	9	35	9	9	5	121
Total man-months per month of interim action	30	31	39	40	40	40	40	40	69	40	40	31	480

[a]Peak employment = 69 persons; average employment = 40 persons per month.

Table A.5.3 Equipment requirements, stabilization at the New Rifle site

Type of equipment	Pieces of equipment per month of remedial action																				Total equipment-months by type
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Compactor	0	0	0	0	1	1	1	1	1	1	1	2	2	3	3	3	2	2	1	1	26
Bulldozer	0	2	2	2	5	5	5	5	5	5	5	7	7	10	18	18	16	16	14	5	152
Front-end loader (5-cubic yard)	0	0	0	0	4	4	4	4	4	4	4	9	9	12	26	26	23	23	21	7	184
Grader	0	0	0	0	0	0	0	0	0	0	0	2	2	2	3	3	3	3	3	2	23
Scraper	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	24
Truck (18-cubic yard)	0	0	0	0	23	23	23	23	23	23	23	40	40	46	91	91	75	75	70	24	713
Water truck	0	0	0	0	1	1	1	1	1	1	1	2	2	3	3	3	2	2	1	1	26
Total pieces of equipment per month of remedial action	0	2	2	2	36	36	36	36	36	36	36	64	64	78	146	146	121	121	110	40	1148

Table A.5.4 Personnel requirements, stabilization at the New Rifle site[a]

Type of equipment	Pieces of equipment per month of remedial action																				Total equipment-months by type
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Truck drivers	0	0	0	0	28	28	28	28	28	28	28	50	50	61	106	106	85	85	75	29	739
Equipment operators	0	2	2	2	12	12	12	12	12	12	12	22	22	29	52	52	44	44	39	15	409 (403)
Operator supervision	0	1	1	1	3	3	3	3	3	3	3	6	6	7	14	14	12	12	11	4	110
Field services and general supervision	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	340
Other	1	6	6	6	11	11	11	11	11	11	11	17	17	19	33	33	28	28	26	12	309
Total man-months per month of remedial action	18	26	26	26	67	67	67	67	67	67	67	104	104	121	210	210	178	178	164	73	1,907

[a]Peak employment = 210 persons; average employment = 95 persons per month.

A.5.5 Equipment requirements, disposal at the Estes Gulch site

Type of equipment	Pieces of equipment per month of remedial action																																								Total equipment-months by type
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
Compactor	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	61
Bulldozer	0	5	5	8	8	8	8	5	5	5	5	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	4	4	4	4	4	4	4	4	4	4	242
Front-end loader (5-cubic yard)	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	3	3	3	3	3	3	3	3	3	3	3	233
Grader	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
Scraper	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	33
Truck (18-cubic yard)	0	4	4	65	65	65	65	65	65	65	65	65	65	66	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	8	8	8	8	8	8	8	8	8	5	5	1981
Water truck	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	60
Total pieces of equipment per month of remedial action	0	12	12	82	82	82	82	78	78	78	78	82	83	84	91	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	19	19	19	19	19	19	19	18	18	16	16	2,641

Table A.5.6 Personnel requirements, disposal at the Estes Gulch site[a]

Type of personnel	Number of personnel per month of remedial action																																									Total man-months per type of personnel
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
Truck drivers	0	66	66	66	66	66	66	66	66	66	66	66	67	68	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	9	9	9	9	9	9	9	9	9	7	7	2041
Equipment operators	0	7	7	16	16	16	16	12	12	12	12	16	16	16	16	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	10	10	10	10	10	10	10	9	9	9	9	600
Operator supervision	0	1	1	8	8	8	8	7	7	7	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	1	1	1	1	1	1	1	1	1	1	1	233
Field services and general supervision	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	798
Other	0	6	6	20	20	20	20	19	19	19	19	20	20	21	21	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	8	8	8	8	8	8	8	7	7	7	7	686
Total man-months per month of remedial action	19	38	38	129	129	129	129	123	123	123	123	129	130	132	135	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	47	47	47	47	47	47	47	45	45	43	43	4358

[a]Peak employment = 139 persons; average employment = 104 persons per month.

A.5.7 Equipment requirements, disposal at the Lucas Mesa site

Type of equipment	Pieces of equipment per month of remedial action																																										Total equipment-months by type
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
Compactor	0	1	1	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	65
Bulldozer	0	5	5	8	8	8	8	5	5	5	5	6	6	6	6	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	4	4	4	4	4	4	4	4	4	4	4	242
Front-end loader (5-cubic yard)	0	0	0	6	6	6	6	6	6	6	6	6	6	6	7	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	4	4	4	4	4	4	4	4	4	3	3	243
Grader	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
Scraper	0	1	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	33
Truck (18-cubic yard)	0	4	4	81	81	81	81	81	81	81	81	81	81	81	83	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	9	9	9	9	9	9	9	9	9	6	6	2451
Water truck	0	1	1	2	2	2	2	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	65
Total pieces of equipment per month of remedial action	0	12	12	100	100	100	100	94	94	94	94	99	99	99	102	107	107	107	107	107	107	107	107	107	107	107	107	107	107	107	107	21	21	21	21	21	21	21	20	20	16	16	3130

Table A.5.8 Personnel requirements, disposal at the Lucas Mesa site[a]

Type of personnel	Number of personnel per month of remedial action																																									Total man-months per type of personnel
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	
Truck drivers	0	5	5	88	88	88	88	82	82	82	82	83	83	83	83	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	88	10	10	10	10	10	10	10	10	10	7	7	2,534
Equipment operators	0	7	7	17	17	17	17	12	12	12	12	16	16	16	17	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	11	11	11	11	11	11	11	10	10	10	10	616
Operator supervision	0	1	1	10	10	10	10	9	9	9	9	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	2	2	2	2	2	2	2	2	2	1	1	298
Field services and general supervision	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	798
Other	0	6	6	24	24	24	24	23	23	23	23	24	24	24	20	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	8	8	8	8	8	8	8	8	8	7	7	778
Total man-months per month of remedial action	19	38	38	153	153	153	153	145	145	145	145	152	152	152	151	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	50	50	50	50	50	50	50	49	49	44	44	5,024

[a]Peak employment = 161 persons; average employment = 120 persons per month.

Table A.5.9 Fuel consumption

Type of equipment	Gallons			
	No action (Interim actions at Old and New Rifle site)	Stabilization at the New Rifle site	Disposal at the Estes Gulch site	Disposal at the Lucas Mesa site
Demolition equipment (such as wrecking ball, backhoe, or cranes)	68,000			
Compactor	-	51,000	181,000	193,000
Bulldozer	28,000	236,000	373,000	373,000
Front-end loader (5-cubic-yard)	-	205,000	370,000	390,000
Grader	-	20,000	40,000	39,000
Scraper	-	43,000	91,000	91,000
Truck (10-cubic-yard truck with 8-cubic-yard pup)	55,000	870,000	3,940,000	4,936,000
Water truck	-	14,000	50,000	55,000
Totals	198,000	1,439,000	5,045,000	6,077,000

Table A.5.10 Energy consumption

Facility	Kilowatt-hours			
	No action (Interim actions at Old and New Rifle site)	Stabilization at the New Rifle site	Disposal at the Estes Gulch site	Disposal at the Lucas Mesa site
Field office	18,000	29,000	126,000	126,000
Change/shower trailer(s)	80,000	134,000	577,000	577,000
Laundry	40,000	67,000	289,000	289,00
Dewatering and waste-water treatment facility	7,000	11,000	49,000	49,000
Totals	145,000	241,000	1,041,000	1,041,000

Table A.5.11 Water consumption

Activity	Gallons			
	No action (Interim actions at Old and New Rifle site)	Stabilization at the New Rifle site	Disposal at the Estes Gulch site	Disposal at the Lucas Mesa site
Interim/ Remedial Actions				
o Site preparation and dust control	750,000	80,196,000	212,226,000	258,915,000
o Tailings consolidation	-	17,897,400	16,318,234	16,318,000
o Cover (radon barrier and frost protection layer)	-	7,556,680	21,716,000	27,794,000
o Restoration	--	14,317,920	19,016,000	19,016,000
Subtotal	750,000	119,968,000	269,276,000	322,043,000
Potable water	427,000	1,630,000	4,238,000	5,085,000
Equipment washing	64,000	5,868,000	10,758,000	10,758,000
Total	1,241,000	127,466,000	284,262,000	337,886,000

Table A.5.12 Major earthwork volumes

Activity	Estimated in-place volumes (cubic yards)			
	No action (Interim actions at Old and New Rifle site)	Stabilization at the New Rifle site	Disposal at the Estes Gulch site	Disposal at the Lucas Mesa site
Site preparation				
o Site access roads				
1. Fill	34,270		24,000	70,000
2. Gravel	16,049		6,000	24,000
Tailings pile				
o Excavate, haul, spread, and compact	-	4,135,000	4,135,000	4,135,000
Radon barrier				
o Excavate, haul, spread, and compact	-	190,000	336,000	497,000
Frost protection layer				
o Excavate and spread	-	237,500	384,000	384,000
Erosion protection				
o New Rifle borrow site	-	163,000	113,900	318,000
o Glenwood Springs borrow site		216,000	36,400	32,000
Site restoration				
o Backfill at New Rifle site	-	435,000	795,400	795,400
o Backfill at Old Rifle site	-	459,000	459,000	459,000

Table A.5.13 Construction costs[a]

Activity	1986 dollars			
	No action (interim actions at Old and New Rifle site)	Stabilization at the New Rifle site	Disposal at the Estes Gulch site	Disposal at the Lucas Mesa site
Site preparation	915,000	1,600,000	2,068,000	2,964,000
Demolition	4,400,000	-	-	-
Decontamination	203,000	182,000	289,000	1,800,000
Tailings excavation and/or relocation	-	2,977,000	19,108,000	49,458,000
Radon barrier	-	824,000	1,077,000	1,282,000
Frost protection	-	1,030,000	1,228,000	1,282,000
Erosion protection	-	5,155,000	2,766,000	3,588,000
Site restoration	100,000	3,217,000	2,070,000	2,049,000
Fencing	92,000	475,000	315,000	312,000
Total	5,710,000	15,460,000	28,921,000	62,735,000

[a]These estimated costs do not include the costs of:

- Property acquisition.
- Engineering design.
- Overall project management including construction management and supervisory and field services.
- Remedial action at vicinity properties.
- Long-term surveillance and maintenance.
- Interim actions at the Old and New Rifle sites ($5,710,000).
- Access road improvements, including an estimated additional $486,000 to improve Highway 13 for the Estes Gulch alternative, or $400,000 to $500,000 to improve County Road V.5 for the Lucas Mesa alternative.

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APPENDIX B

ALTERNATIVES ANALYSES

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B.1 INTRODUCTION

This appendix describes the detailed process by which the U.S. Department of Energy (DOE) and the state of Colorado selected the alternate disposal sites for the Rifle uranium mill tailings. This process involved the general public, the state of Colorado, the DOE, and other Federal agencies. The process included technical criteria and rankings to determine the suitability of the sites and resulted in the Lucas Mesa and Estes Gulch sites being selected for inclusion in the draft environmental impact statement (EIS). This appendix also describes other remedial action alternatives that were considered but not in detail (e.g., reprocessing of the tailings prior to disposal and the use of train transportation).

B.2 STATE OF COLORADO ALTERNATE DISPOSAL SITE NOMINATION PROCESS

The following description of Colorado's alternate disposal site nomination process was obtained from the report entitled Potential Sites Suitable for Reclamation and/or Reprocessing of the Grand Junction and Rifle Uranium Mill Tailings Piles, issued in 1982 (CGS, 1982).

The state of Colorado established general placement objectives, conducted a regional survey to identify potential disposal sites, and evaluated the potential sites to select the better sites for nomination to the DOE for inclusion in the EIS.

To ensure the safe, long-term containment of uranium tailings material, a number of general placement objectives were established by Colorado Geological Survey (CGS) for tailings disposal in Colorado. These placement objectives were as follows:

- Tailings or waste disposal areas should be located at a relatively remote site so as to reduce potential population exposures and the likelihood of human intrusion to the maximum extent reasonably achievable.

- Tailings or waste disposal areas should be located at a site where disruption and dispersion by natural forces are eliminated or reduced to the maximum extent reasonably achievable.

- Tailings and waste should be placed below grade, in trenches or pits excavated into relatively impervious shale.

- Tailings and waste should be covered with a minimum of three meters of earthen materials that are designed to reduce surface exhalation of radon from the tailings or waste to less than two picocuries per square meter per second above background levels, to reduce root and animal penetration and salt migration, and are constructed to minimize erosion.

- Reclamation of the tailings or waste areas should include a full, self-sustaining vegetative cover or riprap to minimize wind and water erosion. The final contour slopes should be as close as possible to the natural surface, but not steeper than a ratio of five horizontal to one vertical.

- Seepage of toxic materials to the ground or surface water should be minimized to the maximum extent reasonably achievable so that groundwater and other natural systems will not be degraded. Seepage control measures should include consideration of both physical and geochemical methods.

- Tailings and waste should not adversely affect important mineral resources or unique historic, archaeologic, wildlife, or ecologic areas.

- Tailings or waste should be confined to a single area to preclude the proliferation of numerous, small disposal areas.

- The final disposition of the tailings and waste should be such that ongoing active maintenance is not necessary to preserve isolation and that monitoring will be minimized to the maximum extent reasonably achievable.

Sites were selected on the basis of these placement objectives through a two-phase selection process. Phase I of this process consisted of a series of elimination or filtering steps in which "potential sites" were delineated within a specific area around the tailings sites. The specific areas evaluated were the 15-mile radius around each tailings pile, and the 20-mile-wide corridor along the railroad from the Utah-Colorado state line to Glenwood Springs and from Grand Junction south to the Mesa-Delta county line. Phase II involved review and evaluation of these potential sites to select three to five candidate sites for further detailed study by the DOE.

B.2.1 PHASE I

The first step in Phase I was to determine the geologic formations (i.e., suitable formations) that possessed acceptable permeability, thickness, and lateral lithologic continuity. The formations were to have beds of low or very low permeability that were at least 150 feet thick and were laterally persistent for many square miles. Formations that met these criteria in part were identified as "possibly suitable formations."

In the specific area only one formation, the Mancos Shale, met the criteria for suitable formations. The Mancos Shale, a thick, laterally persistent, Cretaceous marine shale, is generally acceptable as a host formation for a tailings repository. The uppermost part of the formation, however, complexly interfingers with several sandstone beds. Similarly, the lower part of the Mancos contains limy beds and transitional silty and sandy zones. No sites were selected in either of these parts of the Mancos Shale.

One formation in the specific area, the Wasatch Formation, was classified as a possibly suitable formation. The Wasatch Formation consists of continental deposits of claystone with occasional sandstone and limestone beds. The middle part of the Wasatch Formation in the vicinity of DeBeque is particularly sandy; no sites were selected in this part.

The Green River Formation was initially considered as a possibly suitable formation because it contains thick sequences of shale, much of which is oil-rich. Additional evaluation, however, found that a site within the Green River Formation could inhibit future oil shale mining and the formation crops out only in steep cliff areas. Thus, the formation was not considered further.

The second step of Phase I consisted of delineating areas of favorable slope that were underlain by suitable formations or, where necessary, by possibly suitable formations. The most favorable slopes range from two to five percent, but slopes of five to 10 percent or less than two percent were also considered acceptable. Areas that were

underlain by suitable formations or potentially suitable formations and that had acceptable slopes and size were considered to be "target areas." A target area may contain more than one potential site.

Thirty target areas were selected, and, of these, 10 areas were considered as containing potential disposal sites. These areas were identified as Lucas Mesa, Monument Gulch, Parachute, North Rifle, Flatiron Mesa, Mamm-Divide Creek, Cactus Valley, Grass Valley, New Castle, and Garfield Creek.

The third step of Phase I evaluated the 10 target areas and selected potential sites by excluding areas that met the following criteria:

- o Areas of insufficient size.
- o Areas subject to extensive river flooding.
- o Areas of critical groundwater resources or recharge.
- o Areas of complex geologic structure (e.g., abundant faulting, folding, jointing).
- o Areas susceptible to geologic hazards that could disrupt the repository (e.g., active faulting, subsidence, unstable slopes).
- o Areas with severe erosion potential or unstable landforms.
- o Areas of Quaternary glacial or igneous activity.
- o Areas with critical mineral, geothermal, archaeologic, cultural, historic, wildlife, or ecologic resources.
- o Areas of critical surface water, springs, and present or planned large bodies of water.
- o Areas of concentrated human habitation or future growth areas--towns, subdivisions, and densely populated rural areas.
- o National Parks, National Monuments, Wildlife Refuges, wilderness areas, and wild and scenic river areas.
- o Areas of prime, irrigated agricultural lands.
- o Areas with severe transportation safety aspects.

Consideration of these criteria in regard to the target areas resulted in the selection of potential sites. A number of sites within target areas received further consideration during this study, but were not recommended as potential sites. The potential sites recommended for the relocation and/or reprocessing of the Rifle uranium mill tailings piles were the Lucas Mesa site and the Flatiron Mesa site.

The final step of Phase I was to evaluate and rank the potential sites by use of a geotechnical grading matrix (Table B.2.1). To use the grading matrix, scores were assigned to a number of geologic, hydrologic, and meteorologic factors for each site. Each factor was assigned a rank value from zero to four in the matrix based on the characteristics of the particular site being evaluated. Some factors are more important than others, and are weighted accordingly. The total site score was calculated by adding all factor scores. A maximum score of 152 was possible.

B.2.2 PHASE II

Potential sites were reviewed and further evaluated during Phase II by a Candidate Site Review Committee. The Committee was comprised of representatives of the following agencies:

- Colorado Geological Survey.
- Colorado Department of Health, Radiation Control Division.
- University of Colorado, Institute of Behavioral Sciences.
- Colorado Division of Wildlife.
- City Manager, Rifle.
- Colorado Division of Water Resources, State Engineer's Office.
- Remedial Action Lay Advisory Committee, Grand Junction.
- Colorado Department of Health, Waste Management Division.
- Colorado Mined Land Reclamation Division.
- Mesa County Health Department.
- Colorado Department of Health, Water Quality Control Division.
- Colorado Department of Highways.
- City of Grand Junction.
- Colorado Department of Health, Epidemiology Division.
- Garfield County Commissioner.

The Committee evaluated the Lucas Mesa and Flatiron Mesa sites not only considering geotechnical data, but also other factors including transportation elements, land use and ownership, wildlife, archaeologic and ecologic impacts, local attitudes toward particular sites, reclamation potential, economics, and site remoteness.

The two sites ranked as follows:

Site	Point Score
Flatiron Mesa site	112
Lucas Mesa site	108

The following positive and negative aspects of these sites were identified (CGS, 1982):

Table B.2.1 Geotechnical rating matrix: Rank x weight = factor score; 0 = low rank; 4 = highest rank; highest possible score = 152

Site designation: _____ Site location: _____

Factor	Rank 0	1	2	3	4	Weight	Factor score
1. Land slope	>10%		<2% or 5% to 10%		2% to 5%	1	
2. Surficial materials lithology	Gravel or sand	Very fine sand or sandy silt	Silt	Silty clay	Clay	1	
3. Surficial materials thickness (if clay or silty clay, site ranks 4)	>20 ft	10 to 20 ft	5 to 10 ft	2 to 5 ft	0 to 2 ft	2	
4. Host rock lithology	Sandstone, limestone, or conglomerate	Very fine sandstone or sandy siltstone	Siltstone	Silty shale or claystone	Shale or claystone	2	
5. Host rock thickness (if conglomerate or sandstone, site ranks 0)	<50 ft	50 to 75 ft	75 to 100 ft	100 to 200 ft	>200 ft	2	
6. Presence of fracturing (joints and shear zones)	Very high	High	Moderate	Low	Very low	1	
7. Seismic risk	Very high	High	Moderate	Low	Very low	1	

Table B.2.1 Geotechnical rating matrix: Rank x weight = factor score; 0 = low rank; 4 = highest rank; highest possible score = 152 (Continued)

Site designation: _____ Site location: _____

Factor	Rank 0	1	2	3	4	Weight	Factor score
8. Susceptibility to natural slope failures, subsidence, or hydro-compaction	Moderate to high		Low		Very low	4	
9. Present erosional/ depositional setting	Intense gullying	Moderate gullying	Minor gullying	Sheet or rill wash	No erosion or undergoing deposition	4	
10. Long-term geomorphic stability	Very poor	Poor	Moderate	Good	Excellent	4	
11. Conflict with mineral resources	Serious conflicts		Moderate conflicts		None or minor conflicts	1	
12. Aquifer character-istics of surficial material	Produces large amounts of good quality water	Produces minor-mod. amounts of good quality water	Produces large amounts of poor quality water	Produces minor-mod. amounts of poor quality water	Produces little or no water	4	
13. Aquifer character-istics of host rock	Produces large amounts of good quality water	Produces minor-mod. amounts of good quality water	Produces large amounts of poor quality water	Produces minor-mod. amounts of poor quality water	Produces little or no water	4	

Table B.2.1 Geotechnical rating matrix: Rank x weight = factor score; 0 = low rank; 4 = highest rank; highest possible score = 152 (Concluded)

Site designation: _____ Site location: _____

Factor	Rank 0	1	2	3	4	Weight	Factor score
14. Depth to 1st underlying important bedrock aquifer	<50 ft	50 to 75 ft	75 to 100 ft	100 to 200 ft	>200 ft	2	
15. Distance to nearest major spring, perennial stream, perennial lake, or major irrigation ditch	On site	0 to 0.5 mile	0.5 to 1 mile	1 to 2 miles	>2 miles	2	
16. Size of drainage basin above site	>2 sq miles	1 to 2 sq miles	0.5 to 1 sq mile	0 to 0.5 sq mile	at head of drainage	>2	
17. Evaporation to precipitation ratio	<1		1 to 2		>2	1	

Total site score ____

Lucas Mesa site

Good long-term stability; acceptable geotechnical characteristics, but the erosion rates of the mesa flank must be carefully evaluated; good riprap on the site; just over one mile to an irrigation ditch and the Colorado River; very remote; very steep haul route; possible to use a conveyor; near private lands.

Flatiron Mesa site

Good to excellent long-term stability; good geotechnical characteristics, but the erosion rates of the mesa flank must be carefully evaluated; good riprap on the site; less than one mile to Beaver Creek, a public water supply for Rifle; very remote; very steep haul route; direct truck haul from Rifle is feasible; possible to use a conveyor; near private lands.

Neither of these sites are completely ideal when all relevant factors are considered. The advantages and disadvantages of each site were compared to determine which site was the most favorable for continued evaluation for long-term containment of the uranium tailings.

Of the two sites in the Rifle area, only Lucas Mesa was considered a viable alternate for the draft environmental impact statement. It must be emphasized that this investigation was of a regional nature. Detailed evaluation of all relevant factors would be necessary during later studies by the DOE.

B.3 U.S. DEPARTMENT OF ENERGY ALTERNATE DISPOSAL SITE SELECTION PROCESS

The following description of the DOE's alternate disposal site selection process was obtained from the report entitled Preliminary Evaluation of Alternative Disposal Sites for the Grand Junction, Old Rifle, and New Rifle Uranium Mill Tailings, issued in March, 1983 (DOE, 1983).

B.3.1 EVALUATION CRITERIA

The DOE evaluated the Lucas Mesa site nominated by the state of Colorado against 25 evaluation criteria in five categories. The evaluation criteria were based on site characteristics that affect suitability for a tailings repository. The five categories were (1) environmental criteria, including land use and wildlife characteristics; (2) geologic characteristics pertinent to the long-term stability of the site; (3) hydrologic characteristics that control the potential for contaminating ground and surface water; (4) land ownership and land-use restrictions; and (5) engineering economics. The two engineering-economics criteria were combined for this evaluation. Therefore, a total of 24 criteria were used.

The DOE defined the ideal and the least desirable site characteristics for each criterion. The perfect disposal site would be rated "ideal" for all of the 24 criteria. The five categories of criteria are discussed below.

Environmental criteria

This category included six evaluation criteria (Table B.3.1). The first three were related to land uses on and around the potential disposal site. These criteria were important because the long-term impacts of the disposal site depend on how people use the surrounding land.

The remaining three criteria related to the National Environmental Policy Act and to three environmental review laws: the Fish and Wildlife Coordination Act, the National Historic Preservation Act of 1966, and the Endangered Species Act of 1973. By using these criteria, the intent of these three laws was included in the site-selection process.

Geologic criteria

All but one of the six geologic criteria (Table B.3.2) related to the long-term stability of the disposal site. In order to meet the EPA standards for long-term stability, the disposal site must not be subject to erosion by wind or water, or disturbances by landslides, subsidence, caving, or earthquakes.

The other geologic criterion was the presence of economic mineral resources. In some circumstances, the presence of tailings on the site could hinder the development of mineral resources under the site.

Table B.3.1 Environmental criteria

Criterion	Ideal	Least desirable
Population density	Low: characteristic of rangeland area or wilderness area	High: location in an urban area
Potential for use as farmland	None: no soil present, or poor soil quality	High: soils well developed and suitable for farm location, in existing farmlands
Potential for use as a transportation corridor	Low: location in open terrain, not in line of sight between settlements or in natural corridors	High: location in a corridor (valleys, canyons) connecting urban areas
Presence of antiquities and historical sites	None present: within 1 mile	Some present: at the site
Presence of endangered, threatened, or rare species	None present: no critical habitats	Some present: habitat critical in survival of wildlife species
Scenic and recreational values	None or low: barren, monotonous landscape surrounds site	High: scenic and recreational areas located within 1 mile

Table B.3.2 Geologic criteria

Criterion	Ideal	Least desirable
Presence of economic mineral resources	None present: absence of development and interest in development, as shown by records of ownership, mineral leasing rights, and the like	Some present: mineral developments exist or are proposed for site or lands adjacent to site
Potential for erosion by winds	Negligible: sheltered from wind or location in deposition region for soils and sediments	High: evidence of blowouts, sandblasting, or scouring
Potential for erosion by water	Negligible: as evidenced by slope, drainage pattern, and absence of arroyo cutting	High: evidence of sheet erosion and arroyo cutting; degrading slopes; location in floodplain
Potential for landslides	Negligible: nearly level terrain; unconsolidated soil layers well integrated with bedrock	High: steep terrain; evidence of rockslides or mudslides
Potential for subsidence, caving	Negligible: absence of near-surface mines or natural voids beneath site; water table below level of bedrock	High: mines, caverns, voids under site; evidence of subsidence from underground drainage or other causes
Seismic risk	Low: location in zones of no earthquake damage or minor damage of surface structures	High: location in zone of major damage to surface structures

Hydrologic criteria

All of the hydrologic criteria were environmental characteristics that affect the likelihood of ground and surface water being contaminated by the tailings repository. These criteria are presented in Table B.3.3.

Criteria related to land ownership and land-use restrictions

Two factors that could prevent the disposal of tailings at a site are land ownership and land-use restrictions. These factors are considered in the site-selection process by the criteria given in Table B.3.4.

Criteria related to engineering economics

An important consideration in selecting a disposal site is the cost of tailings disposal in a manner that is environmentally sound. Two criteria that would be indicators of these costs, distance by road or rail from the existing pile, and distance by road or rail to sources of cover, cap, and other construction materials, were considered. However, the costs of disposal were estimated and the cost estimates for six categories of construction activities were used instead to evaluate engineering economics.

The costs used in the evaluation were for the following activities:

- o Disposal site preparation.
- o The loading of tailings from the existing pile.
- o Haul to the disposal site.
- o The handling of tailings at the disposal site.
- o The construction of the cover for the repository.
- o Capital costs.

B.3.2 EVALUATION METHOD

The criteria presented in the preceding section were used to determine the suitability of the Lucas Mesa alternate site for the disposal of uranium mill tailings. This section describes the mathematical method used to calculate a score for the site.

Weighted-score method

Each criterion was assigned to an expert in the related technical discipline. For instance, a groundwater expert was assigned the "depth of water table" criterion. Before the scoring began, these experts collected as much information as possible about the Lucas Mesa site.

Table 8.3.3 Hydrologic criteria

Criterion	Ideal	Least desirable
Precipitation	Low: less than 7 inches per year	High: more than 20 inches per year
Evapotranspiration	High: exceeds precipitation by more than 15 inches per year (arid)	Low: precipitation exceeds evapotranspiration (humid)
Distance to rivers, lakes, or perennial streams	Large: more than 10 miles	Small: rivers, ditches, lakes, or streams near the site
Depth to water table	Large: more than 500 feet	Small: less than 10 feet
Unsaturated-zone materials	Unweathered and unfractured clays, shales, or rocks of low permeability and high sorptive capacity	Gravel, sand, or highly fractured rock
Horizontal groundwater speed (near water table)	Low: less than 0.1 meter per year	High: more than 1 meter per year
Quality of uppermost groundwater	Poor: more than 10,000 parts per million total dissolved solids	Excellent: potable water (0 to 1000 parts per million total dissolved solids)
Saturated-zone materials (near water table)	Unfractured shales, clays, or materials containing zeolite minerals	Gravel, sand, or highly fractured rocks, clay material with high organic content
Potential for flowing artesian wells	None: hydraulic head much less than surface elevation	High: hydraulic head exceeds surface elevation

Table B.3.4 Criteria related to land ownership and land-use restrictions

Criterion	Ideal	Least desirable
Land ownership	Federal Government	Private owners (many owners less desirable than a single owner)
Legal encumbrances and covenants regarding land use	None	Many

The scoring began by assigning a range of possible scores for each criterion. The experts were allowed to select any range, an example being one to 10. A score within the selected range was then assigned to each site. The highest score was given to the best site as determined by that criterion.

For some criteria the site scores were subjective; they were based on the available data and information obtained by a site inspection. For example, the scores for the "scenic and recreational values" criterion were based on first-hand observation.

For most of the criteria, however, the scores were determined directly from a quantitative measure. For example, the scores for the "depth to water table" criterion were based on the expected depth of the water table at the Lucas Mesa site. In this example the range of scores would be 30 to 500, with 30 feet being the minimum depth of the water table. The site score would be the expected depth of the water table. In this case, the highest quantitative value (i.e., water table at 500 feet) would result in the highest score.

For a few criteria, a site with the highest quantitative measure received the lowest score, an example being the cost of moving the tailings from the site with the highest moving costs receiving the lowest score. The example that follows illustrates the scoring process for this type of criterion and explains how the quantitative measures were inverted to obtain a score.

A scale of one to 10 was selected for scoring the precipitation criterion. The amount of precipitation expected at each of the four sites was determined as shown in Table B.3.5. As indicated in Table B.3.3, an ideal site would have less than seven inches of precipitation per year, whereas the least desirable site would have more than 20 inches per year.

The site scores, also shown in Table B.3.5, were calculated by using the following formula:

Table B.3.5 An example of site scoring

Site	Inches of precipitation (Q)	Score (S)	Normal score (NS)	Weighted score (WS)
1	8	9.3	92	1.8
2	12	6.5	61	1.2
3	16	3.8	31	0.6
4	18	2.4	16	0.3

$$S = \frac{(LD - Q)}{(LD - I)} (U - L) + L$$

where

S = the site score for a criterion.
LD = the least desirable quantitative measure for the criterion (i.e., 20 inches of precipitation per year).
I = the ideal quantitative measure for the criterion at a site (i.e., the precipitation expected at the site).
U = the upper limit of the range of scores (in this case 10).
L = the lower limit of the range of scores (in this case one).

This initial scoring process yielded scores for each criterion but with different scales (e.g., one to 10, one to two). In order to compile the various scores, it was necessary to place them on a uniform scale of 10 to 100. This was done by means of the following formula:

$$NS = \frac{S - L}{U - L} 100$$

where

NS = a normalized score for the criterion at a site and the other items are as defined previously.

For each site, the scores for the 24 criteria were summed and the totals for each site compared. For a perfect site (i.e., all criteria score 100) the total would be 2400. Comparing the totals of these scores gives equal weight to each category; therefore, precipitation would be as important as transportation costs.

Weighting factors

The scoring process was then taken one step further. Weighting factors, which describe the relative importance of the criteria, were incorporated by using the following equation:

$$WS = NS \frac{WF}{TW}$$

where

WS = the weighted score for the criterion.
WF = the weighting factor for the criterion.
TW = the sum of all weighting factors.

In the precipitation example, the weighting factor is two, with the sum of all weighting factors being 100. This means that two percent of the total score will be attributed to precipitation. When the weighted scores for a site are summed, the sums will be between zero and 100, with 100 being an ideal site.

The weighting factors used in this analysis are given in Table B.3.6.

B.3.3 ALTERNATIVES SELECTED

The weighted scores assigned to the Lucas Mesa site for site suitability criteria are presented in Table B.3.7. The total weighted scores for all criteria are presented in Table B.3.8. Compared to the total weighted score of 100 for an ideal site, the total weighted scores for the Lucas Mesa site were such that the DOE agreed to include the Lucas Mesa site with truck transportation in the draft EIS.

B.3.4 CLOSE-IN ALTERNATIVES

In the summer of 1985, the DOE conducted a further site screening process to identify an additional alternate site in the Rifle area that was technically suitable and less costly than relocation to Lucas Mesa. This time, the alternate site selection process consisted of four phases (Figure B.3.1): Phase I - designation of a search region; Phase II - preliminary screening of the designated search region; Phase III - preliminary screening and evaluation of potential areas; and Phase IV - identification and evaluation of candidate sites. Technical factors were applied during each phase to reduce the number (i.e., area) of candidate areas acceptable for tailings disposal. Phase I defined the criteria for selecting the designated search region. Phase II applied the regional screening guidelines used to eliminate areas within the search region from further evaluation. Phase III screened and evaluated potential areas for detailed review in the selection process. Phase IV further reduced the areas to small parcels of land (i.e., sites) and ranked the selected sites.

Phase I

The first phase in the selection process was the designation of a search region. Criteria used to define this region were: (1) disposal within the state of Colorado, and (2) disposal within Garfield County.

Table B.3.6 Weighting factors

Criteria		Weight
Environmental criteria		
Population density		4
Potential for use as farmland		2
Potential for use as transportation corridor		2
Presence of antiquities, etc.		1
Presence of endangered or threatened species		1
Scenic and recreational values		1
	Subtotal	11
Geologic criteria		
Presence of economic mineral resources		3
Potential for wind erosion		8
Potential for water erosion		8
Potential for landslides		3
Potential for subsidence and caving		3
Seismic risk		3
	Subtotal	28
Hydrologic criteria		
Precipitation		2
Evapotranspiration		2
Distance to rivers, lakes, etc.		2
Depth of water table		4
Unsaturated-zone materials		4
Horizontal groundwater speed		2
Quality of uppermost groundwater		2
Saturated zone materials		2
Potential for artesian wells		1
	Subtotal	21
Criterion related to engineering economics: disposal cost		30
Criteria related to land ownership and use restrictions		
Land ownership		8
Legal encumbrances		2
	Subtotal	10
	Total	100

Table B.3.7 Weighted scores for site-suitability criteria

Criterion	Lucas Mesa
Environmental criteria	
Population density	1.8
Potential for use as farmland	0.9
Potential for use as transportation corridor	1.6
Presence of antiquities, etc.	0.5
Presence of endangered and threatened species	0.7
Scenic and recreational values	0.4
Subtotal	5.9
Geologic criteria	
Presence of economic mineral resources	1.5
Potential for wind erosion	7.0
Potential for water erosion	6.7
Potential for landslides	1.5
Potential for subsidence and caving	3.0
Seismic risk	2.7
Subtotal	22.4
Hydrologic criteria	
Precipitation	3.6
Evapotranspiration	0.4
Distance to rivers, lakes, etc.	0.3
Depth of water table	1.5
Unsaturated-zone materials	3.6
Horizontal groundwater speed	1.2
Quality of uppermost groundwater	1.0
Saturated-zone materials	1.0
Potential for artesian wells	0.5
Subtotal	13.1
Land ownership and land use restrictions	
Land ownership	3.2
Legal encumbrances	2.0
Subtotal	5.2

Table B.3.8 Total weighted scores for the alternate sites

Source of tailings	Transportation method	Lucas Mesa
Rifle	Truck	69.3
	Rail and truck	54.7
	Rail and conveyor	-

Criterion 1 required disposal of the uranium tailings within the state of Colorado. The rationale for this criterion is found in the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), Section 106, which requires approval from the governor of the state to receive the tailings.

Criterion 2 directed that the uranium tailings be disposed within Garfield County, Colorado. This criterion was developed to avoid inter-county conflicts, reduce potential project opposition, and expedite the remedial action process.

To fulfill these criteria, a search region covering a six-mile radius from the existing tailings piles was selected. This radius encompassed approximately 113 square miles.

It is recognized that the criteria used to designate the search region were arbitrary. No regulations or guidelines exist that require a specific search region. The area designated for Phase I provided a realistic area for initial evaluation and allowed for the identification of acceptable alternate sites. It should be recognized, however, that the process depicted in Figure B.3.1 is one of iteration. That is, should subsequent phases have determined that there were too few or no suitable areas for tailings disposal, the Phase I search region would be expanded and the evaluation process repeated.

Phase II

Phase II established regional screening guidelines consisting of geotechnical and environmental factors to eliminate lands within the search region that were unsuitable for uranium tailings disposal. The framework for the regional screening guidelines was initially developed by the DOE. The Rifle Community Task Force on Uranium Tailings Disposal, state of Colorado, U.S. Forest Service, U.S. Bureau of Land Management, and the U.S. Nuclear Regulatory Commission provided input into the development of the guidelines.

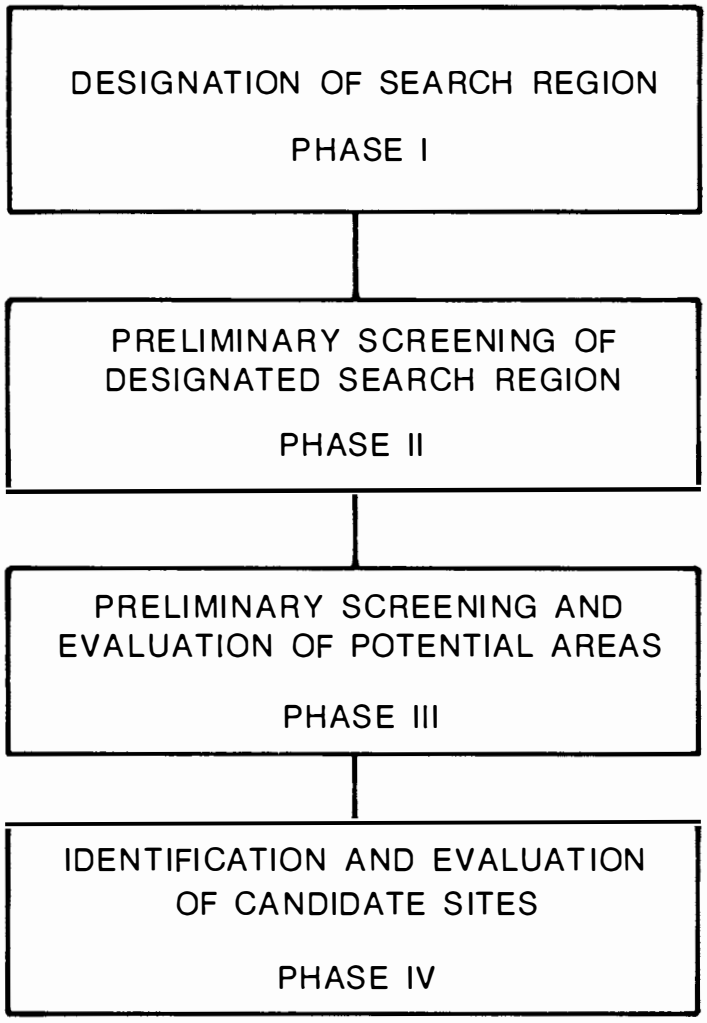


FIGURE B.3.1
ALTERNATE SITE SELECTION PROCESS

The regional screening guidelines identified 23 characteristics and a "buffer zone" around each characteristic (i.e., criteria definition) to be avoided in the selection of alternate disposal areas. Table B.3.9 presents the guidelines.

The guidelines were not weighted nor ranked as to their relative importance but were used to eliminate broad areas from consideration that, if included, may have required a greater complexity in the design (e.g., steep slopes) or posed problems of a regulatory nature (e.g., presence of endangered species). Screening guidelines, by their nature, may exclude a few acceptable areas. However, with more than 113 square miles in the initial search region, it was generally agreed among the agencies that several areas suitable for tailings disposal could be identified.

A team comprised of specialists in the fields of geotechnical engineering, geology, hydrology, seismology, and environmental sciences applied the regional screening guidelines to the lands within the search region. Aerial photographs, the Garfield County Comprehensive Plan, and technical reports from the state of Colorado, U.S. Bureau of Land Management, U.S. Forest Service, U.S. Soil Conservation Service, and the U.S. Geological Survey (USGS), provided the basis for this effort.

The lands within the buffer zone of each characteristic (i.e., eliminated areas) were identified and plotted on USGS topographic maps (1:24,000). Eliminated areas were identified by codes on these maps.

Approximately 100 square miles or 90 percent of the lands within the six-mile radius of Rifle were eliminated from further evaluation. The remainder of the lands, approximately 13 square miles, formed the basis for the Phase III evaluation.

Phase III

The 13 square miles identified in Phase II were evaluated by the team of technical specialists, plus a design engineer, to select several areas suitable for tailings disposal.

The selection process required each technical specialist on the team to reexamine the literature in greater detail and to apply his or her knowledge and professional judgment of the characteristics that are conducive for disposal of tailings in a manner that will meet the EPA standards (40 CFR Part 192) without highly complex design features. For example, area accessibility and terrain, nearby structures, potential borrow sites for cover material, and constructibility were features considered by the engineer; the hydrologist evaluated the presence or absence of complex watersheds, depth to groundwater, and watershed size; the geotechnical engineer considered nearby faults and fault zones, latest seismic activity and extent, erosion potential, liquefaction potential, and slope stability. Table B.3.10 presents a list of desirable characteristics used to guide the evaluation team in the selection of

Table 8.3.9 Regional screening guidelines

Characteristic	Criteria definition
Geologic faults	Areas within 0.25 mile of Holocene or recent faulting.
Liquefaction potential	Within 0.25 mile of areas having saturated loose sands or visible surface indications of disrupted drainage or broken ground.
Landslides	Areas within 0.25 mile of visible indications of slope instability.
Volcanic activity	Areas within 2 miles of exposed Late Quaternary volcanic deposits.
Erosive soils	Areas of known highly-erosive soils.
Slopes and escarpments	Slopes steeper than 33 percent grade; or areas from the top of an escarpment in excess of 10 feet in height established by the intersection of the ground surface with a plane inclined at a 20° angle from a horizontal plane passing through the toe of the escarpment, or 100 feet, whichever is greater.
Water bodies	Lakes, ponds, reservoirs, rivers, or perennial streams.
Wetlands	Wetlands as defined by the U.S. Fish & Wildlife Service.
Floodplains	100-year floodplains as defined by the U.S. Department of Housing & Urban Development, or within 0.125 mile of stream centerline.
Aquifers	Principal recharge areas and transition zones for sole source aquifers or other areas of potential water use.
Surface drinking water supplies	Areas within 1 mile of surface drinking water supplies.
Communities	Areas within 1 mile of community lines (legal boundary).

Table B.3.9 Regional screening guidelines (Concluded)

Characteristic	Criteria definition
Mineral resources	Significant known recoverable resources of oil, gas, coal, and other minerals (except uranium and gravel).
Subsidence areas	Within 0.25 mile of areas susceptible to subsidence by natural or man-made causes.
Transportation and communication corridors	Areas within the rights-of-way of state, Federal, and county roads, and Garfield County Airport.
Archaeological and historical resources	Within 100 feet of archaeological or historical resources and sites on the National Register of Historic Places.
Prime farmland	Areas designated by the Soil Conservation Service as being within the Class II soil capability classification.
State and National Parks	Within 0.25 mile of parks and monuments under Federal, state, or local jurisdiction.
Wilderness and natural areas	Within 0.25 mile of wilderness areas, wilderness study areas, natural areas, areas of critical environmental concern, and roadless areas as identified by the U.S. Forest Service, Bureau of Land Management, and the state of Colorado.
Wildlife refuges	Within 0.25 mile of wildlife refuges and designated migratory bird feeding areas.
Critical habitat	Within 0.25 mile of designated critical habitat for threatened or endangered species, fishery resource areas, and botanically and geologically sensitive areas; within 0.5 mile of known bald eagle or osprey nests and sage grouse strutting grounds.

Table B.3.10 Desirable characteristics for alternate areas

o GEOTECHNICAL - Relative distance from active faults - Low potential for liquefaction - Comparative slope stability - Relative erosion potential	o ENGINEERING - Relative distance from existing tailings - Proximity of borrow materials - Transportation network - Terrain - Few existing structures
o HYDROLOGICAL - Minimal drainage area - Away from terraces - Higher depth to groundwater - Away from floodplains - Toward top of watershed unit	o ENVIRONMENTAL - Away from critical habitats - Proximity to state and national parks - Distance to wildlife refuges - Location away from wilderness and natural areas

alternate areas. In summary, professional judgment was exercised by the specialists that were ultimately to prepare the conceptual design to select areas having attributes desirable for tailings disposal.

From the Phase III team analysis, areas having features that were desirable to the majority of the technical specialists were selected (Figure B.3.2) for evaluation in Phase IV.

Phase IV

Early in Phase IV, the selected areas were inspected by the technical evaluation team to verify the suitability of each area, identify potential problems with an area which might eliminate the area from further consideration, and select specific sites within each area to rank on a comparative basis. In addition to the areas selected by the technical evaluation team, several new areas recommended by the Rifle Task Force and the Colorado Geological Survey were included in the field evaluation. A total of eight areas were analyzed in the field. These areas were identified as Yellow Slide Gulch, Grass Mesa, Webster Hill, Webster Mesa, Anvil Point, Murphy Reservoir, Hubbard Mesa, and Estes Gulch. Figure B.3.2 shows the approximate location of each alternate area.

During the field survey, five of the areas identified were eliminated as a result of recent or planned developments that are in conflict with the disposal siting criteria.

Yellow Slide Gulch and the Murphy Reservoir areas were eliminated due to the presence of underground pipeline systems. Similarly, Webster

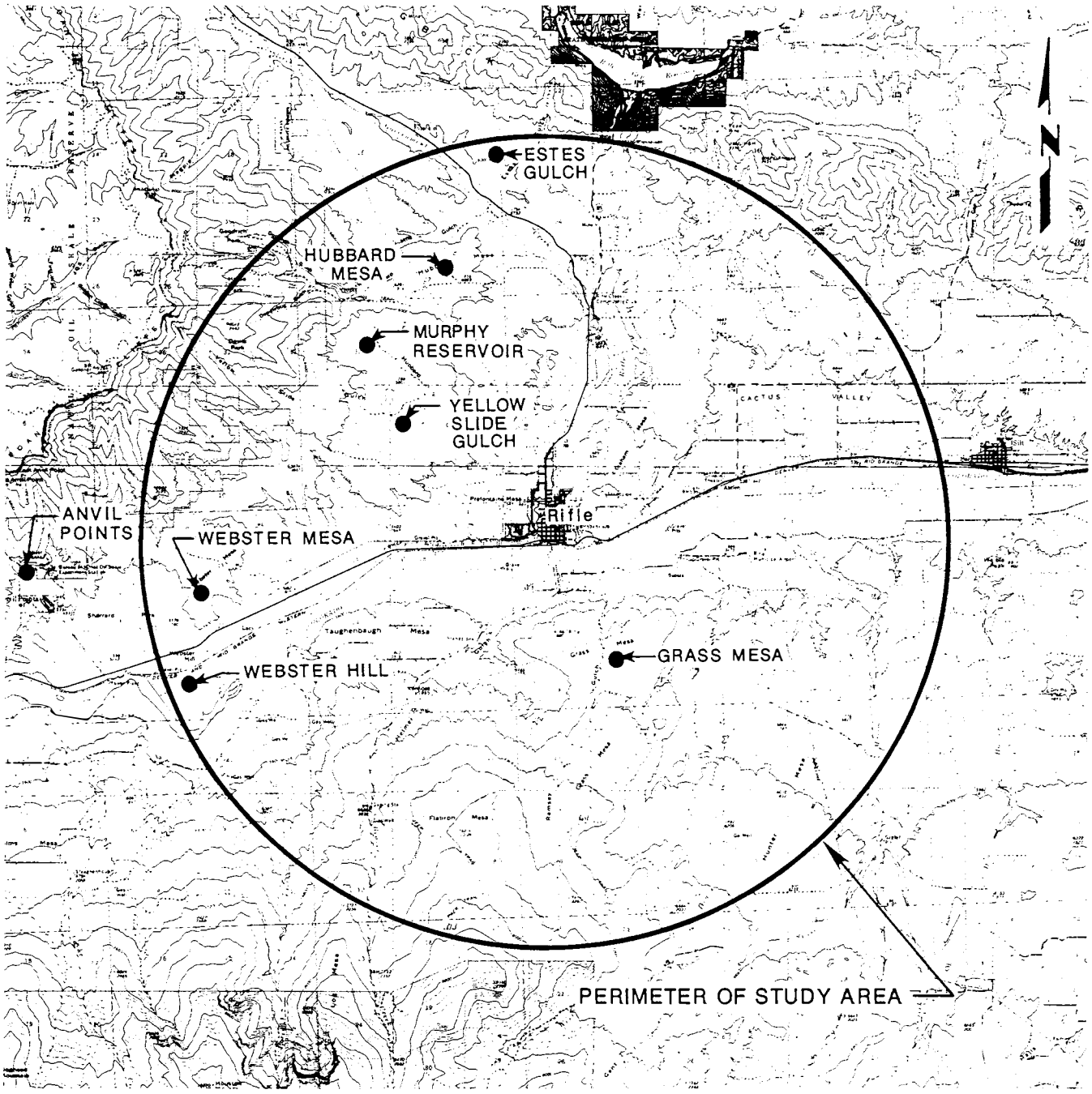


FIGURE B.3.2
LOCATIONS OF FIELD-EVALUATED AREAS

Hill recently has been developed as a natural gas field with additional drilling planned in the area. A natural gas pipeline gathering system would add further complexity to the utilization in the area, eliminating the area from further consideration.

Grass Mesa, located on the south side of the Colorado River, is being subdivided into 40-acre parcels, eliminating this site as well.

Anvil Point, the site of the former DOE oil shale project, was examined extensively and rejected for two reasons: the available area was not large enough for the entire tailings volume, and the area appears highly susceptible to heavy flooding due to its location at the foot of a canyon.

The remaining areas, Webster Hill, Hubbard Mesa, and Estes Gulch, were examined and parcels of approximately 100 acres were identified at each site. To provide an accurate ranking of each proposed site, a geotechnical drilling program was undertaken. Due to the expense of the drilling program, the program was structured to first drill the two leading candidate sites. In the event drilling of one of these two sites identified major subsurface problems, the third site would be drilled.

The drilling program started with the Hubbard Mesa and Estes Gulch sites. Drilling of these sites produced no significant subsurface problems.

Following the completion of the drilling activities at these two sites, each site was numerically ranked utilizing geotechnical, hydrological, environmental, and engineering criteria shown in Table B.3.11. The criteria were based on modifications to Criteria for Evaluating Disposal Sites (DOE, 1982) and the geotechnical ranking matrix used by the Colorado Geological Survey in the preliminary disposal site screening report (CGS, 1982). These criteria ranked each alternate site for 30 site-specific characteristics. Each characteristic was weighted. A total of 408 points for each site was possible.

Each team member was responsible for ranking each site only within their own areas of expertise. The geologist and hydrologist ranked only geotechnical factors, while the environmentalist and engineer evaluated factors within their disciplines.

The results of the ranking indicate that Estes Gulch and Hubbard Mesa ranked very similar to each other; Estes Gulch scored 284.5 and Hubbard Mesa scored 282.5 (Table B.3.12). Either site would be acceptable as a disposal site.

Geotechnically, Hubbard Mesa ranked higher on seven factors. These included land slope, lithology of surface materials, permeability of soils, potential slope failure, erosional/depositional setting, geomorphic stability, and potential as a recharge area. Estes Gulch ranked higher in two factors: bedrock lithology and depth to groundwater.

Table B.3.11 Rifle alternate site selection--geotechnical, hydrological, environmental, and engineering rating matrix

Factor	Rank 0	1	2	3	4	Weight	Factor score[a]
1. Land slope	>10%	10 to 7.5%	7.5 to 5%	5 to 2.5%	2.5 to 0%	1	
2. Surficial materials lithology	gravel or sand	very fine sand or sandy silt	silt	silty clay	clay	2	
3. Surficial materials thickness	0 to 2 ft	2 to 5 ft	5 to 10 ft	10 to 20 ft	>20 ft	1	
4. Bedrock lithology	sandstone, limestone, conglomerate, or basalt	very fine sandstone, sandy siltstone, tuffs or altered tuffs	siltstone	silty shale or claystone	shale, claystone, or granite	2	
5. Permeability of soils and/or rock above the shallowest useable aquifer (including fracture flow)	High k=1 to 10^{1}cm/sec	Medium k=10^{-1} to 10^{-3}cm/sec	Low k=10^{-3} to 10^{-5}cm/sec	Very low k=10^{-5} to 10^{-7}cm/sec	Practically impermeable k=10^{-7} to 10^{-10}cm/sec	4	
6. Distance to nearest seismic risk active fault[b]	<0.25 mi	0.25 to 2 mi	2 to 10 mi	10 to 20 mi	>20 mi	4	

Table B.3.11 Rifle alternate site selection--geotechnical, hydrological, environmental, and engineering rating matrix (Continued)

Factor	Rank 0	1	2	3	4	Weight	Factor score[a]
7. Susceptibility to slope failures, subsidence, or hydroconsolidation[c]	moderate to high		low		very low	4	
8. Present erosional/depositional setting	intense gullying	moderate gullying	minor gullying	sheet or rill wash	no erosion or undergoing deposition	4	
9. Long-term geomorphic stability	very poor	poor	moderate	good	excellent	4	
10. Conflict with mineral resources	serious conflicts		moderate conflicts		none or minor conflicts	1	
11. Aquifer characteristics of surficial material	produces large amounts of good quality water		produces large amounts of poor quality water		produces little or no water	4	
12. Aquifer characteristics of bedrock	produces large amounts of good quality water		produces large amounts of poor quality water		produces little or no water	4	

Table B.3.11 Rifle alternate site selection--geotechnical, hydrological, environmental, and engineering rating matrix (Continued)

Factor	Rank 0	1	2	3	4	Weight	Factor score[a]
13. Recharge area to useable aquifer	in recharge area of aquifer that produces large amounts of good quality water		in recharge area of aquifer that produces large amounts of poor quality water		not in recharge area of aquifer	4	
14. Depth to water table in shallowest bedrock aquifer below site	<50 ft	50 to 75 ft	75 to 100 ft	100 to 200 ft	>200 ft	4	
15. Distance to nearest major spring, perennial stream, perennial lake, or major irrigation ditch	on site	0 to 0.5 mi	0.5 to 1 mi	1 to 2 mi	>2 mi	2	
16. Size of drainage basin above site	>2 sq mi	1.5 to 2 sq mi	1 to 1.5 sq mi	1 to 0.5 sq mi	<0.5 sq mi	2	
17. Evaporation to precipitation ratio	wet		moderate		dry	1	
18. Population density	High		Medium		Low	4	

Table B.3.11 Rifle alternate site selection--geotechnical, hydrological, environmental, and engineering rating matrix (Continued)

Factor	Rank 0	1	2	3	4	Weight	Factor score[a]
19. Farmland potential	High; SCS Class II soils or better		Medium; SCS Class IV present		Low; no soils	4	
20. Irrigated lands	Totally irrigated		Partially irrigated		None	3	
21. Potential for use as transportation corridor	High; location is natural corridor connecting urban areas—valleys, canyons are examples				Low; location in open terrain, not in line of sight between settlements	3	
22. Presence of antiquities and historical sites	Some present on site		None present within 0.5 mile		None present within one mile	4	
23. Presence of endangered, threatened, or rare species	Found on site, critical habitat		None present, evidence of prior usage		None present, no critical habitats	4	

Table B.3.11 Rifle alternate site selection--geotechnical, hydrological, environmental, and engineering rating matrix (Continued)

Factor	Rank 0	1	2	3	4	Weight	Factor score[a]
24. Scenic and recreational values	High; scenic/ recreational areas within one mile		Medium; scenic/ recreational areas within three miles		Low; monotonous landscape surrounds site	3	
25. Land use	High; many restrictive covenants on use				Low; no legal encumbrances or covenants on use	4	
26. Distance from existing site	Large; >10 mi		Moderate; 6 to 8 mi		Low; <4 mi	7	
27. Distance to borrow site: fine materials/ coarse materials	Large; >10 mi		Moderate; 6 to 8 mi		Low; <4 mi	2.5/2.5	
28. Land ownership	Private; many owners		Private; large blocks of land		Federal lands	6	
29. Existing road network	Poor condition; extensive improvements required		Moderate condition; some improve- ments required		Good condition; no or few improvements required	3	

Table B.3.11 Rifle alternate site selection---geotechnical, hydrological, environmental, and engineering rating matrix (Concluded)

Factor	Rank 0	1	2	3	4	Weight	Factor score[a]
30. Road grade - spots with positive grade from mill site and tailings to disposal site	>10%		8 to 10%		0 to <8%	3	

[a]Factor score = rank x weight.
[b]Refers to a fault with Maximum Credible Earthquake of 7.0 magnitude or greater.
[c]Determination of susceptibility is based on visible evidence of recent slope failures, subsurface materials, and subsurface conditions.

Table 8.3.12 Ranking of Rifle alternatives

Ranking criteria[a]	Potential disposal site score	
	Hubbard Mesa	Estes Gulch
Geotechnical factors		
1. Land slope	3	1
2. Surficial materials lithology	5	4
3. Surficial materials thickness	3	3
4. Bedrock lithology	2	6
5. Permeability of soils	12	8
6. Distance to nearest active fault	16	16
7. Susceptibilty to slope failure	8	4
8. Erosional/depositional settling	12	4
9. Geomorphic stability	16	12
10. Conflict with mineral resources	4	4
Subtotal	81	62
Hydrological factors		
11. Aquifer characteristics--surficial materials	16	16
12. Aquifer characteristics--bedrock	16	16
13. Recharge area	16	12
14. Depth to water table	12	16
15. Distance to nearest major spring	4	4

Table B.3.12 Ranking of Rifle alternatives (Continued)

Ranking criteria[a]	Potential disposal site score	
	Hubbard Mesa	Estes Gulch
Hydrological factors (continued)		
16. Size of drainage basin	B	8
17. Evaporation to precipitation ratio	4	4
Subtotal	76	76
Environmental factors		
1B. Population density	16	16
19. Farmland potential	B	12
20. Irrigated lands	12	12
21. Transportation use	6	12
22. Antiquities and historical sites	4	4
23. Threatened and endangered species	16	16
24. Scenic and recreational values	3	6
Subtotal	65	7B
Engineering factors		
25. Land use	16	16
26. Distance from existing site	7	7
27. Distance to borrow site--fine/coarse materials	10/2.5	10/2.5
2B. Land ownership	12	24

Table B.3.12 Ranking of Rifle alternatives (Concluded)

Ranking criteria[a]	Potential disposal site score	
	Hubbard Mesa	Estes Gulch
Engineering factors (continued)		
29. Existing road network	3	3
30. Road grade	6	6
Subtotal	56.5	68.5
Total	278.5	284.5

[a]Factor numbers correspond to factor numbers in Table B.3.11

Hubbard Mesa and Estes Gulch ranked the same on hydrological factors. Hubbard Mesa ranked higher on the recharge area to the useable aquifer, but Estes Gulch ranked higher on the depth to the water table in the shallowest bedrock aquifer below the site. The sites were rated equal on all other hydrological ranking factors.

On environmental factors, Estes Gulch ranked higher, primarily due to its lower farmland potential, its potential use as a transportation corridor, and its lower potential for scenic and recreational use. No Hubbard Mesa environmental ranking factor scored higher than Estes Gulch.

The engineering evaluation scored Estes Gulch higher on one factor: land ownership. The Estes Gulch site is currently owned by the Bureau of Land Management and ranked higher than Hubbard Mesa, which is privately owned. On all other ranking factors, the sites were rated equal.

B.4 ALTERNATIVES NOT CONSIDERED IN DETAIL

B.4.1 REPROCESSING THE TAILINGS PRIOR TO DISPOSAL

The DOE is required by the Uranium Mill Tailings Radiation Control Act to determine the practicality of reprocessing the uranium mill tailings for recovery of their residual mineral content at both the Old Rifle and New Rifle tailings piles. Detailed chemical and economic analyses of the Old Rifle and New Rifle tailings were conducted for the DOE in 1982 (MSRD, 1982a,b). The evaluations concluded that the only metals in economically recoverable quantities at Old Rifle were uranium and vanadium, while uranium, vanadium, and molybdenum may be recoverable at the New Rifle site.

These economic evaluations concluded that for the Old Rifle site, total projected costs for reprocessing would be approximately $19 million and would yield only $7 million worth of marketable production. Similarly, the total projected costs for tailings reprocessing at the New Rifle site were estimated to be $44.3 million with a marketable production valued at approximately $20 million. The combined costs of reprocessing the Old Rifle and New Rifle tailings piles is approximately $63.3 million with a market value of $27 million.

The net reprocessing costs would therefore be about $36.3 million. The reports further concluded that for reprocessing to reach the break-even point, the market value for all minerals extracted would have to increase by over 100 percent. Since this economic evaluation, the market values for uranium and molybdenum have dropped even lower while the market value for vanadium has risen slightly.

In addition, reprocessing the tailings would not reduce the radium content of the tailings. Since the radioactive decay of radium is the source of radon (the principal health hazard from the tailings) there would be no reduction of the hazard from radon daughters. Therefore, the reprocessed tailings would still require remedial action to meet EPA standards. Reprocessing the tailings was therefore rejected as unreasonable.

B.4.2 STABILIZATION ON THE NEW RIFLE SITE

In addition to stabilization at the New Rifle site, a similar design concept called stabilization on the New Rifle site was evaluated. This alternative would involve consolidating and stabilizing the Old and New Rifle tailings and contaminated materials in an elongated, cigar-shaped pile in the northernmost portion of the New Rifle site. This would require moving all of the Old and New Rifle tailings to the area currently occupied by the former New Rifle ore storage and milling facilities. Compared to the stabilization at the New Rifle alternative, the stabilized tailings pile would be at a higher elevation with a greater depth to groundwater, and the stabilized pile would require less expensive erosion protection to protect against flooding of the

Colorado River. There would also be less transportation of tailings and less traffic impacts than with the Estes Gulch and Lucas Mesa relocation alternatives.

However, with this alternative, groundwater protection would still be difficult to resolve, and the tailings and contaminated materials would still be located outside the city of Rifle. While this alternative may be feasible, further evaluation revealed that the cost of this alternative would be substantially greater than that for stabilization at the New Rifle site but not substantially less than that for disposal at the Estes Gulch site. Stabilization on the New Rifle site was therefore eliminated from further consideration.

8.4.3 RETURNING THE TAILINGS TO THE MINES

The uranium ore processed at the Old Rifle and New Rifle mill sites was mined from a large number of surface and underground mines in the western Colorado and eastern Utah area. These mines have been abandoned for many years and many have collapsed and are not accessible.

The possibility of returning the Rifle tailings to these mines was considered but was rejected as infeasible and unreasonable because many of the mines are inaccessible and the environmental conditions (such as the presence of groundwater) are not conducive to tailings disposal.

8.4.4 TRANSPORTATION ALTERNATIVES

The D&RGW Railroad runs between the Rifle tailings site and the town of De8eque which is approximately four miles north of the Lucas Mesa site. It was therefore determined that the combination of train and truck transport to relocate the Rifle tailings to the Lucas Mesa site would be feasible. Further evaluation of train and truck transport revealed that this alternative would involve greater environmental impacts and costs, and the alternative was therefore eliminated from further consideration.

REFERENCES FOR APPENDIX 8

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APPENDIX D

SOILS, GEOLOGY, AND SEISMICITY

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D.1 SOILS

D.1.1 GENERAL

Soil conditions at the Rifle tailings sites and the Estes Gulch alternate disposal site were investigated using various standard techniques available to the geotechnical engineering profession. Field procedures consisted of drilling borings and excavating test pits supplemented by laboratory analysis to determine the physical characteristics of the soils. Sufficient geotechnical investigations have been performed to determine subsurface features at each site and at the potential borrow sites. Laboratory tests and field tests were performed in accordance with the standard methods and specifications of the American Society for Testing and Materials (ASTM) or accepted practice. A more detailed description of field and laboratory testing programs is provided in Section D.1.3.

D.1.2 SUBSURFACE FEATURES

Old Rifle site

Figure D.1.1 depicts the Old Rifle site and boring locations which were used to develop stratigraphic cross sections presented in Figures D.1.2 and D.1.3. As can be seen from these cross sections, the tailings pile consists predominantly of very loose to medium dense, silty sands (sand-slime mixtures) covered with a thin veneer of soil. Penetration test values (2.5-inch inside diameter) ranged from two to 30 blows per foot within the tailings. Below the tailings a medium-stiff to stiff, clayey to silty sand is found. These finer-grained, natural alluvial soils overlie dense to very dense sand, gravel, and cobble alluvium, which, in turn, overlies bedrock of the Wasatch Formation at depths ranging from 16 to 21 feet. Groundwater was encountered in the shallow alluvium and in a portion of the tailings.

New Rifle site

Figure D.1.4 shows the New Rifle site with corresponding boring locations required to develop the stratigraphic cross sections presented in Figures D.1.5 and D.1.6. The tailings consist of very loose to dense, highly gradational sands, sand-slime mixtures (including interlayered sands and slimes), and slimes. Penetration tests (2.5-inch diameter) as low as three blows per foot were obtained in the tailings but typically ranged from 10 to 30 blows per foot. Below the tailings pile, intermittent channels of medium-stiff to stiff, fine-grained alluvium overlie dense sand, gravel, and cobbles. Penetration tests (2.5-inch diameter) typically exceeded 100 blows per foot in the lower alluvial zone. Bedrock is encountered at depths ranging from 20 to 25 feet below the existing grade and consists of interbedded claystones, siltstones, and sandstones of the Wasatch Formation.

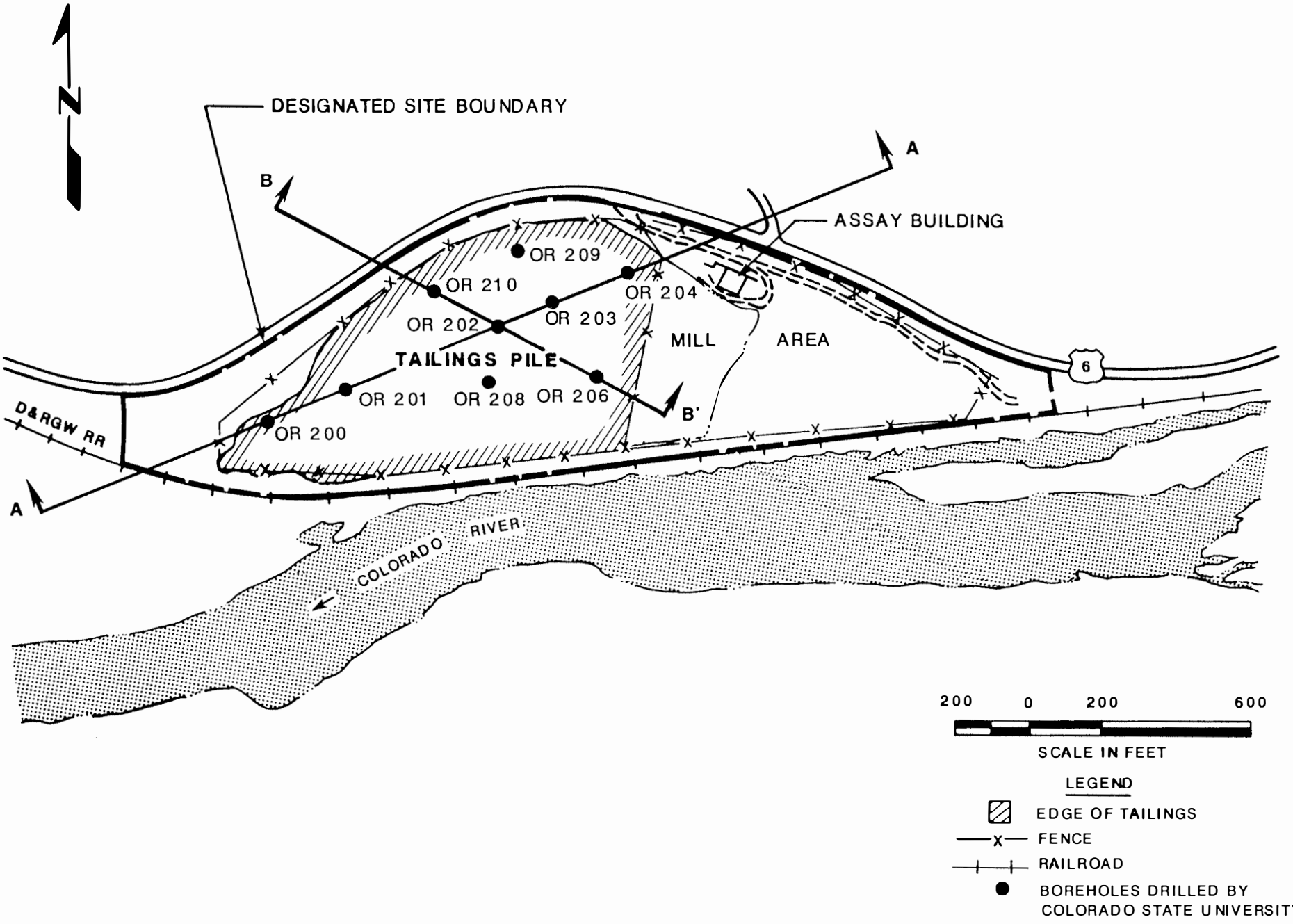
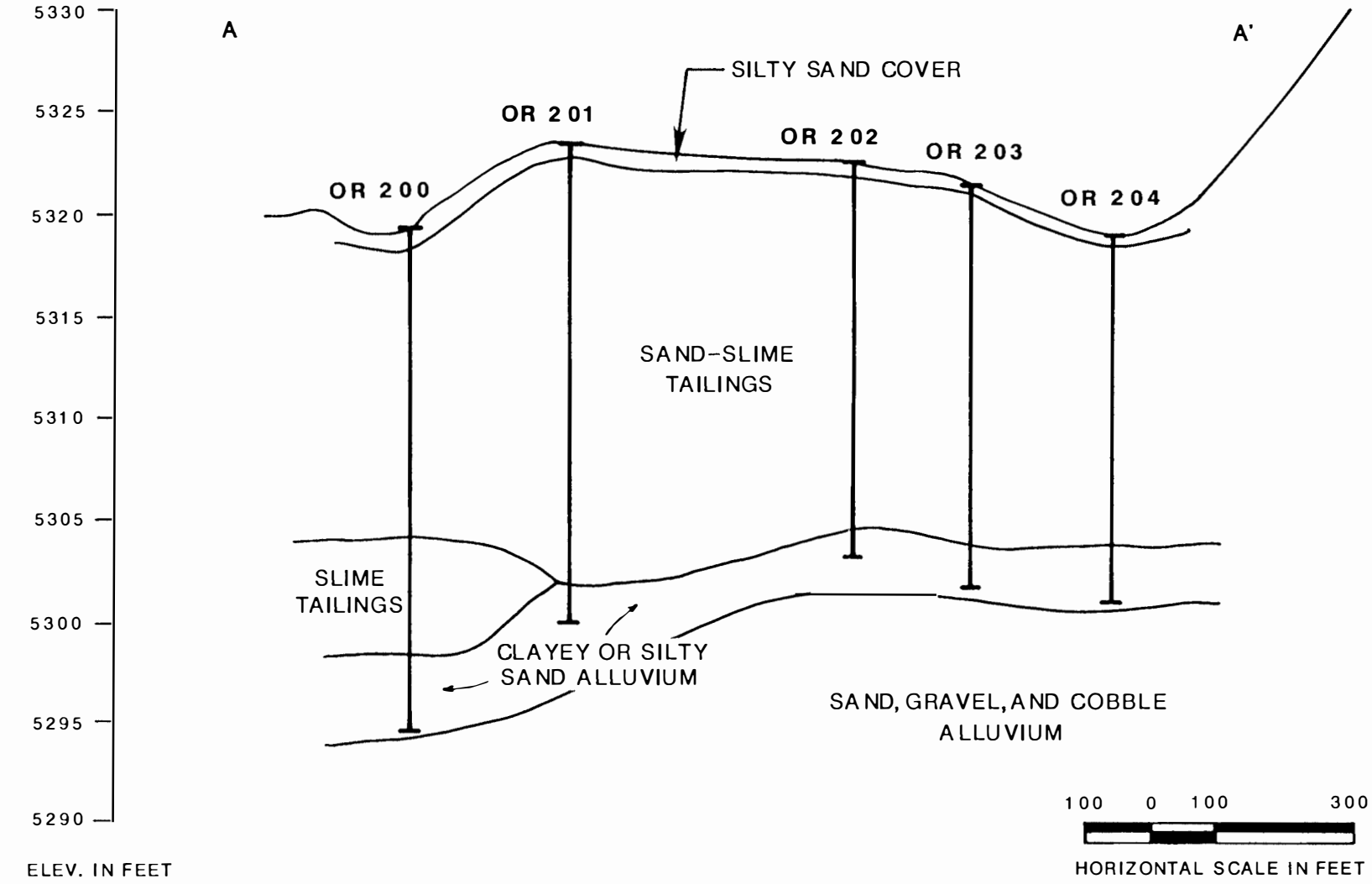


FIGURE D.1.1

TAILINGS BORING LOCATIONS, OLD RIFLE SITE

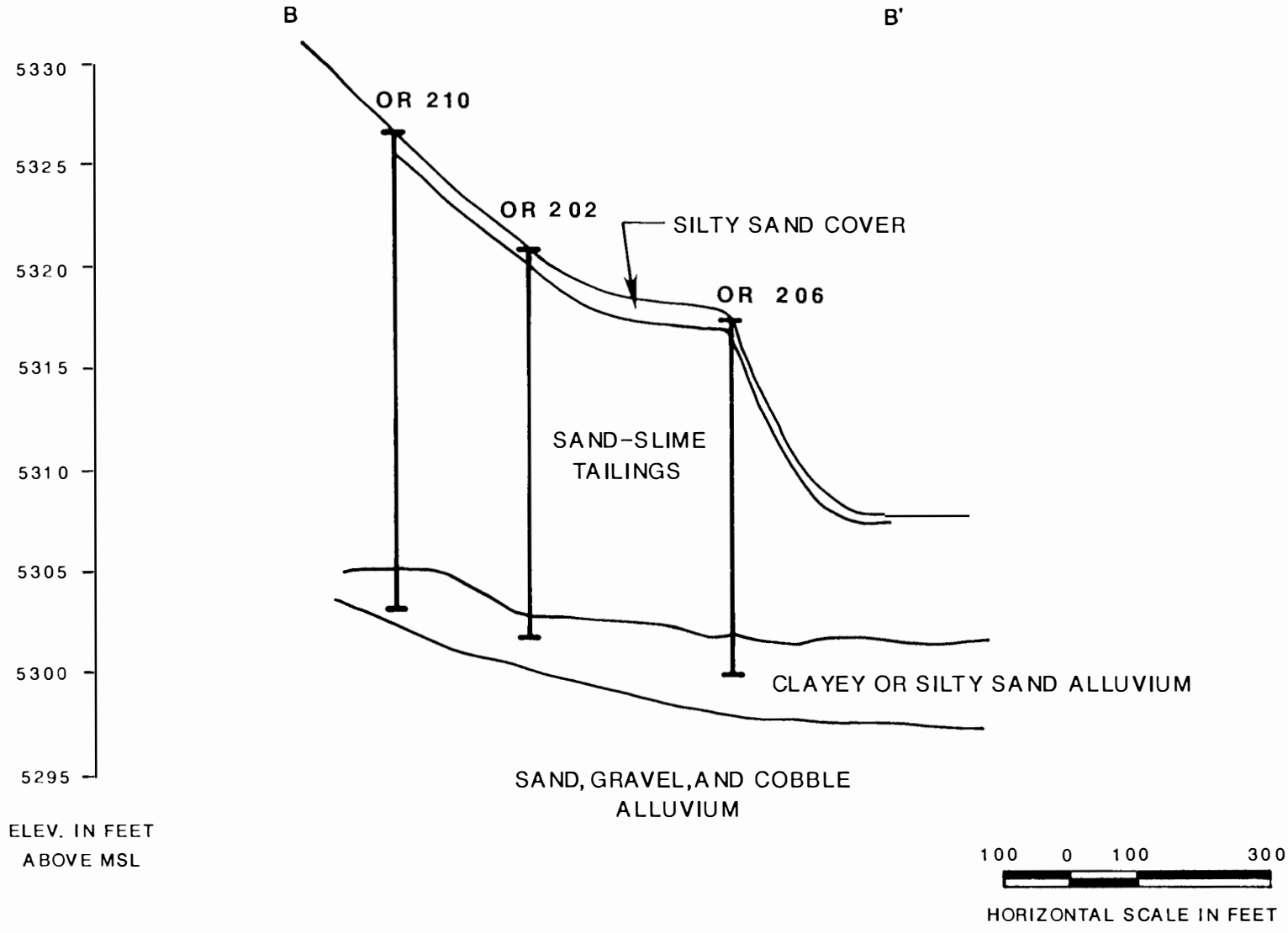
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FIGURE D.1.2

TAILINGS CROSS SECTION A-A', OLD RIFLE SITE



REF: CSU, 1985.

FIGURE D.1.3
TAILINGS CROSS SECTION B-B', OLD RIFLE SITE

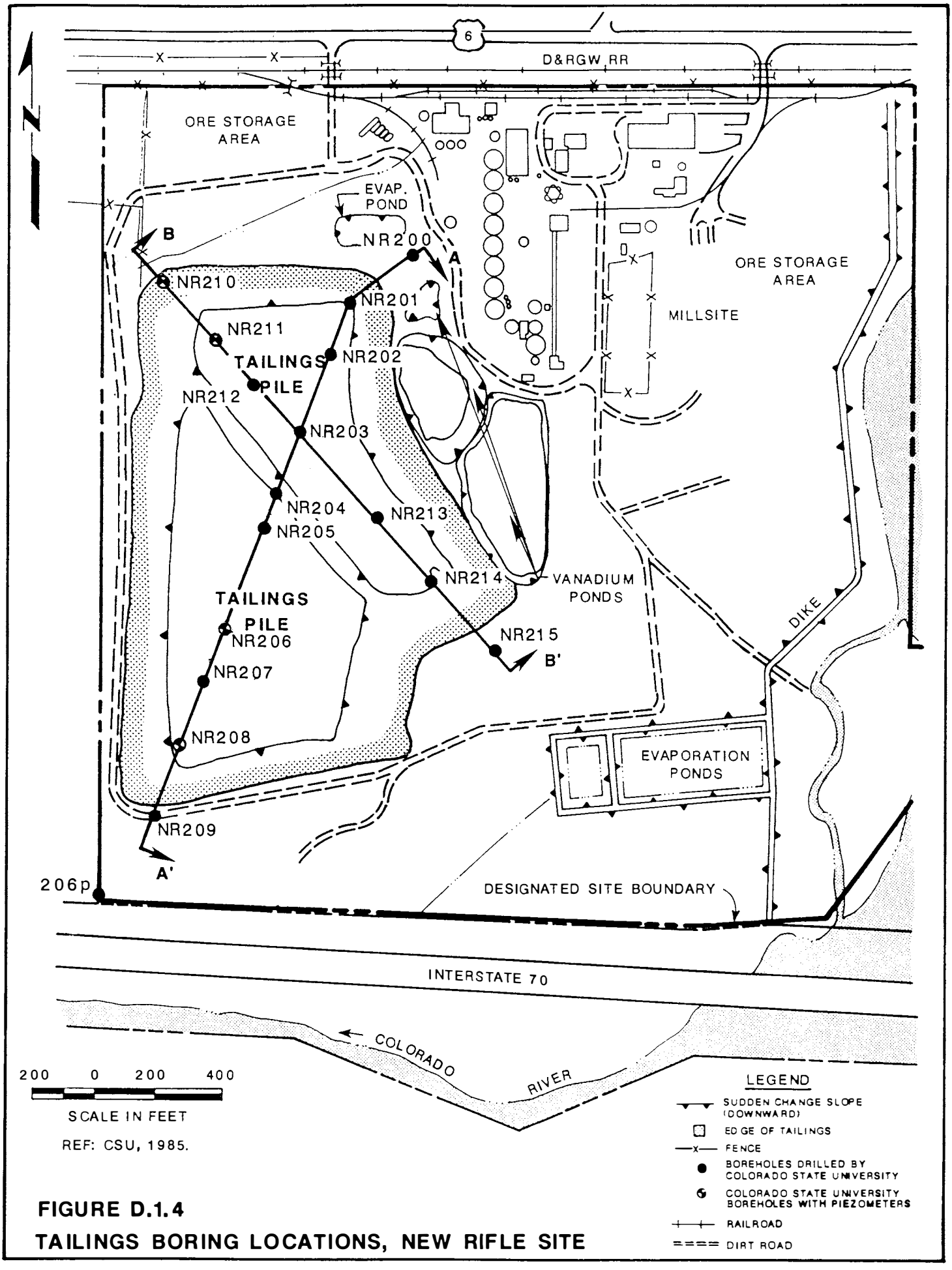
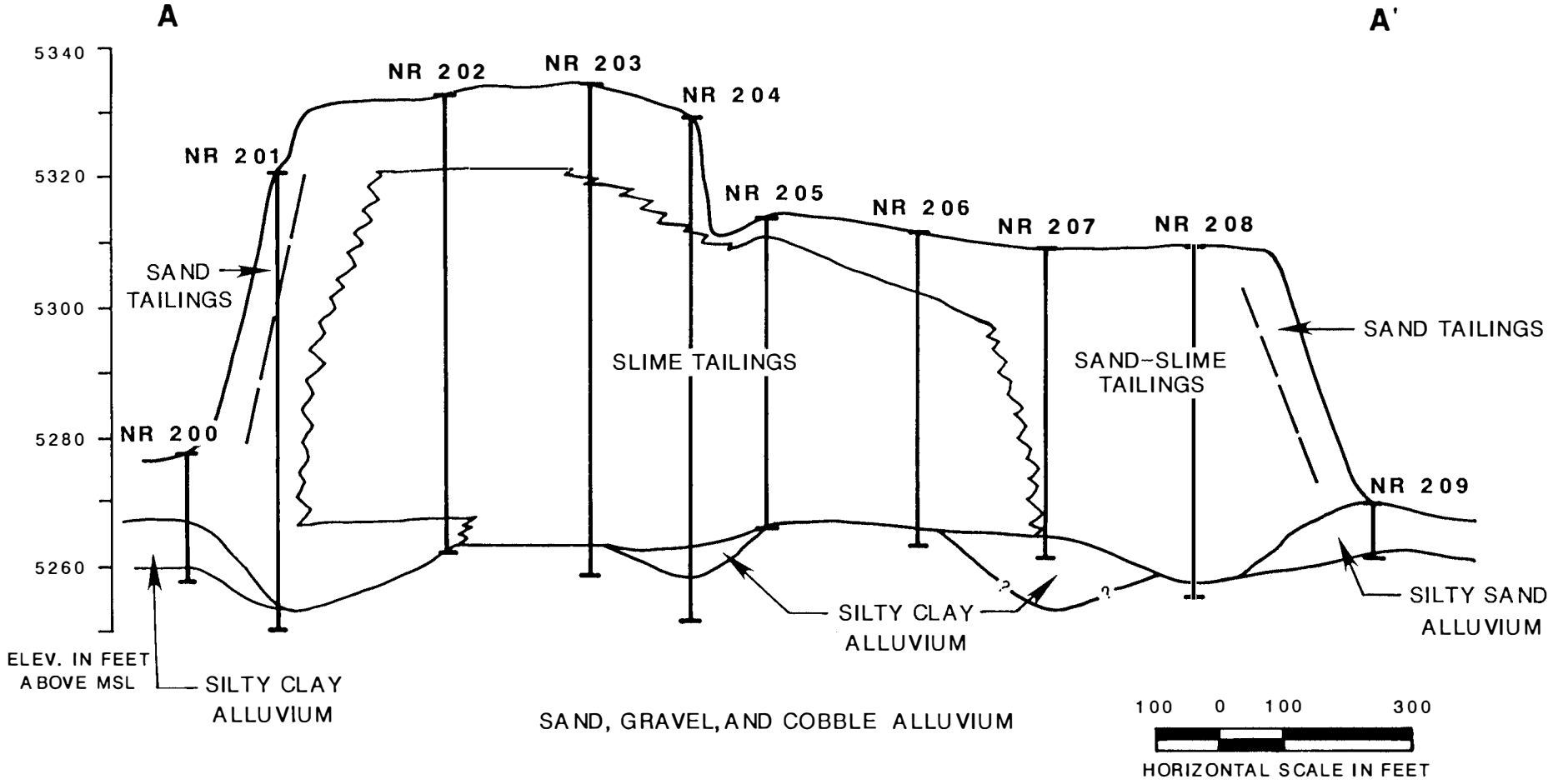


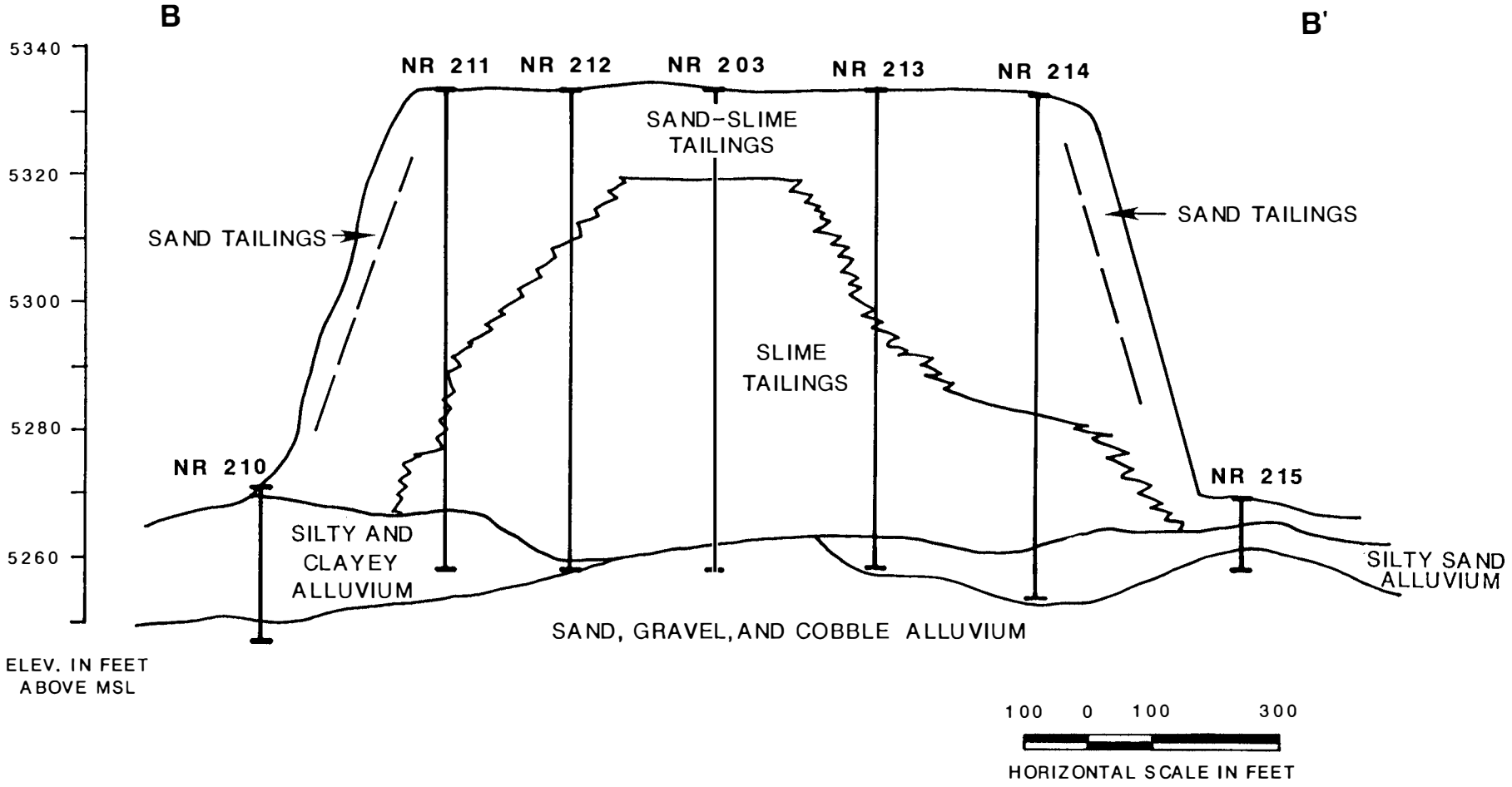
FIGURE D.1.4

TAILINGS BORING LOCATIONS, NEW RIFLE SITE



REF: CSU, 1985.

FIGURE D.1.5
TAILINGS CROSS SECTION A-A', NEW RIFLE SITE



REF: CSU, 1985.

FIGURE D.1.6
TAILINGS CROSS SECTION B-B', NEW RIFLE SITE

Estes Gulch site

The locations of the borings and stratigraphic cross sections at the Estes Gulch site are shown on Figure D.1.7. The cross sections are shown on Figures D.1.8 and D.1.9. The site is a pediment slope underlain by three to 43 feet of dry, hard, moderately plastic, silty clay soil with varying amounts of sand. Penetration values (2.5-inch inside diameter) typically ranged from nine to 30 blows per foot in the upper 10 feet and exceeded 100 blows per foot below this depth. The soil is usually weakly cemented with calcium and often contains zones of pin-sized holes, generally within the upper 1 foot. Dessication cracks are common on the surface, which enhance the formation of erosion tubes, or "pipes." These erosion pipes are generally located within 50 feet of gullies and arroyos. The soil appears to have been derived from the Wasatch Formation upslope of the pediment.

Remnants of a massive slide debris, consisting of sandstone boulders and shales, occurs on the cedar-covered ridges flanking the site. The depth of the slide debris ranges from 15 feet in the lower elevations to 50 or more feet at the head of the fan-shaped slide. The slide pre-dates the erosion of the pediment slope and subsequent soil deposition within the site area.

Evidence of paleo-channels, containing sandstone boulders derived from the slide debris, are found in the gullies that have been deeply incised into the soils.

The Wasatch Formation consists of interbedded claystones, siltstones, and sandstones. As a part of the structure of the Grand Hogback, the underlying bedrock dips 65-70 degrees from horizontal, and is often fractured.

Lucas Mesa site

The locations of the borings at the Lucas Mesa site are shown on Figure D.1.10. The stratigraphic cross sections are shown on Figures D.1.11 and D.1.12. This site is underlain by 30 to 89 feet of highly variable, very dense sands, gravels, cobbles, and boulders in a matrix of clayey silt. Occasional layers and lenses of cleaner, coarse-grained material are present. Field estimates of the particle size distribution of the soil mass, as observed in test pits, are as follows:

	Distribution (percent)	
Material	Depth 0-1.5 feet	Depth >1.5 feet
Silt and clay	45	35
Sand	37	29
Gravel and cobbles to six inches	8	6
Cobbles and boulders	10	30

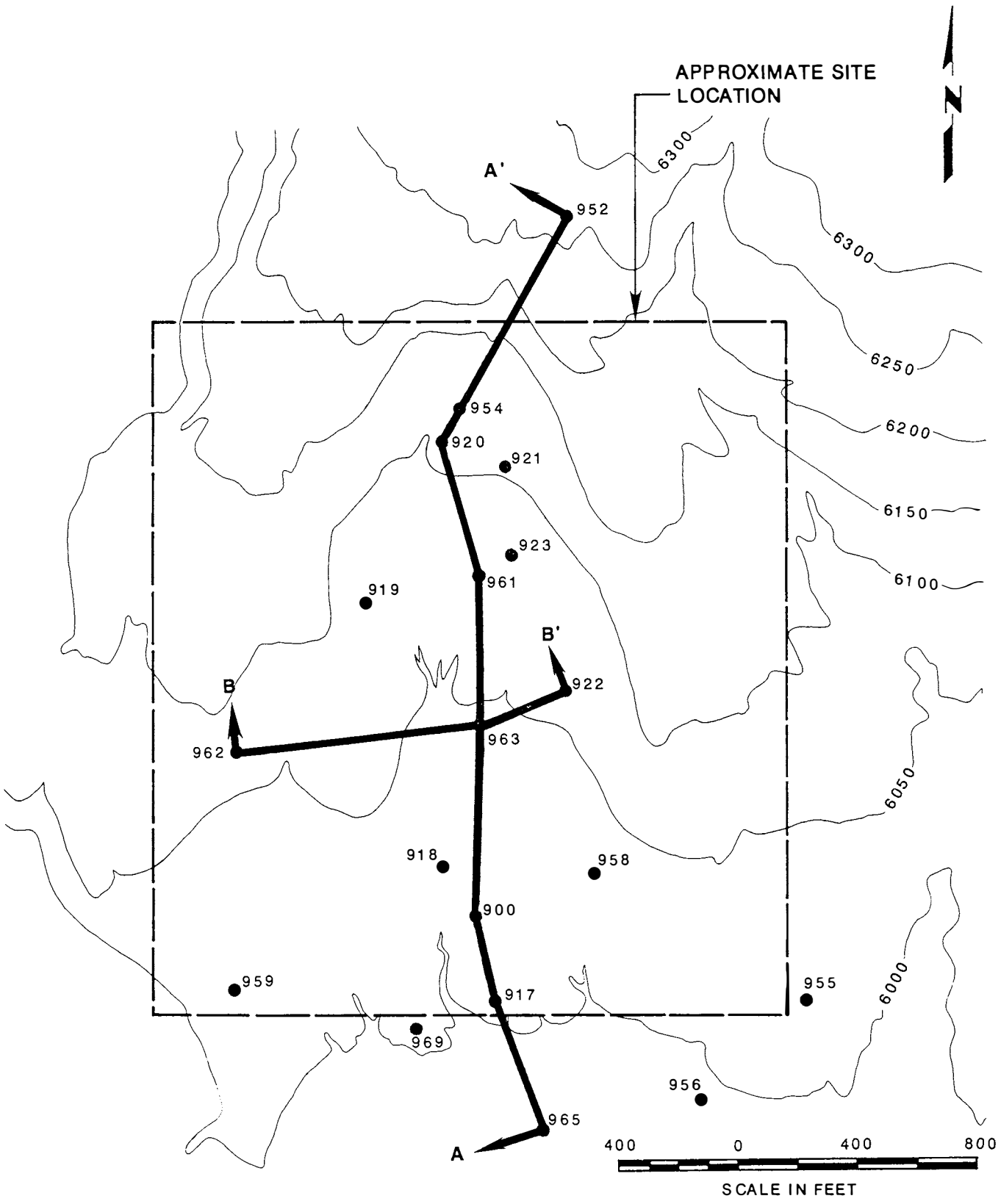


FIGURE D.1.7
SUBSURFACE BORING LOCATIONS, ESTES GULCH SITE

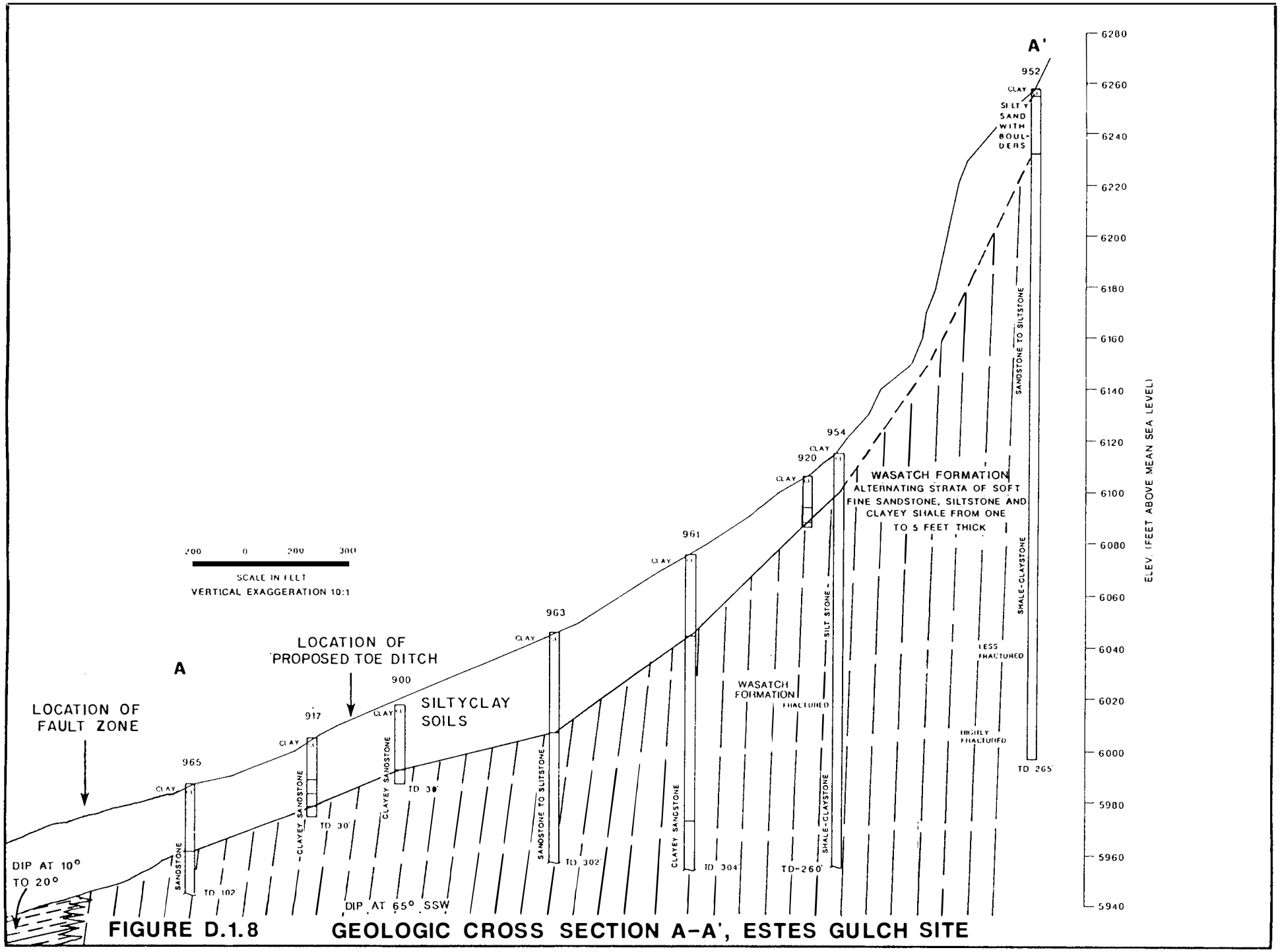


FIGURE D.1.8 GEOLOGIC CROSS SECTION A-A', ESTES GULCH SITE

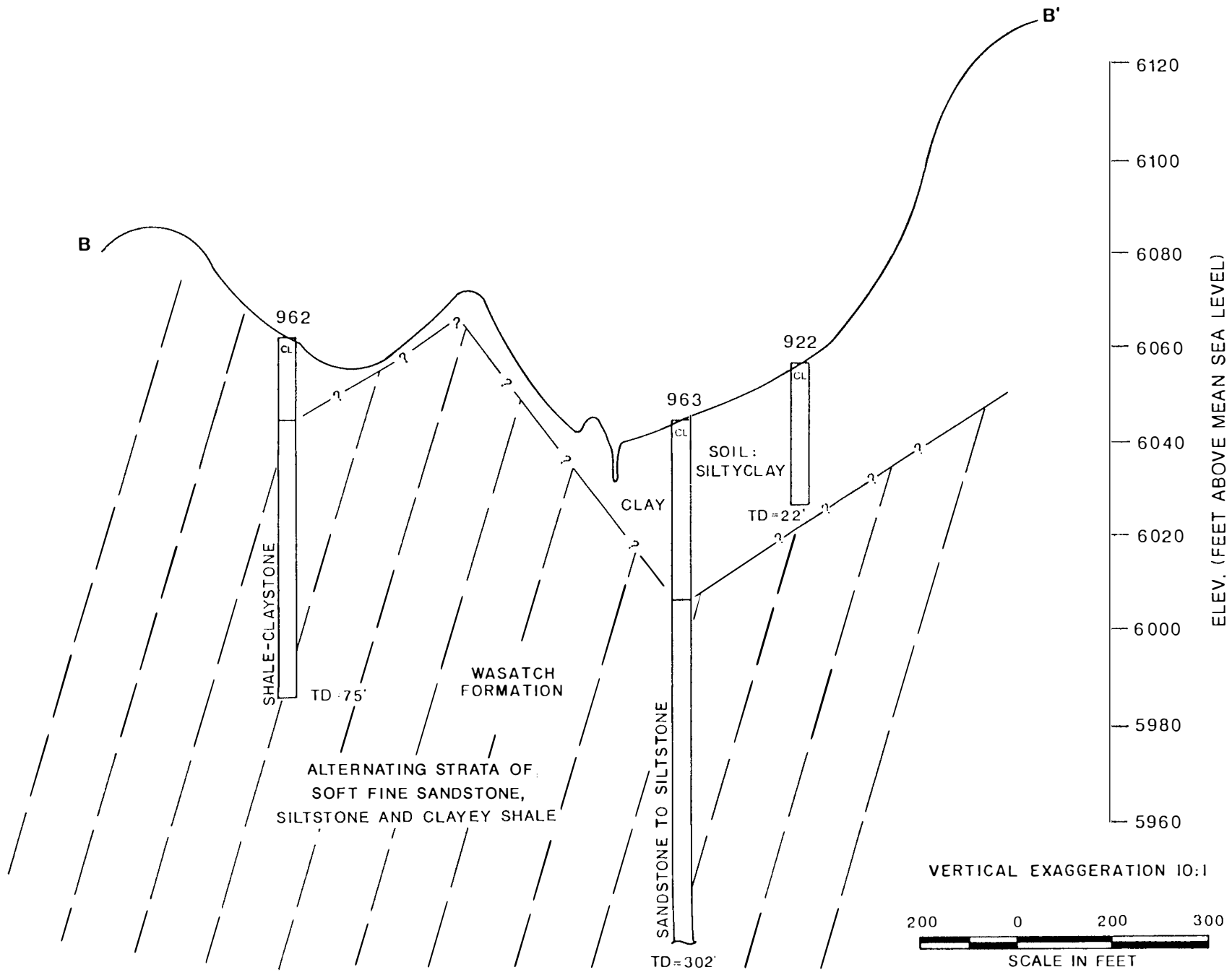


FIGURE D.1.9 GEOLOGIC CROSS SECTION B-B', ESTES GULCH SITE

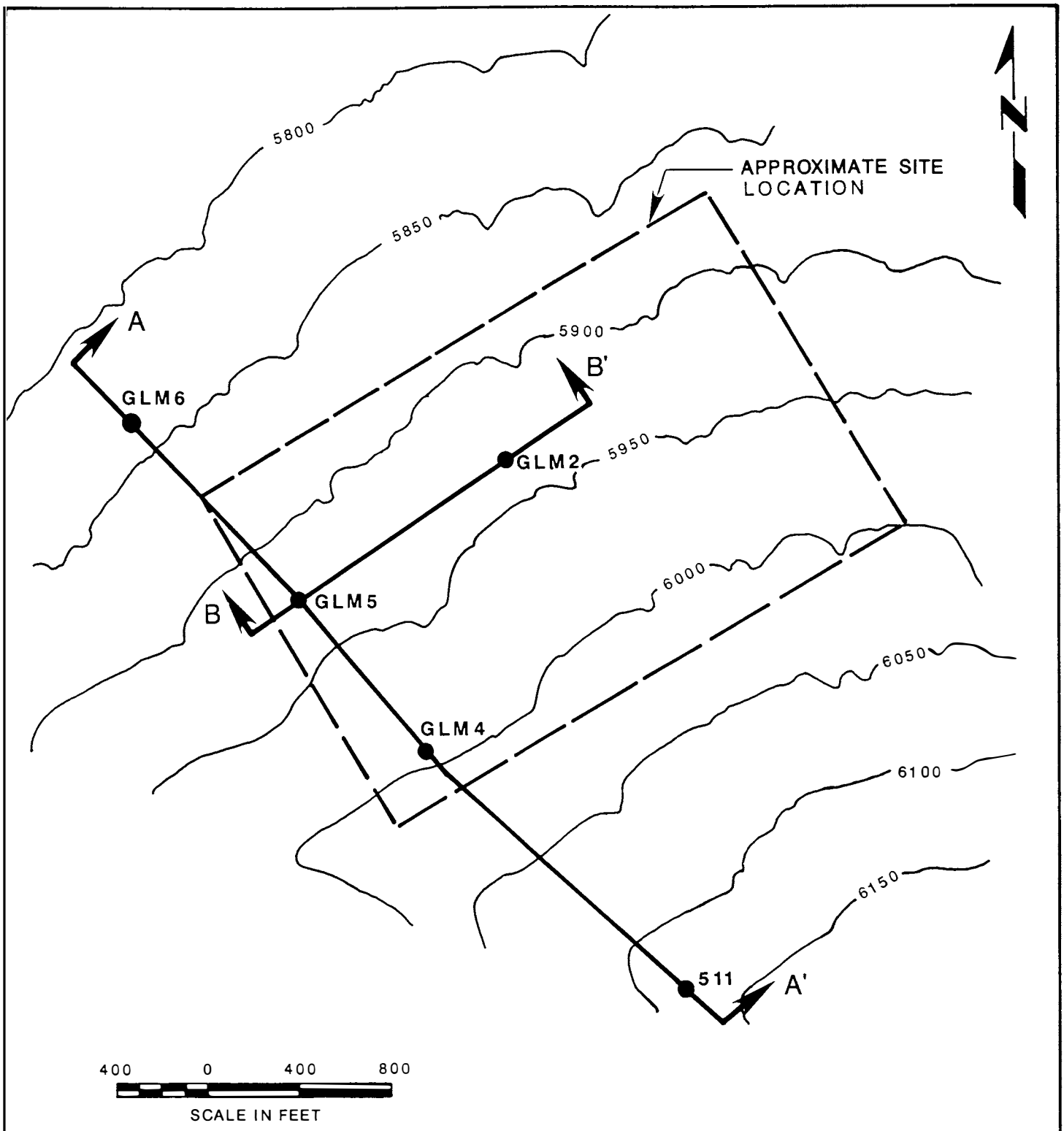


FIGURE D.1.10

SUBSURFACE BORING LOCATIONS, LUCAS MESA SITE

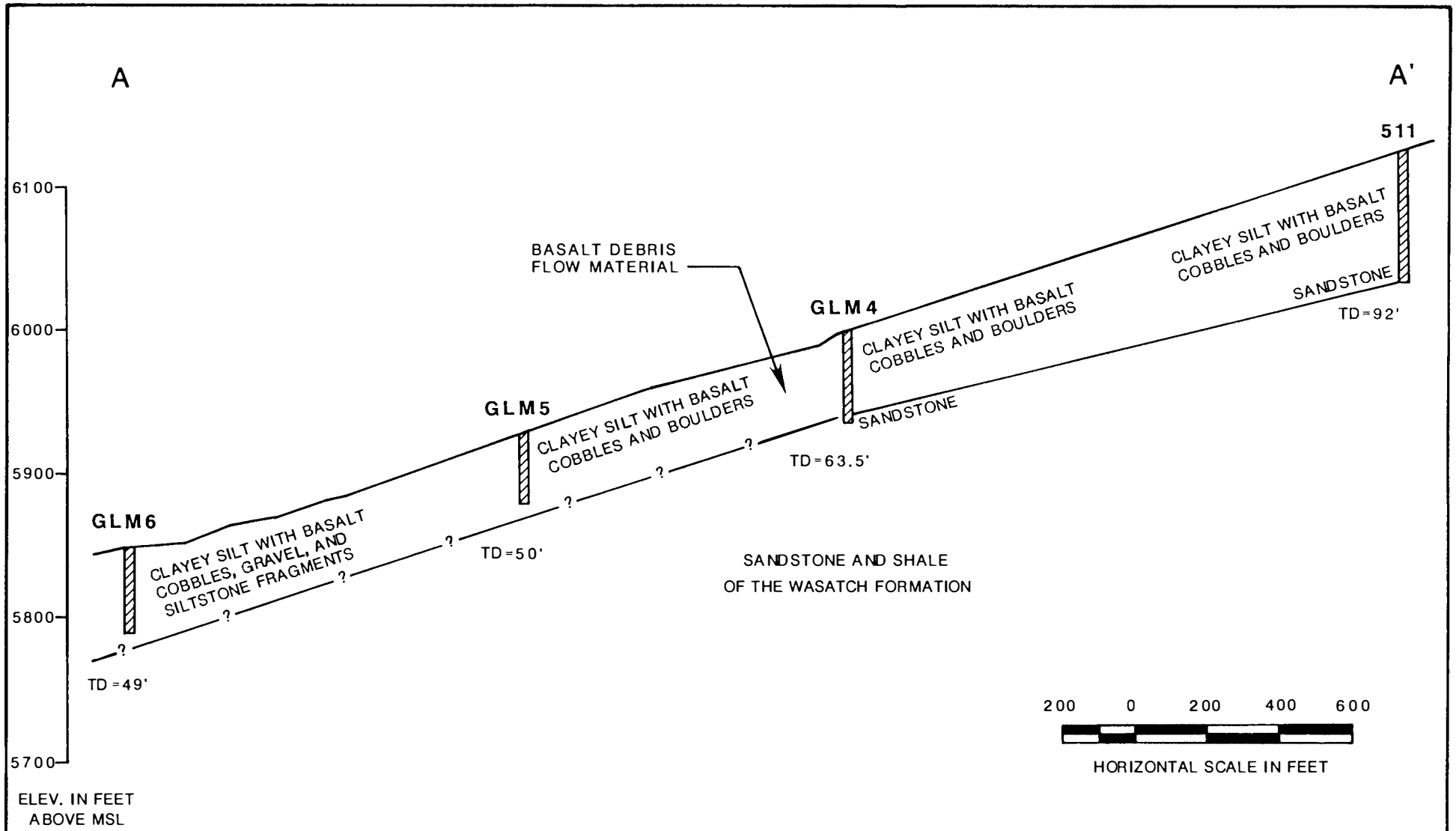


FIGURE D.1.11
GEOLOGIC CROSS-SECTION A-A', LUCAS MESA SITE

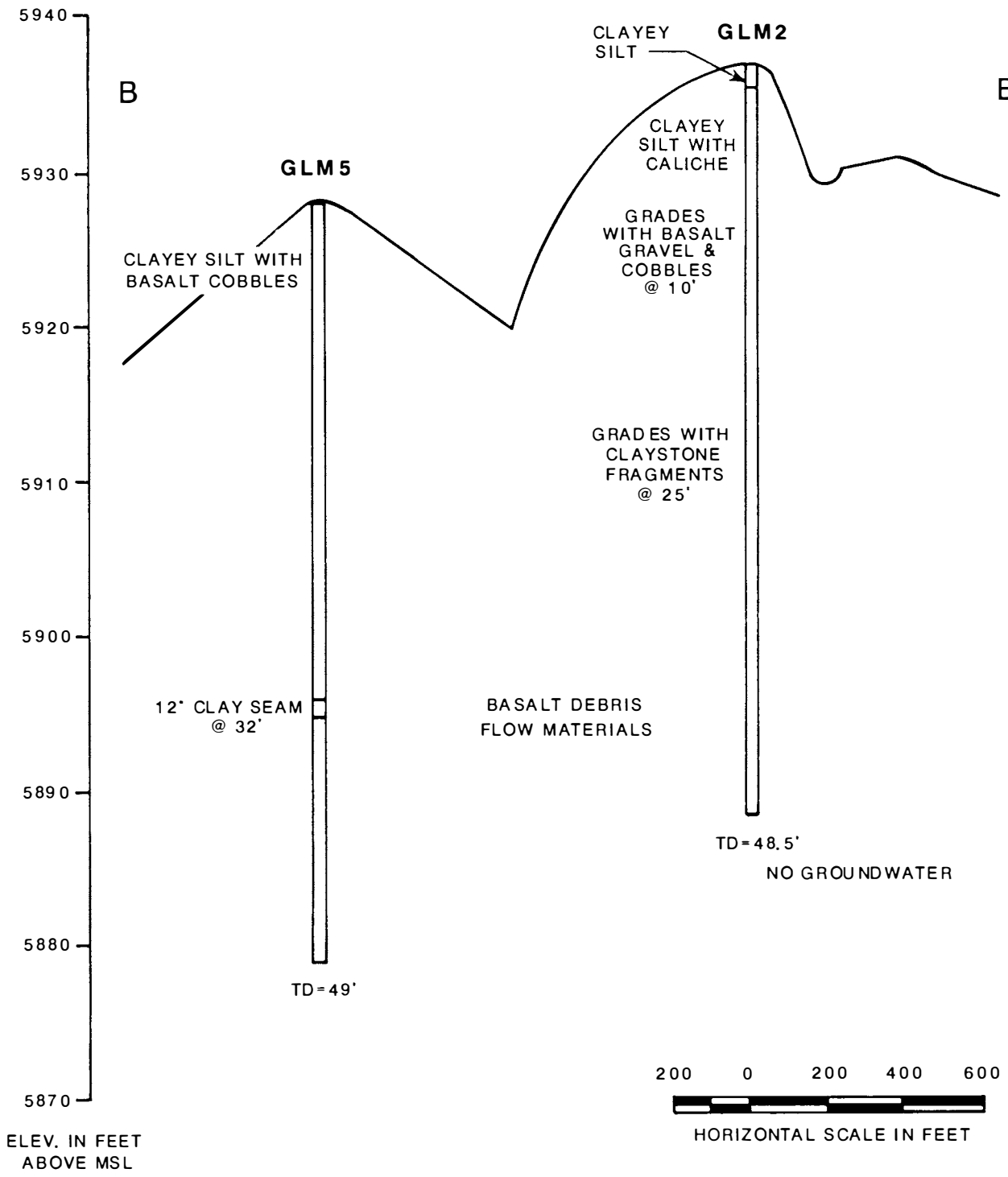


FIGURE D.1.12
GEOLOGIC CROSS-SECTION B-B', LUCAS MESA SITE

Standard penetration test data on these soils exceeded 100 blows below the depth of five feet and 22 to 75 blows above the depth of five feet and indicate, respectively, dense and medium dense to very dense soils. The bedrock surface appears to dip toward the north at a slightly flatter slope than the surface topography. An insufficient number of boreholes were drilled into bedrock at the site to delineate its topographic surface. The bedrock encountered in each boring consisted of sandstone from the Wasatch Formation.

D.1.3 FIELD STUDIES AND LABORATORY TESTING

Field studies

In order to determine the subsurface conditions at the tailings sites, alternate disposal sites, and selected borrow sites, a series of drilling and test pit excavations were conducted. Borings were extended using conventional hollow-stem auger and rotary drill rigs. Sampling techniques included the Standard Penetration Test (ASTM D1586), the large diameter split-barrel sampler (ASTM D3550), and Shelby tube samples (ASTM D1587). Representative samples were selected for laboratory testing. Rock coring was conducted using ASTM D2113 coring methods.

Logged exploratory borings and, in some cases, test pits at the Old and New Rifle sites were conducted by Mountain States Research and Development (MSRD, 1982a,b), NUS Corporation (NUS) (DOE, 1983), Colorado State University (CSU, 1985), Bendix Field Engineering Corporation (BFEC, 1985), and the DOE. The NUS logs present graphical as well as field and laboratory test data conducted on samples obtained from borings. Blow counts shown on these logs represent the Standard Penetration Test. The MSRD data are represented by numerous boring logs. Logs were maintained by a field engineer or geologist who visually classified the soils encountered and collected nearly continuous disturbed and undisturbed samples. Blowcounts were obtained using a large-diameter sampler; however, no testing of samples was performed other than for assay purposes. BFEC sampled the tailings piles for radiation data, and a geologist visually logged the holes. A DOE engineer obtained undisturbed Shelby tube samples of select material types with the cooperation of BFEC. . The DOE drilled numerous borings for geohydrological investigations in areas surrounding the tailings piles. Some holes were continuously sampled by the Standard Penetration Test in the Colorado River alluvium, some were continuously rock cored into the Wasatch Formation, and others were geophysically logged. In all cases, the field program was supervised by a geologist or engineer, and logs were maintained, based on visual classification, for all borings.

Test pits were excavated by the DOE in order to identify suitable borrow sites along the Colorado River. The test pits were visually logged and classified by field engineers or geologists, and samples were obtained for limited laboratory testing.

At the Estes Gulch site, the DOE drilled a series of boreholes and dug test pits for the collection of both geotechnical and groundwater data. All boreholes and test pits were logged and classified by a field engineer or geologist. Geotechnical borings were continuously sampled for laboratory tests, and a record of blowcounts was maintained. Geohydrological borings were logged from cuttings in the alluvium and bedrock; some were continuously cored in the bedrock, and some were geophysically logged. Slant coreholes were drilled to investigate vertical fractures and packer tests were conducted in select vertical coreholes.

At the Lucas Mesa site, both NUS and the DOE drilled boreholes and dug test pits for geotechnical and geohydrological purposes. Data were collected of a similar type and in a similar manner to the data collected at the Estes Gulch site.

Logs of all available boreholes and test pits are maintained in the DOE UMTRA Project Office in Albuquerque, New Mexico.

Laboratory tests

A series of mechanical and physical properties tests were conducted on selected soil samples obtained during the field programs. Tests included in-situ moisture and density determinations, specific gravity, Atterburg limits, gradation, compaction, consolidation, triaxial and direct shear, hydraulic conductivity, and selected rock durability tests. A summary of geotechnical material properties resulting from these tests is presented in Table D.1.1.

Table 0.1.1 Summary of soils material properties

Site	Material type or classification[a]	Specific gravity	Dry density (pounds per cubic foot)	Water content (percent)	Percent finer than No. 200 sieve	Plasticity index[b] (percent)	Liquid limit (percent)	Compaction data (ASTM 0698)		Shear strength data				Hydraulic conductivity (centimeters per second)
								Optimum moisture content (percent)	Maximum dry density (pounds per cubic foot)	Total stress		Effective stress		
										Cohesion (lbs/sq ft)	Δ (degrees)	Cohesion (lbs/sq ft)	Δ (degrees)	
Old Rifle	Sand tailings	2.66-2.69	86-92	3.3-23.6	4-24	NP	--	15.5-16.3	102.2-105.0	0-360	31-54	0-170	35-38	2.0×10^{-2}-7.9×10^{-5}
	Sand-slime tailings	2.66-2.72	81-85	6.1-9.1	30	NP	--	---	---	---	---	---	---	1.2×10^{-4}-1.7×10^{-6}
	Slime tailings	2.69	51-90	6.1-71.8	72-100	6-20	29-59	---	---	0	36	---	---	6.8×10^{-6}
New Rifle	Sand tailings	2.68-3.06	74-93	2.6-32.2	1-25	NP-19	45-53	15.6	104.9	0	26	0	34-38	3.5×10^{-3}
	Sand-slime tailings	2.69-2.86	76-110	0.0-18.0	32-69	NP	---	15.5-21.5	100.0-110.0	0-300	26-48	0	34-43	2.4×10^{-4}-2.9×10^{-5}
	Slime tailings	2.75 2.81	65-91	40.1-48.5	70-100	NP-22	53-63	---	---	24	28	150	42	7.2×10^{-4}-1.5×10^{-5}
Lucas Mesa	SM, ML	2.60-2.70	95-109	8.0-28.2	28-82	NP-19	29-47	23.5-31.7	82.0-90.0	100-590	9-34	125-100	35-41	1.3×10^{-4} 3.2×10^{-5}
Estes Gulch	SM, SC, CL	2.67-2.73	86-116	3.2-12.6	36-98	NP-23	20-45	14.2-17.6	105.0-114.0	0-1650	10-34	0-100	24-34	1.2×10^{-5}-1.3×10^{-8}
Second Street borrow site	ML, CL-ML	2.70-2.72	---	4.2-12.0	55-90	NP-7	23	13.9-15.0	108.0-111.0	0-150.0	23-33	0-100	31-42	5.0×10^{-6}-1.6×10^{-8}

[a]Material classification according to the Soil Conservation Service Unified Soil Classification System: SM denotes silty sand; SC denotes clayey sand; CL denotes clay; ML denotes silt.
[b]NP denotes non-plastic.

D.2 GEOLOGY

D.2.1 PHYSIOGRAPHY

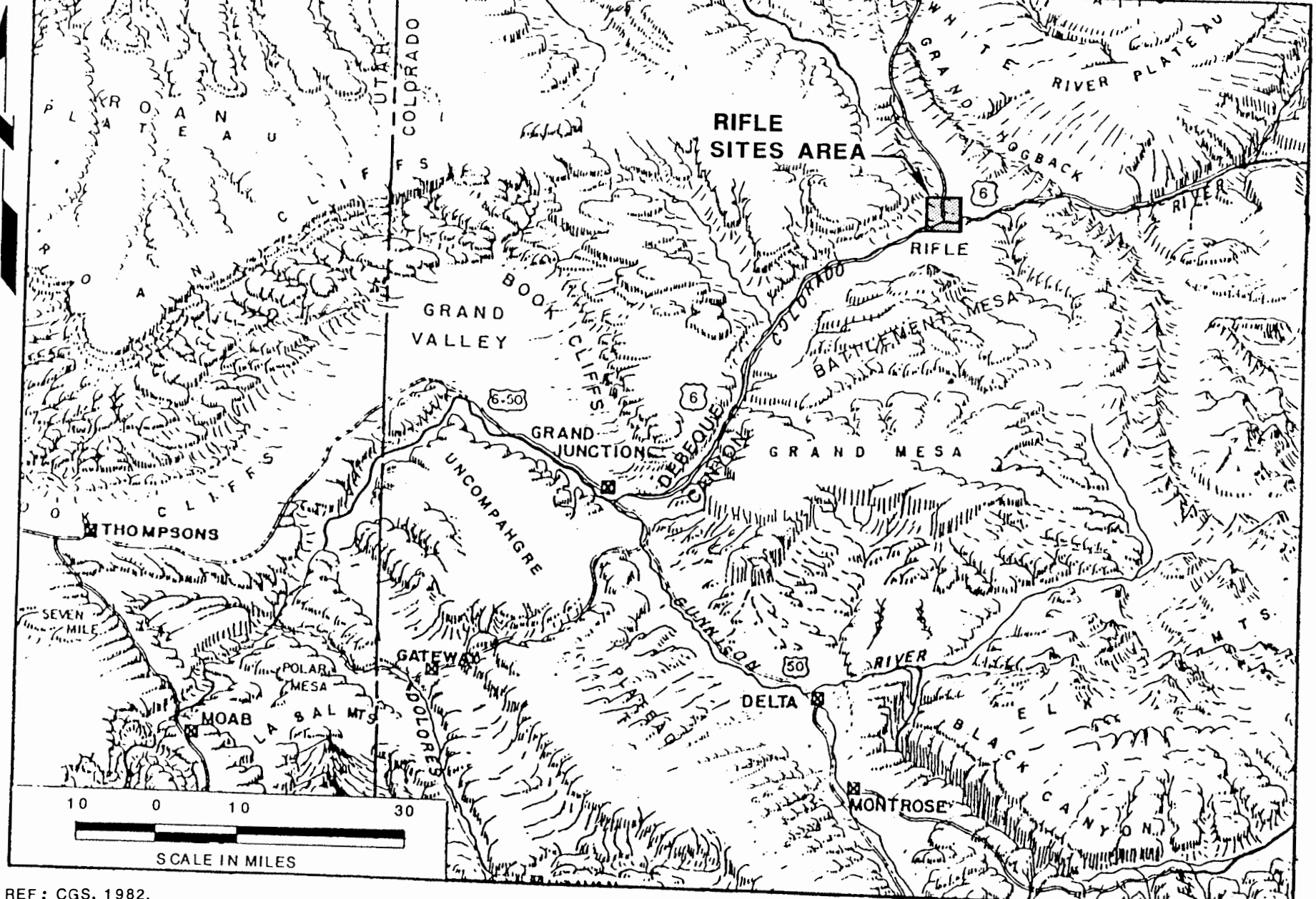
The Rifle tailings sites are along the northeastern edge of the Colorado Plateau physiographic province near its boundary with the Southern Rocky Mountains province. The Wyoming Basin physiographic province lies to the north of the site area. In the Rifle area, the Colorado Plateau province is divided into two sections: the Canyonlands section to the south, and the Uinta Basin section to the north. These two sections are separated from one another by the Book Cliffs, a prominent topographic escarpment formed by the Mesa Verde Group outcrop. The Canyonlands section in the site area is characterized by monoclinal folds, upwarped plateaus, and lava-capped mesas. The Uinta Basin section exhibits a mature, stream-eroded upland surface known as the Roan Plateau. The basin forms an embayment between the Middle and Southern Rocky Mountains physiographic provinces. Little faulting is associated with the structural upwarps and basins in the region except in the northwest-trending basin south of and parallel to the Uncompahgre Upwarp (Hunt, 1967). Principal physiographic elements within the region include the Colorado River valley, Uncompahgre Plateau, Grand Mesa, Battlement Mesa, Roan Plateau, White River Plateau, and the Grand Hogback (Figure D.2.1).

Along the Colorado River valley, the narrow DeBeque Canyon portion separates the broad, open Grand Valley to the west from the steep walled, flat bottomed valley to the east between the Roan Plateau and Battlement Mesa. East of Rifle, the Colorado River cuts through the Grand Hogback monocline after passing around the south side of the White River Plateau.

South of the town of Rifle, Battlement Mesa rises to a height of nearly 11,000 feet, with the highest surfaces capped by basaltic lava flows. The northern edge of the mesa consists of multiple levels of pediments and alluvial fans that slope toward the Colorado River. North of the Colorado River, the Roan Plateau consists of an eroded surface of hills developed on the shales of the Green River Formation and Uinta Formation.

The Grand Hogback monocline forms the western boundary of the Southern Rocky Mountain physiographic province. The steeply tilted hogback forms a drainage barrier between the steep canyon and mountain region northeast of the White River Plateau and the broad, flat valleys of the Colorado River basin.

The region is drained by the Colorado River and its tributaries, including the Gunnison River. Principal tributaries of the Colorado River in the site area are Rifle Creek and Government Creek, both perennial streams. Most other creeks within the site area are ephemeral.



REF: CGS, 1982.

FIGURE D.2.1
PHYSIOGRAPHIC FEATURES OF THE RIFLE AREA

D.2.2 REGIONAL GEOLOGY

The regional dip of rock layers in the Rifle-Grand Junction area is to the north and northeast. The oldest rocks, therefore, are exposed to the southwest and become progressively younger to the northeast. The oldest rocks exposed in the area are the complexly folded Precambrian schists and gneisses found along the Colorado River on the Uncompahgre Plateau (Lohman, 1981). These rocks are, in turn, covered by a sedimentary section many thousands of feet thick. The oldest of the sedimentary formations, the Triassic Chinle Formation, is found southwest of Grand Junction unconformably overlying Precambrian rocks. The large time interval missing between the Precambrian and Triassic rocks supports the premise that the Uncompahgre Plateau was uplifted and eroded some 250 to 220 million years ago, then subsequently buried by a thick sequence of sedimentary rocks. The lower part of this sequence in the Grand Junction area has a thickness of over 500 feet and includes the Triassic Chinle formation, Wingate Sandstone, and Kayenta Formation (Figure D.2.2).

Overlying these layers are approximately 800 feet of Jurassic rocks, including the Entrada Sandstone and the Summerville and Morrison Formations. Of the approximately 7000 feet of overlying Cretaceous rocks present in the Rifle-Grand Junction area, the Mancos Shale, which outcrops near Grand Junction, comprises about 4000 feet.

The Wasatch Formation, an interbedded sequence of shale, siltstone, and sandstone of early Tertiary age, overlies the Mesa Verde Group. In some areas, the basal part of the Wasatch Formation is mapped as a separate formation, the Ohio Creek Conglomerate. The Wasatch Formation has been divided into three members by Donnell (1961a,b). Shale and claystone dominate the lower and upper members whereas the middle member is primarily sandstone. Overlying the Wasatch Formation is the Tertiary Green River Formation containing one of the world's richest oil shale deposits (Lohman, 1981). This formation forms much of the Roan Cliffs exposed along the Colorado River near Rifle. Recently, the upper sandstone and siltstone member of the Green River Formation, the Evacuation Creek member, has been named the Uinta Formation (Tweto et al., 1978).

Along the Grand Hogback and northward to the interior of the White River Plateau, rock units of Precambrian to Cretaceous age are exposed. Cambrian to Permian beds of sandstone, siltstone, shale, limestone, and conglomerate crop out in increasingly steeply dipping layers to the north edge of the Grand Hogback monocline. The steeply dipping monocline itself consists of siltstone, sandstone, shale, and coal beds of Triassic to late Cretaceous age (Tweto et al., 1978).

The Colorado River valley at Rifle is cut into Wasatch Formation bedrock. The valley is bordered to the north by outcrops of the eastern section of the Book Cliffs and to the south by an eastern extension of the Roan Cliffs. The thick sequence of sedimentary rocks that forms the cliffs and the valley lies within a structural downwarp known as the Piceance Basin. The bedrock generally slopes toward the axis of the basin; however, in the Rifle area, the general structural trend has

GEOLOGIC AGE	STRATIGRAPHIC UNIT	ROCK DESCRIPTION	APPROXIMATE THICKNESS IN FEET
Early Tertiary	Uinta Formation	Tan, gray, and buff siltstone, sandstone, and marlstone.	800-1000
	Green River Formation	Tan to gray calcareous siltstone with dark brownish gray kerogen-rich beds (oil shale); forms steep slopes and cliffs.	1000-3000
RIFLE SITES →	Wasatch Formation and Ohio Creek Conglomerate	Varigated sandstone, siltstone, shale, mudstone, conglomerate; forms benches and slopes.	300-5000
		Unconformity	
Late Cretaceous	Mesa Verde Group	Buff colored sandstones and siltstones with coal beds; forms cliffs.	1000-5000
	Mancos Shale	Gray and black shale with thin beds of sandstone and limestone; forms slopes and valley floors.	3000-6000
	Dakota Sandstone	Sandstone, coaly shale, conglomerate; forms benches and slopes.	100-225
		Unconformity	
Early Cretaceous	Burro Canyon Formation	Green siltstone, shale, sandstone, conglomerate; forms benches and slopes.	10-225
Late Jurassic	Morrison Formation	Varicolored claystone, sandstone, siltstone with thin limestone beds; forms slopes and badlands.	300-600
Middle Jurassic	Summervile Formation	Red and green colored siltstone, mudstone and thin sandstones; forms slopes.	40-60
	Entrada Sandstone	White and salmon-red quartz sandstone; Slick Rock member forms cliffs.	75-300
		Unconformity	
Late Triassic (?)	Kayenta Formation	Red and purple siltstone, shale, sandstone, and conglomerate; forms bench between cliffs.	0-200
Late Triassic	Wingate Sandstone	Buff and light red sandstone; cross-bedded; forms steep cliffs.	300-400
	Chinle Formation	Red siltstone, shale, limestone, and conglomerate; forms steep slopes at foot of cliffs.	80-120
		Unconformity	
Precambrian Proterozoic Y and X	Unnamed	Gneiss, schist, granite, and pegmatite dikes; forms floors of canyons in Uncompahgre Plateau.	Unknown

REF. FCRI, 1982.

FIGURE D.2.2
GENERALIZED STRATIGRAPHIC COLUMN, RIFLE AREA

been modified by the White River Uplift, and the strata dip approximately five to 10 degrees toward the west-southwest. The transition between the Piceance Basin and the White River Uplift is marked by the Grand Hogback which is less than 10 miles northeast of Rifle and is associated with faulting of Cretaceous and Tertiary Age rock units (Tweto el al., 1978).

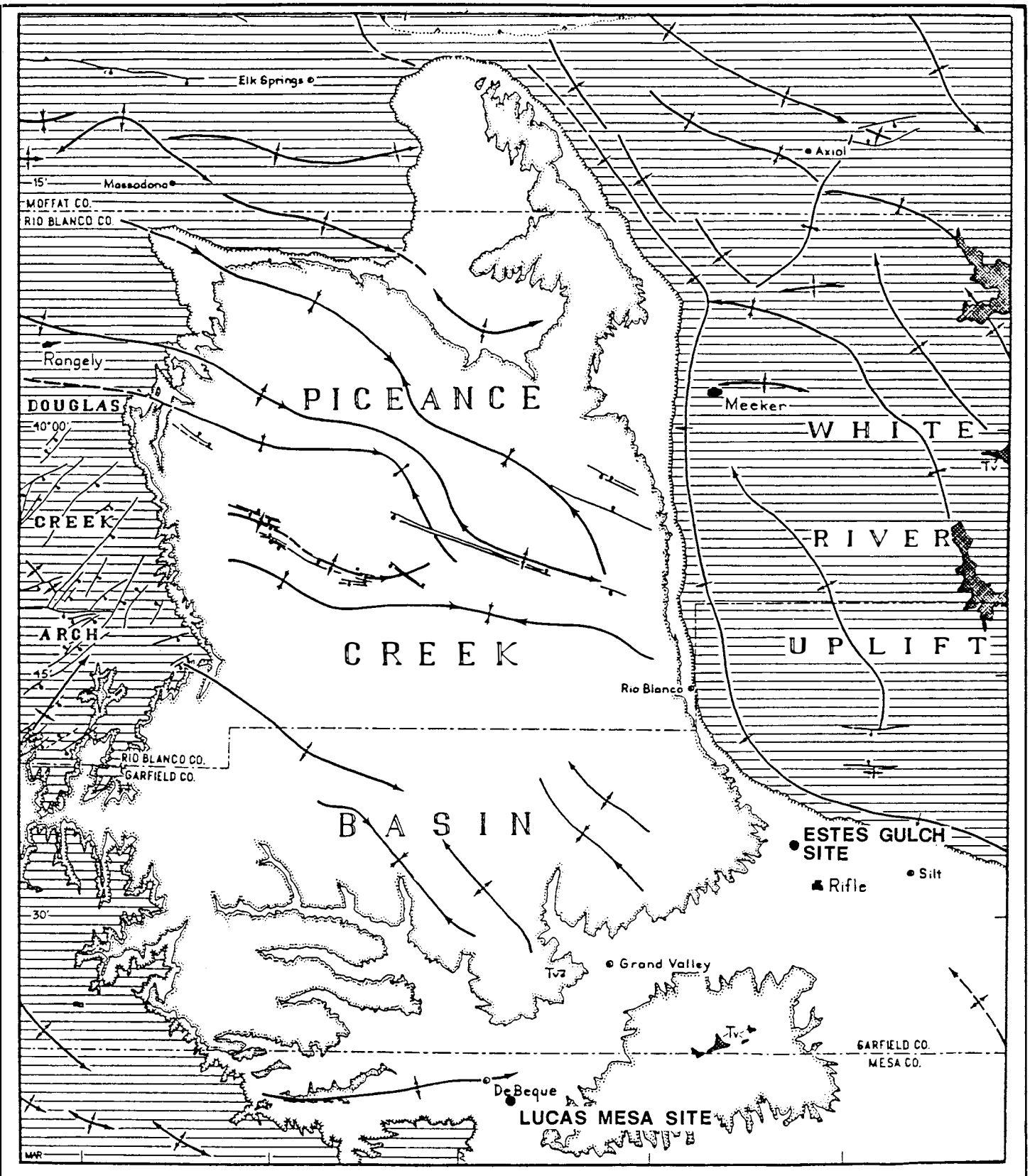
D.2.3 REGIONAL STRUCTURE

Regional structure in the Rifle-Grand Junction area consists of broad uplifts and deep structural basins (Schwochow, 1978). The Uncompahgre Uplift, which trends northwest-southeast, is the most obvious structural feature. These uplifts and basins have smaller-scale folds and faults associated with them. For example, the northeast margin of the Uncompahgre Uplift is bounded by normal faulting and monoclinal folding. The Grand Hogback monocline to the northeast and east of Rifle marks the boundary between the Colorado Plateau and White River Uplift. The Rifle area lies on the extreme northeastern edge of the Colorado Plateau near the boundary with the Rocky Mountain Foreland and White River Uplift.

The Colorado Plateau is a structurally unique area in the western United States in that it has been only moderately deformed in comparison with the more intensely deformed and tectonically active regions that surround it. The most distinctive structural features of the plateau are monoclines along the edges of major uplifts. Most of the structural deformation has occurred along these features (Kelley, 1955). The major tectonic divisions of the Colorado Plateau are defined by geographically widespread uplifts and structural basins. Each of the major uplifts is bounded on one side by a major monocline. Structural and tectonic divisions along the northeast edge of the Colorado Plateau are shown on Figure D.2.3.

The regional structural setting of the Colorado Plateau is influenced by the Cordilleran Foldbelt to the west and south. The foldbelt is characterized by flat-lying thrust faults that have yielded toward the foreland to the east and northeast. The zone of frontal breakthrough of the thrust parallels and nearly coincides with the older zone of transition between the Cordilleran geosyncline and the platform along the western edge of the craton. Locally, traces of the thrusts appear to bend eastward into Arizona and New Mexico. Uplifts and basins of the Rocky Mountain Foreland lie east and north of the Colorado Plateau. The intensely deformed regions noted above contrast markedly with the vast expanses of gently dipping strata and scattered monoclines of the Colorado Plateau.

During the late Cretaceous and throughout the Laramide orogeny (early Tertiary), the Colorado Plateau was subjected to compressional stress, producing folds usually expressed by east-dipping monoclines. Other structural elements developed during this time include the Rocky Mountain Foreland and the basins and the uplifts of the Colorado Plateau interior. A change in the stress regime to one of regional tension during the Miocene initiated the development of a system of



REF: MURRAY AND HAUN, 1974.

5 0 5 10

SCALE IN MILES

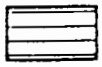
FIGURE D.2.3
TECTONIC MAP OF THE PICEANCE CREEK BASIN

EXPLANATION

OUTCROP SYMBOLS



MIOCENE (?) AND PLIOCENE
VOLCANIC ROCKS



MESOZOIC AND PALEOZOIC ROCKS
(LOCALLY INCLUDES TERTIARY BROWNS PARK FORMATION)



BASE OF EOCENE GREEN RIVER FORMATION



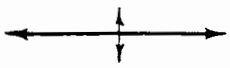
PRECAMBRIAN ROCKS



BASE OF EOCENE AND PALEOCENE
WASATCH FORMATION

STRUCTURE SYMBOLS

FOLDS



ANTICLINE
SHOWING DIRECTION OF PLUNGE



SYNCLINE
SHOWING DIRECTION OF PLUNGE



MONOCLINE

FAULTS



NORMAL FAULT
BAR AND BALL ON DOWNTHROWN SIDE

REVERSE FAULT
DOTTED WHERE CONCEALED OR INFERRED

FIGURE D.2.3
TECTONIC MAP OF THE PICEANCE CREEK BASIN (CONCLUDED)

high-angle normal faults superimposed on the earlier Laramide folds to the west, south, and southeast of the plateau. Epeirogenic uplift of the entire plateau apparently occurred late in Cenozoic time and may be related to the synchronous development of the Basin and Range structures. Injection of laccoliths and other intrusions occurred after Laramide time producing domes and other minor modifications of some of the older structures. The stable, intracontinental subplate of the Colorado Plateau interior has experienced about two millimeters per year of uplift since the late Tertiary (Gable and Hatton, 1980).

Enechelon folding along the eastern and northern regions of the Colorado Plateau indicates a northeastward direction of yielding relative to the surrounding areas. This northeastward direction of yielding appears to be related to the sharp bend in the Cordilleran Foldbelt in southeastern California where the foldbelt cuts into the crystalline basement rocks. East-west compression in the Nevada segment of the Cordilleran Foldbelt and nearly north-south compression in the foldbelt in Arizona and New Mexico gives a resultant vector that trends northeast. Therefore, the northeast yielding of the Colorado Plateau appears to be related to the compressional forces in the foldbelt to the south and west. It seems likely that primary horizontal compression deep within the crust beneath the plateau resulted in local secondary stress fields near the surface having strong vertical components. This implies a strong crust which was capable of transmitting horizontal stresses over long distances without intense deformation (Woodward, 1973).

Northeastward compressional tectonism in the Colorado Plateau and southern Rocky Mountains during the Laramide orogeny resulted in enhancement of pre-existing basement structures in western Colorado. The Colorado Plateau acted as a semirigid plate, rejecting intense deformation and thrust faulting along its western and southern margins, but forming generally north-oriented monoclines over Precambrian basement faults (Baars and Stevenson, 1981). Major uplifts and basins in western Colorado, including the Uncompahgre Uplift, the White River Uplift, the Piceance Basin, and the Grand Hogback, were formed as a result of the westward compressive stresses during the Laramide. Major structures resulting from Laramide tectonism in the Rifle area are the Uncompahgre Uplift, the Piceance Basin, and the White River Uplift.

The Uncompahgre Uplift is a northwestward-trending asymmetrical feature cored with Precambrian rocks and with flanks composed of Mesozoic rock units (Kelley and Clinton, 1960). The northwestern edge plunges toward the Uinta Basin and is characterized by numerous small anticlines and synclines. The southwestern side is modified by numerous high-angle faults, most of which are downthrown to the south or southwest (Kelly and Clinton, 1960). The uplift is a remnant of an older, much larger highland that was a prominent structural feature during the late Paleozoic. The Uncompahgre Uplift is one of the few tectonic features within the stable Colorado Plateau interior that is potentially active. Considerable movement has occurred along bounding faults and monoclines during the Pliocene and Quaternary and may be continuing to the present time (Kirkham and Rogers, 1981).

The Piceance Basin is an asymmetric structural downwarp, elongated northwest-southeast and lying between the Uncompahgre Uplift to the south and the White River Uplift to the north and east. The surface rocks of Upper Cretaceous shales, mudstones, and sandstones dip gently on the south and west and more steeply on the north and east. The portion of the basin near Rifle is characterized by numerous subparallel northwest trending anticlines and synclines (Figure D.2.3). Several northwest trending normal faults with small displacements are also present in the northeastern part of the basin (Donnell, 1961a). The Grand Hogback monocline forms the eastern boundary of the Piceance Basin. A fault zone indicated by a prominent topographic lineament trends roughly east-west about 40 miles northwest of Rifle. Geomorphic investigations of this fault zone have revealed features suggestive of Holocene faulting (McGuire et al., 1982).

The White River Uplift is a roughly circular, high structure occupying part of the northwest-trending deformational zone between the ancestral Rocky Mountain Front Range and the Uncompahgre-San Luis Highland. The steeply dipping Grand Hogback monocline forms the western and southern boundary of the uplift. Major uplift of the feature occurred during the Laramide. The White River Uplift appears to lack a pre-Laramide structural expression, but the border of the uplift may be controlled by older basement faults (Tweto, 1980a). Numerous faults cutting Precambrian to Tertiary bedrock units occur along and north of the Grand Hogback monocline (Tweto et al. 1978). Neogene tectonism in western Colorado resulted in widespread block faulting and elevation of the White River Uplift at least 2000 feet higher than the surrounding areas (Tweto, 1980a).

D.2.4 SITE GEOLOGY

Colluvial, alluvial, or aeolian soils directly underlie the Rifle tailings sites and are described in Section D.1. Underlying the unconsolidated deposits at the sites is the Shire Member of the Wasatch Formation. A brief description of the bedrock units in order of increasing depth down to the Mancos Shale is as follows:

- The Wasatch Formation is a single stratigraphic unit divided into an upper member, the Shire; a middle member, the Molina; and a lower member, the Atwell Gulch. The Shire Member consists of variably colored claystones and siltstones with minor units of lenticular, brown sandstones. The thickness of the Shire Member near Rifle is probably about 1600 feet although some of it may have been removed by erosion. The Molina Member consists mainly of sandstone and thin, interbedded claystones and siltstones. It is probably about 500 feet thick. The Atwell Gulch Member, probably about 600 feet thick, is a series of drab brown and gray shales and sandstones with several thin, discontinuous interbeds of lignite and carbonaceous shale.

- The Ohio Creek Formation is a single massive, or series of massive, conglomeratic sandstones containing mostly pebbles of chert and quartzite derived from older sedimentary rocks. The thickness is approximately 100 feet.

- The Mesa Verde Group is a composite of light brown to white sandstone, gray to black shale, and coal beds of the Williams Fork Formation (maximum thickness of 4500 feet). Also included are massive beds of light brown to white sandstone and interbedded shale and coal of the Iles Formation (maximum thickness of 1600 feet) (Tweto et al., 1978).

- The Mancos Shale is a gray marine shale with a few thin limestone beds and a few beds of sandstone. The Mancos Shale is approximately 6000 feet thick near Rifle (Murray and Haun, 1974; Tweto et al., 1978).

None of the borings drilled at any of the sites penetrated beyond the near-surface Shire Member. Figure D.2.4 depicts a generalized cross section of the Rifle area geology.

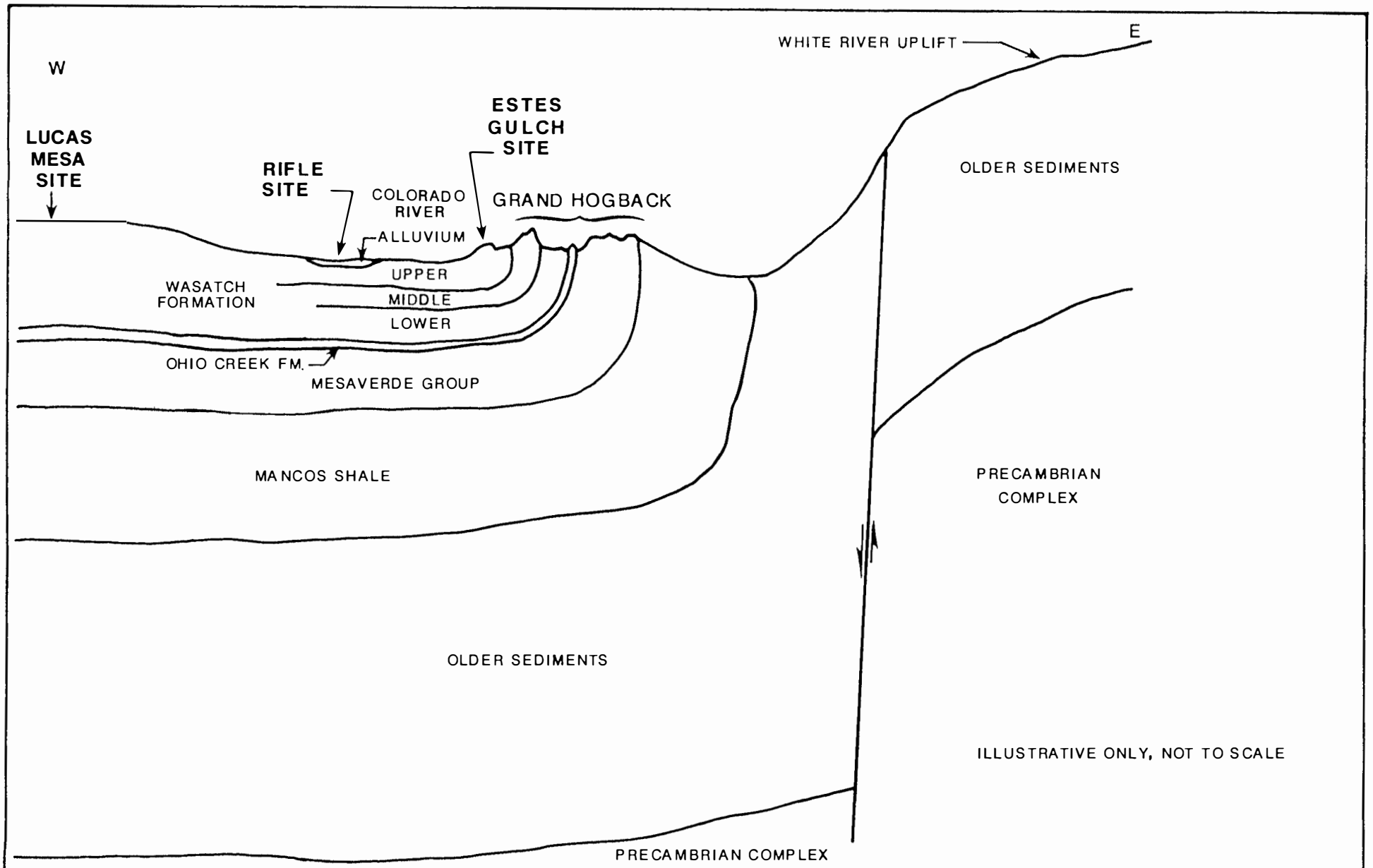
Old and New Rifle sites

At the Old and New Rifle sites, the Wasatch Formation dips at between four to 10 degrees toward the northwest and consists of relatively impervious variegated claystones and siltstones containing minor lenticular beds of sandstone. The locations of subsurface borings at the Old and New Rifle sites are shown in Figures D.2.5 and D.2.7, respectively, and geologic cross sections developed from the borings are shown in Figures D.2.6 and D.2.8 through D.2.10.

Estes Gulch site

At the Estes Gulch site, a soil consisting of alluvial, colluvial, and aeolian deposits mantles the Wasatch Formation to depths of three to 43 feet. The underlying claystones and sandstones of the Wasatch Formation are weathered, fractured, and oxidized to depths of up to 100 feet below their upper contact with the soil mantle. Distinct slickensides are pervasive throughout the claystone. The fracturing appears to be a result of the local faulting and folding processes that created the Grand Hogback monocline.

The formation dips 10-20 degrees to the southwest immediately southwest of the site and abruptly changes to 65 to 70 degrees in a faulted zone which could translate locally into a monoclinal fold. The fault has no topographic expression and occurs on strike within the siltstone and claystone units. Figure D-18 shows the position of the fault 500 to 800 feet downslope from the disposal site. The fault trends with the axis of the Hogback monocline fold and is on strike with the bedding planes. Minor faults occur randomly within the steeply dipping strata beneath the site and appear as smooth planes with thin clay gouge fillings. Typically, closely spaced joints or



REF: DOE, 1983.

FIGURE D.2.4

GENERALIZED GEOLOGIC CROSS SECTION, RIFLE AREA

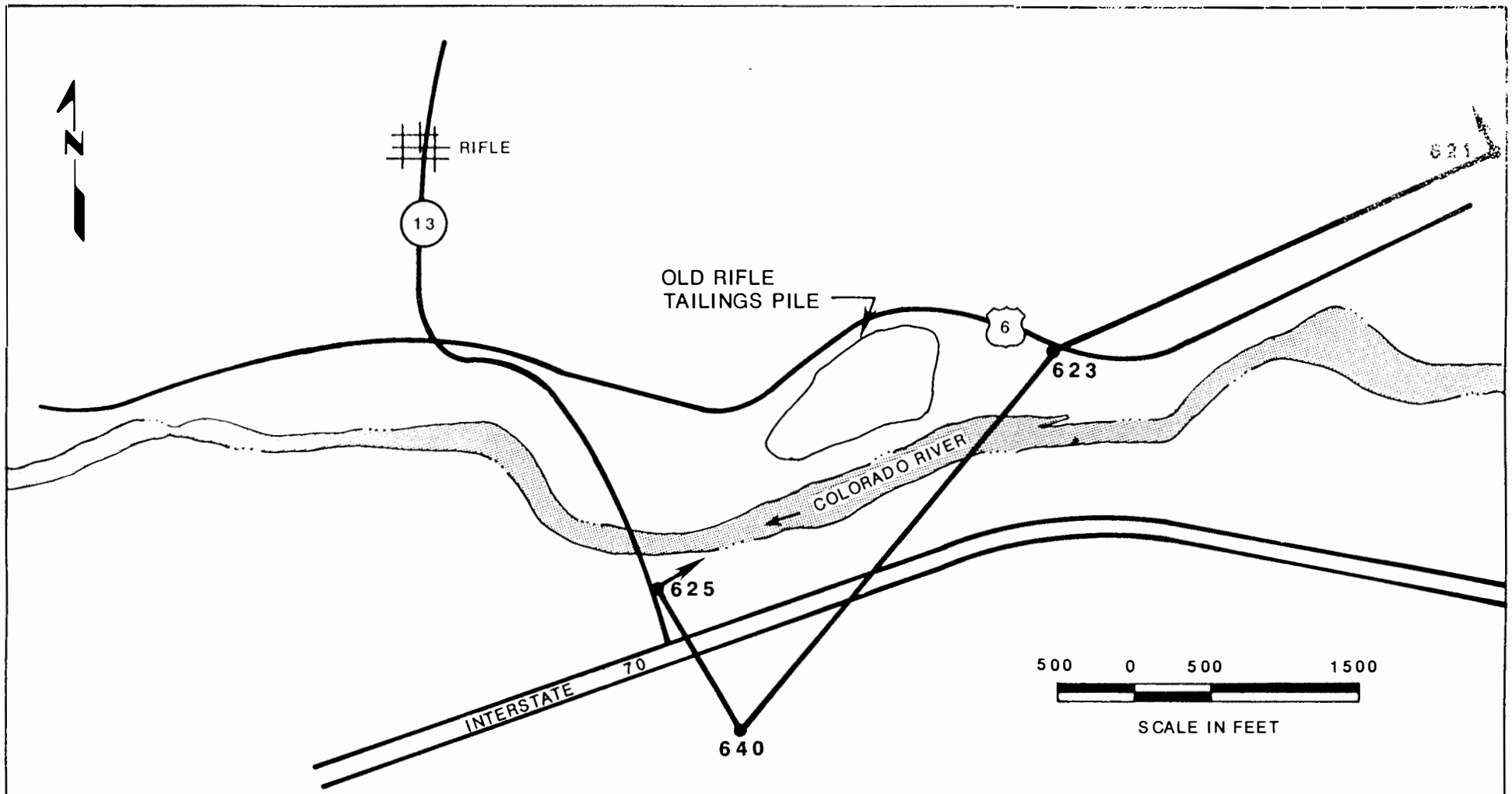


FIGURE D.2.5
SUBSURFACE BORING LOCATIONS, OLD RIFLE SITE

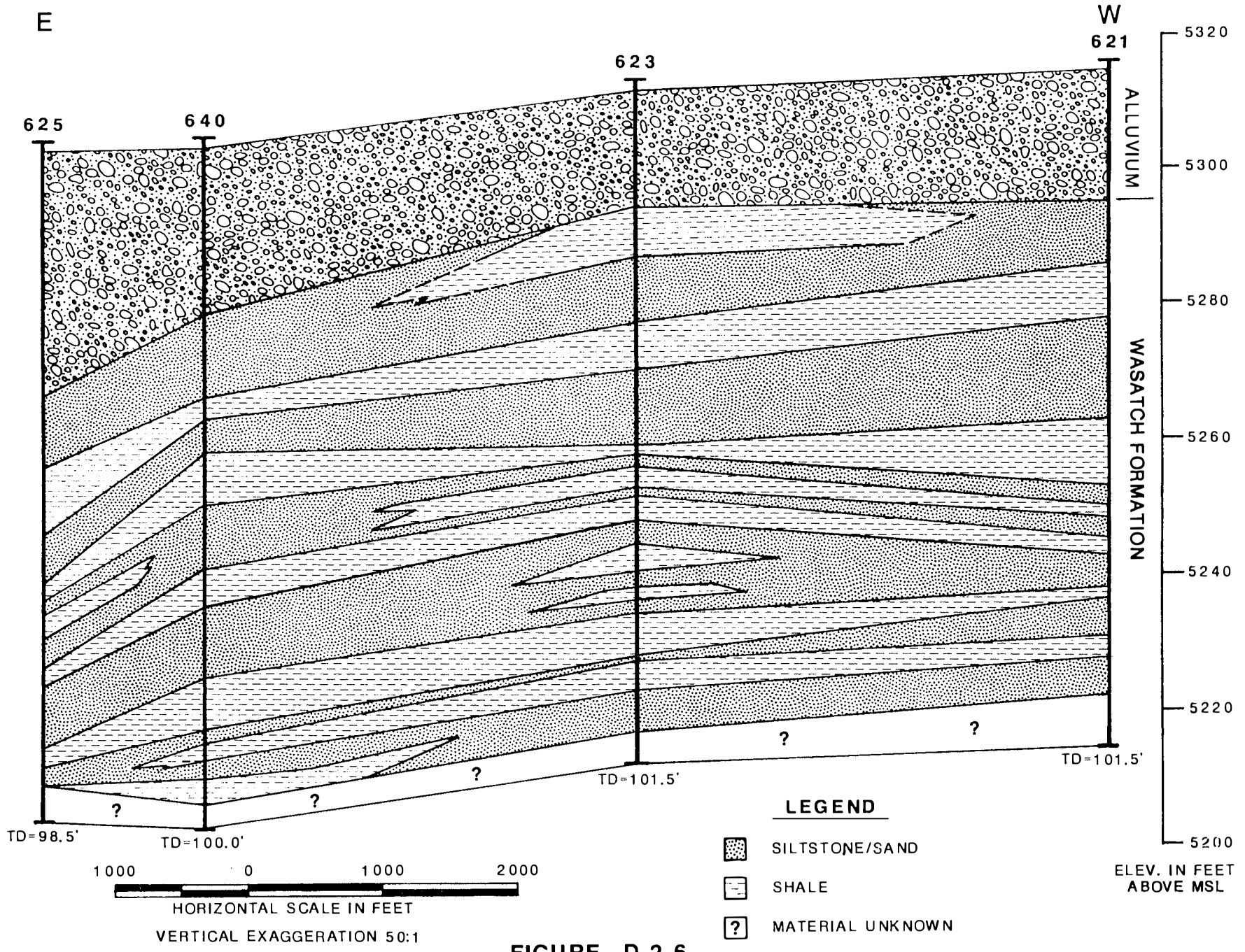


FIGURE D.2.6

GEOLOGIC CROSS SECTION, OLD RIFLE SITE

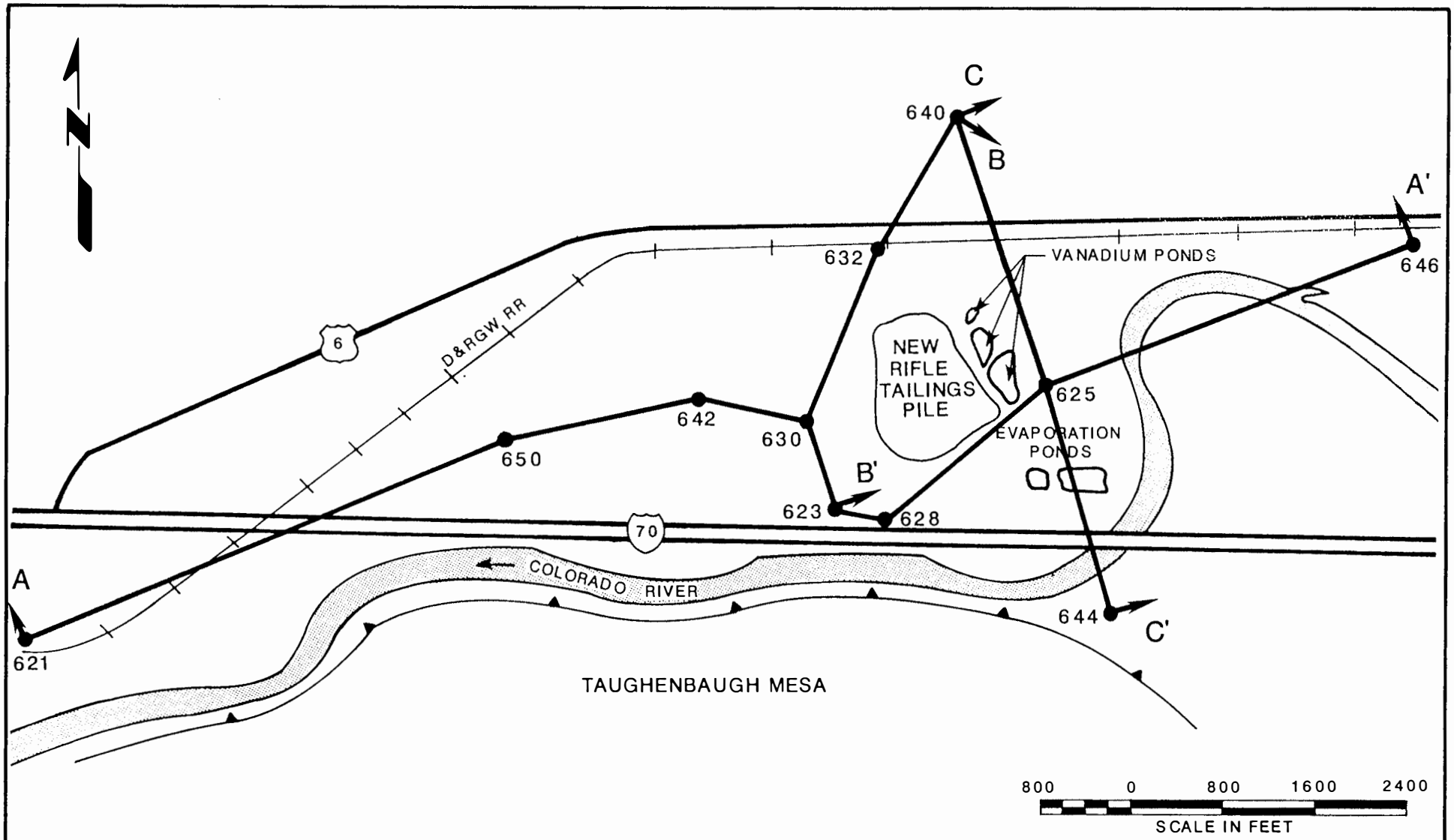


FIGURE D.2.7
SUBSURFACE BORING LOCATIONS, NEW RIFLE SITE

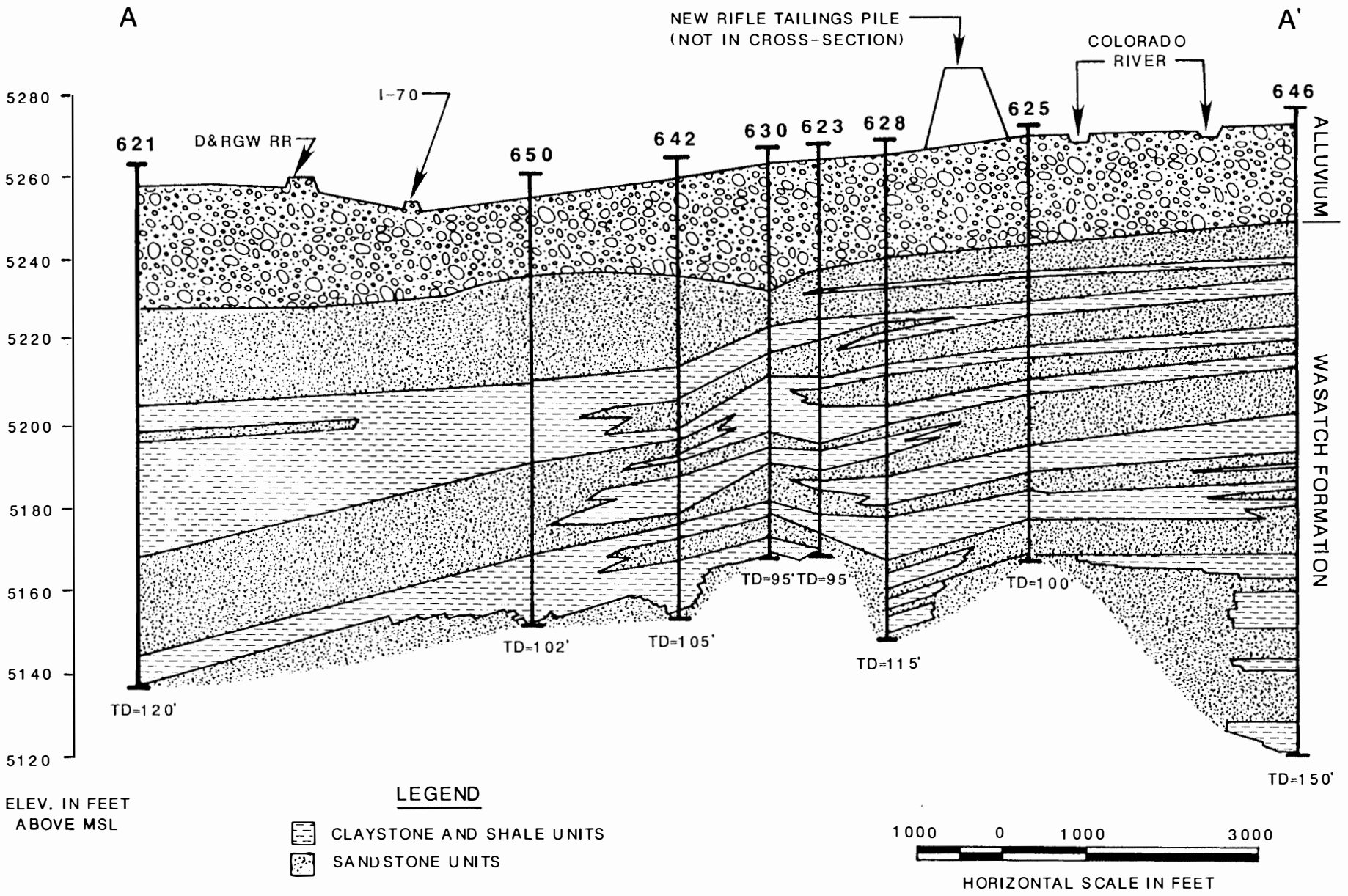


FIGURE D.2.8
GEOLOGIC CROSS SECTION A-A', NEW RIFLE SITE

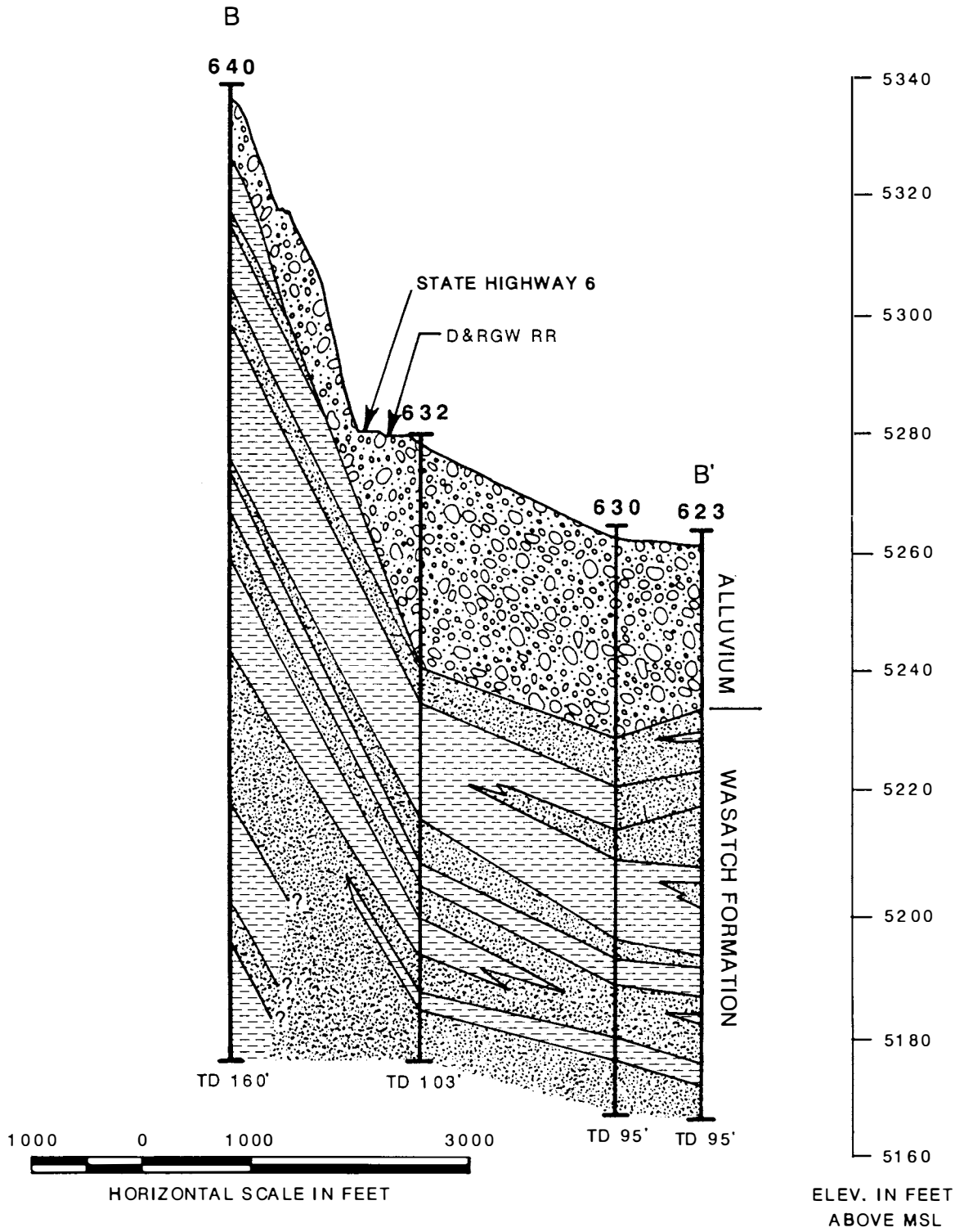


FIGURE D.2.9
GEOLOGIC CROSS SECTION B-B', NEW RIFLE SITE

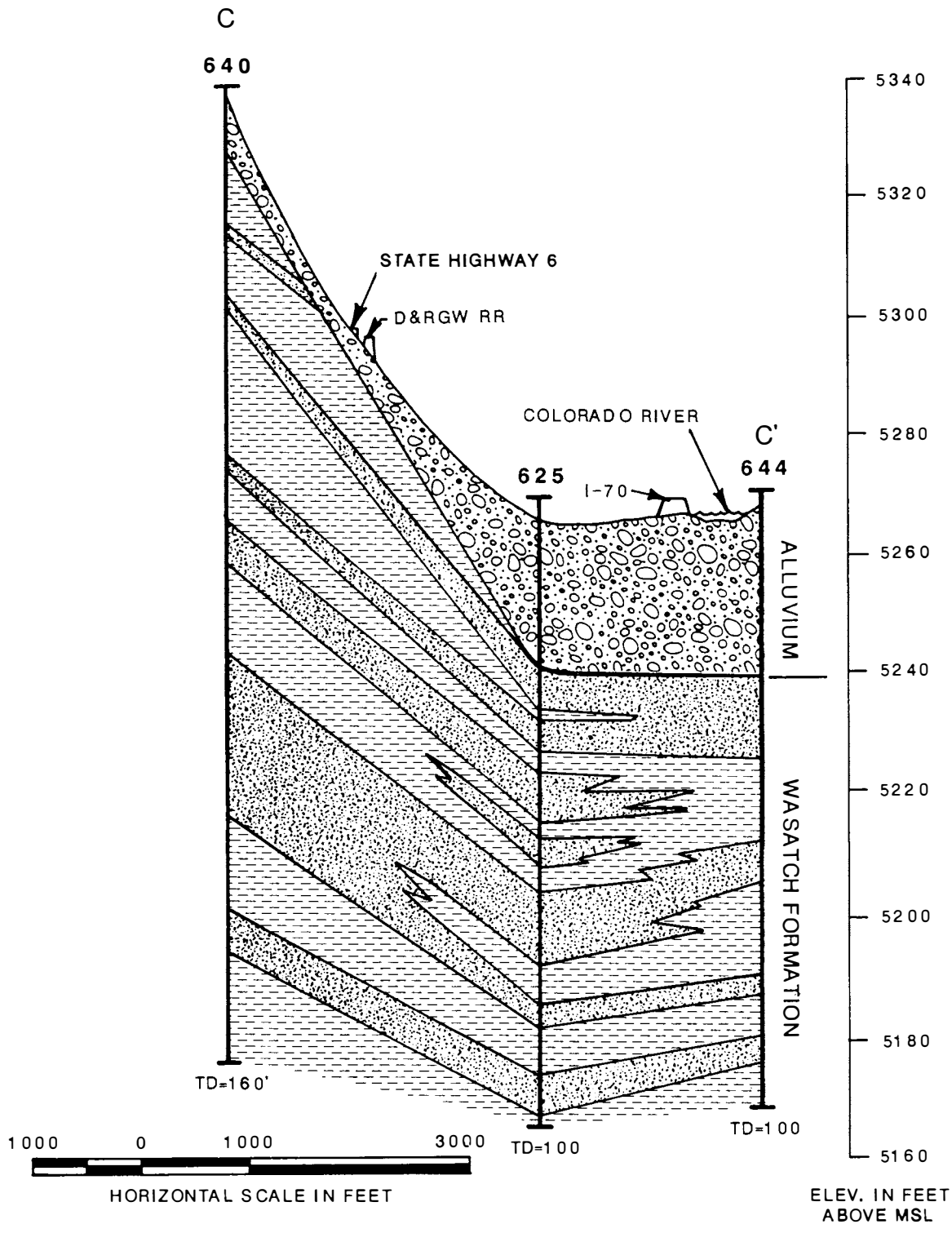


FIGURE D.2.10
GEOLOGIC CROSS SECTION C-C', NEW RIFLE SITE

fractures occur near these gouge-filled faults, and become widely spaced within a few feet of the minor fault. Long reaches of the cores drilled contained no fractures at all. All fractures and faults appeared very tight and usually did not affect core recovery.

The strike of the Wasatch Formation is to the northwest. The site is structurally located within the western limb of the Grand Hogback monocline. Cretaceous units of the underlying Mesa Verde Group sandstones and shales crop out along the monocline to the north of the site. The Tertiary Green River Formation oil shales, sandstones, and marlstones crop out along the eastern Book Cliffs about four miles west of the site.

Lucas Mesa site

As indicated in Section D.1, the Lucas Mesa site is underlain by 30 to 89 feet of basalt gravel, cobbles, and boulders in a matrix of clayey silt. This remnant debris flow from Grand Mesa forms a resistant cap to the mesa which is underlain by the Shire Member of the Wasatch Formation. Borings did not extend over a few feet into sandstone bedrock. Based on surficial geologic information, the Wasatch Formation is relatively flat-lying.

D.3 GEOMORPHOLOGY

D.3.1 REGIONAL GEOMORPHOLOGY

Geomorphic features and Quaternary deposits in the Rifle area reflect the interaction of geologic and climatic variables. The physiography and topography and the Quaternary deposit record attest to the predominance of fluvial and eolian erosion and mass movement processes operating in a semiarid to temperate climate during Quaternary time. Climatic fluctuations are indicated by the abundance of glacial deposits adjacent to high elevation mesas. Since about 10,000 years ago, fluvial erosion processes have been the dominant geomorphic force in the region. Late Cenozoic uplift of the Colorado Plateau has been the major driving force in the evolution of the landscape, triggering landscape rejuvenation, stream channel incision, and removal of massive amounts of sedimentary bedrock. At least 5000 feet of regional downcutting of major rivers into sedimentary rocks of early Tertiary to Late Cretaceous age has occurred since uplift began (Yeend, 1969). Downcutting has produced long, steep slopes, oversteepened cliffs, and narrow canyons. Extremes in elevation, slope exposure, and the range of bedrock types allowed varied geologic processes to operate through time and produced very different effects on the landscape.

Landforms indicative of glacial processes are abundant at higher elevations throughout the region. Glacial, alluvial, and colluvial deposits associated with two major glaciations occur in high elevation areas of the White River Plateau and on Battlement and Grand Mesas south of the Colorado River (Cole and Sexton, 1981; Tweto et al., 1978). Glacial deposits are represented by till, moraines, outwash gravels, and alluvial terrace and fan gravels on the flanks of mesas. At Grand Mesa, ice reached levels as low as 5800 feet, and outwash deposits reach to the level of the Colorado River (Yeend, 1969).

Pediment surfaces and mesa slopes in the area have been extensively modified by slope failure and colluvial processes. Landsliding and slumping of basalt blocks on Grand Mesa have occurred over two sedimentary units containing claystones (Yeend, 1969). The mesa edges are characterized by a wide, irregular surface with disrupted drainages, numerous lakes, and slump blocks. Colluvial processes operating on Battlement Mesa produced solifluction, slumping, landslides, and mudflows. Talus deposits and rock glaciers are also present on steep slopes in the area. Numerous gravel-veneered pediment surfaces occur on the flanks of Grand and Battlement Mesas (Cole and Sexton, 1981).

Since disappearance of the last glaciers, stream downcutting has been the dominant geomorphic process. Arroyos are common features of the more arid slopes. Quaternary age sand and gravel deposits are present along the Colorado River and major tributary streams. Most talus slopes appear to be stable, but small, active slumps, earthflows, and landslides are present adjacent to Grand Mesa (Yeend, 1969). Permanent streams are currently cutting into their floodplains. Active eolian processes are depositing fine grained sand and silt over most bedrock

terraces and pediment surfaces. Stream aggradation is not a common process along perennial, through-going streams. Climatic change would probably result in continued downcutting, perhaps at more accelerated rates than at present.

Rates of denudation and downcutting

In reference to the possible influence of the long-term erosion processes upon remedial action design, a discussion of the rates of denudation and stream downcutting is provided below. The rates of denudation are the rates at which a land surface is being lowered as a result of erosional processes. These rates vary with climate and the amount of precipitation. As pointed out by Schumm (1963), it is obvious that no surface is lowered in a uniform manner; however, rates of denudation and downcutting have been estimated, generally for a period of 1000 years.

Long-term erosion rates calculated from radiometrically dated surfaces and geomorphic relationships observed in the Colorado Plateau range from 0.1 to 3.0 feet per 1000 years during late Tertiary and Quaternary time (Woodward-Clyde Consultants, 1982). For the range of rock lithologies present on the Colorado Plateau, the average rate of downcutting of one foot per 1000 years is a generous estimate (Schumm and Harvey, 1983). For the upper Colorado River and Gunnison River basins, Sinnock (1981) has proposed vertical erosion rates of about 0.1 inch per year (8.3 feet per 1000 years) and lateral cliff migration rates of 0.25 to 1.00 inch per year (20.8 to 83.3 feet per 1000 years) since Miocene time (about 30 million years before the present). Sinnock (1981) also proposes accelerated erosion rates for these areas throughout the middle and late Tertiary and into the Quaternary due to increasing river gradients associated with epeirogenic uplift. Pleistocene erosion rates may represent maximum amounts during the last 65 million years. Studies in the Paradox Valley area, however, indicate that late Pleistocene erosion rates were similar to the long-term rates (Woodward-Clyde Consultants, 1982). The long-term denudation rates discussed above represent an average for the last 1.5 to two million years. The actual incision process probably involves periods of virtually no downcutting alternating with periods of active incision.

Within the Rifle-Grand Junction region, rates of downcutting and scarp erosion are similar to average rates for the Colorado Plateau. Measurements of hillslope erosion on the Mancos Shale near Grand Junction show that the upper portions of the slopes were lowered about 0.25 inch during four years (Schumm and Chorley, 1966). Near Grand Mesa, the average rate of downcutting by the Colorado River is 0.5 foot per 1000 years (Yeend, 1969). Tributaries to the river show current aggradation along small ephemeral streams but are experiencing degradation along major perennial streams. Consequently, downcutting is occurring even at low elevations. Schumm and Harvey (1983) suggest that the Colorado River at Rifle is not incising as a result of uplift and conclude that Pleistocene uplift responsible for the Uncompahgre Plateau has ceased. They also conclude that degradation of the

Colorado River is controlled locally by resistant metamorphic and igneous bedrock and that degradation should not exceed about one foot during a 1000-year period if renewed uplift occurs. Periods of climatic change, whether to warmer and drier conditions or cooler and wetter conditions, would probably result in increased initial rates of downcutting in the Rifle area (Yeend, 1969). A long period of cool, wet conditions would ultimately result in increased sediment yield at higher elevations and stream aggradation at lower elevations.

Major climatic changes during the next 1000 years in the Rifle area will probably be of lesser magnitude than the climatic shift following the last full glacial period in the southwestern United States. This period ended in northwestern Colorado about 10,000 years ago. Valleys of higher elevation in the Rocky Mountains were extensively glaciated as recently as 8000 years ago although some regions were ice-free as early as 14,000 years ago (Burke and Birkeland, 1983). Paleoclimatic reconstructions for the last full glacial period in the southwest differ in interpretation of precipitation and temperature in comparison with the present. Most interpretations of this period propose a climate characterized by increased precipitation, cooler summer temperatures, and milder winters for the desert areas (Spaulding et al., 1983). Other paleoclimatic data suggest a period of precipitation amounts similar to today's but with much colder summers and winters (Brackenridge, 1978). Studies in Canyon de Chelly, Arizona (Betancourt and Davis, 1984), and in the Chaco Canyon region of New Mexico (Betancourt et al., 1983; Hall, 1977), indicate a late glacial climate for the Colorado Plateau characterized by cooler summers and more abundant rainfall concentrated in the winter months. Paleoecological reconstructions based on evidence from the eastern Grand Canyon and the Mogollon Rim regions of Arizona also indicate cooler and probably moister glacial climatic conditions than at present. Upper elevation plateaus north of latitude 36° north probably experienced severe winters. Paleohydrologic reconstructions of the Colorado Plateau region suggest an increase of total annual precipitation of seven to 10 inches (Spaulding et al., 1983). Inactive periglacial features (patterned ground, frost-stirred sediments, ice wedges, permafrost evidence, and talus slopes) occur at numerous locations in the Colorado Rockies, indicating cold periods during the Late Pleistocene (Péwé, 1983). Analyses of periglacial features in the San Francisco Peaks and the White Mountains of Arizona indicate mean annual mountain temperatures 5°C to 6°C (9°F to 11°F) lower than today's (Péwé et al., 1984). Colorado Plateau temperatures were probably lowered by about the same amount.

The record of climatic variation during the past 10,000 years (Holocene) in the western Colorado region of the Colorado Plateau has been inferred from soil and alluvial stratigraphy, periglacial features, and paleoecological evidence. Beginning about 12,000 years ago, the annual average temperatures throughout the Rocky Mountain region were increasing enough to result in retreat of glaciers from lower valleys (Richmond, 1972). Minor fluctuations of mean temperatures between 11,000 and 9000 years ago resulted in readvances of glaciers in upper valleys. Pollen analysis at sites in western Colorado indicates

lower tributaries and a cooler and moister climate from 10,000 to 7600 years before the present. Subalpine sites in southwestern Colorado and Utah show a warm interval from about 7000 to 4000 years before the present (Baker, 1983). This period corresponds to the warm altithermal interval in the Southwest during which all glaciers disappeared from the Rocky Mountains (Richmond, 1972).

From 7600 to 6700 years before the present, the subalpine site at Redrock Lake in central Colorado (10,100 feet above mean sea level) has a pollen record suggesting a climate much like today's and a cooler and moister climate from 6700 to 3000 years before the present (Baker, 1983). The onset of Neoglaciation in the Rocky Mountains about 4000 years ago appears to have been preceded by a period of climatic cooling and increased fluvial erosion beginning as early as 5000 years before the present (Richmond, 1972).

A lower elevation site in western Colorado (Alkali Basin at 3060 feet above mean sea level) presents an interesting contrast with the higher, subalpine sites. Modern vegetation is dominated by sagebrush. Early Holocene pollen analysis shows a pine dominated vegetation with increasingly semiarid-type vegetation from 10,000 to 5000 years before the present (Baker, 1983). A progressively warmer, drier climate is indicated since 10,000 years before the present and especially during the last 5000 years. No evidence is found of an "altithermal" climate, warmer than at present during the middle Holocene, nor of a Neoglacial cooling in the Late Holocene. Paleoclimatic data from the Rocky Mountains show that a Holocene climate has progressed through a time of increasing warmth since about 10,000 years before the present with brief periods of slightly cooler and possibly wetter climate followed by about 3500 years of maximum warmth followed in turn by cooling and a succession of minor fluctuations in temperature to the present (Richmond, 1972). A trend of increasing warmth appears to be present for most areas for the past 4000 years. No long-term cooling trend can be predicted until the present glaciers surpass their maximum limits of the past 4000 years. A dramatic climatic shift from present conditions to cooler, moister conditions, similar to those of the Late Wisconsin, could result in lower mean annual temperatures, increased precipitation, and increased streamflow. Climatic trends over the past 4000 years, however, argue against a dramatic climatic shift to cooler and wetter conditions.

Climatic variation within the last 1000 years in western Colorado has probably been significantly less than the glacial-postglacial change. Interpretations of Colorado Plateau climatic conditions from tree ring studies (Stockton and Jacoby, 1976) and historical records show a high degree of variability in precipitation during the past few hundred years. Average ranges of temperature and precipitation for the past few hundred years, and for the future few hundred to a thousand years, probably are similar to the range of historical records; however, it is recognized that extreme events beyond the range of recorded variability probably occurred in the past and can be expected to occur within the next thousand years.

D.3.2 SITE GEOMORPHOLOGY

Old Rifle site

The Colorado River is the major geomorphic feature affecting the Old Rifle site (Schumm and Harvey, 1983). Other minor impacts including dispersion by wind and surface water runoff must also be considered during design.

The Colorado River upstream from Rifle is an island-braided channel. Approximately three miles downstream from the town of Silt, the river shows a divided flow characteristic with large vegetated islands and numerous gravel bars. The pattern of old channels at this location indicates that the river has, within recent times, occupied positions across an entire section from U.S. Highway 6 to the north to Interstate Highway 70 (I-70) to the south. The Colorado River is a cobble and boulder bed river in this reach, and the probability of future lateral shift of the channel is very high. This conclusion is supported by the patterns observable on the U.S. Geological Survey (USGS) Silt 7.5-minute quadrangle.

Just upstream of the Old Rifle site the river becomes a single channel as it impinges against a bedrock outcrop immediately upstream from the Old Rifle site. The course of the river parallels the site and the Denver and Rio Grande Western (D&RGW) railroad, and it then turns to the north to pass under the State Highway 13 bridge at Rifle.

Recent aerial photographs indicate that the southern river bank has been farther to the south immediately south of the Old Rifle site. The Old Rifle site occupies an old meander scar; however, this area was not occupied by the river in 1890 when the General Land Office surveys were made. In spite of the fact that there are bedrock outcrops and controls both upstream and downstream of the site, it is possible that the river could shift laterally into the old meander scar. The secondary-flow channel upstream from the site, if reoccupied by the main flow, would direct the flow into the Old Rifle site. Therefore, although the site is protected upstream and downstream by bedrock outcrops, the potential for lateral shift of the Colorado River toward this site is considered high.

The site at present is well protected by the massive riprap placed to protect the south side of the D&RGW Railroad. Although the flow during a site visit was directed against the riprap at some locations, there is no indication of erosion or failure of the riprap. There are some small salt cedar and cottonwood trees growing out of the riprap indicating that there has been no erosion of the riprap, at least during the last decade. On the opposite side of the river, where the bank is lower than both the railroad grade and the tailings pile surface, there is trash at the top of the bank which indicates that overbank flow occurs to the south during periods of high discharge. The valley is wide and the river will occupy the south side during overbank flow, thereby reducing the flood height and potential damage to the riprap and to the tailings pile.

Cobble and boulder bars are exposed along the reach of the Colorado River adjacent to the Old Rifle site. Some clasts are exposed on the bars with sizes in excess of one foot in longest axis. These boulders are very stable and seem to be locked into position (i.e., imbricated). Some are stained indicating that they have not moved during recent flood events. It is assumed that the cobbles and boulders in the main thread of flow of the Colorado River will be larger and that, in fact, the bed of the river may be armored by large boulders that will prevent scour. Examination of longitudinal profiles for the reach encompassing the Old and New Rifle sites indicates that the Old Rifle site is situated on a less steep reach of the river, as compared to upstream and downstream reaches, which is characterized by the presence of many islands. Reworking of the reach by the river is, therefore, to be expected, and it is likely that the dominant channel will change its location with time.

New Rifle site

The major geomorphic feature impacting the New Rifle site is the Colorado River (Schumm and Harvey, 1983). The New Rifle site lies downstream from the city of Rifle below a divided flow reach of the Colorado River which is characterized by a very large meander bend immediately east of the tailings site. According to the 1890 General Land Office surveys, this bend was not in existence at that time, and the reach was characterized by divided flow. The northernmost channel of this reach passed very close to the New Rifle tailings pile, and its position can be noted on modern aerial photographs. Downstream from the large meander bend, the river is located against the southern valley bluff, and divided flow characteristics are less apparent. Approximately two miles west of the site, the river becomes braided, and a USGS photograph shows that the river is essentially in the same position and has the same characteristics today as it did in 1926.

The evidence from the General Land Office surveys, the USGS Rifle 7.5-minute quadrangle, and aerial photographs indicates that the river has occupied its entire floodplain since 1890 at the tailings pile location. This means that the site is clearly subject to lateral shift of the Colorado River. There is riprap on the downstream limb of the meander which seems to be effective in protecting the site and preventing further lateral shift of the meander. However, the riprap is being outflanked at the apex of the bend, and, if this situation is not corrected, flood waters may enter the site in the near future. It should also be noted that the riprap that is being used appears to be Mesa Verde Sandstone which is deteriorating. Downstream near the I-70 bridge, the riprap is comprised of basalt boulders, and this, of course, is resistant and does not show signs of weathering. Observations in the channel show that there is an algal growth on the gravel except where the flow is confined directly against the riprap. This indicates that the boulders and cobbles do not move readily; it is assumed that the coarse cobbles and boulders in the main thread of the channel have armored the bed and that further incision of the channel is unlikely.

The large bend just upstream from the site is anomalous; that is, it is not characteristic of the Colorado River between Silt and Rifle, and it is the result of man's intervention. The likelihood that this bend will cutoff is high as there are chute channels crossing the point bar within the bend and there is a major chute channel crossing the base of the point bar. This is shown as a divided-flow side channel on the USGS Rifle quadrangle, and it appears as the dry channel on the aerial photographs.

Estes Gulch site

The geomorphic hazards at the Estes Gulch site are gully erosion, arroyo encroachment, wind erosion, and surface water runoff. Surface water runoff and wind erosion are of minor consequence if the stabilized tailings pile is properly designed. The Estes Gulch site is at the head of a hollow and has little upland drainage.

Gully erosion and arroyo encroachment have a greater potential to impact the site. The gullies that are present at the site are deeply incised indicating recent downcutting. Also, numerous piping features are resulting from the dessication cracks that are forming in the clayey soil adjacent to the deep gullies. The piping is accelerating forward and lateral erosion. A small pond construction at the lower reach of the main gulley system has temporarily stabilized the downcutting. The potential exists for future erosion and downcutting. Development of lateral branches of adjacent arroyos also pose a hazard to the site.

The origin of at least some of the site soils is colluvial in nature, and some of the near surface soils appear to have originated from minor mudflows or surface wash. As a result, some of the site soils may exhibit a structure having the potential for collapse upon wetting.

Lucas Mesa site

The geomorphic processes affecting the Lucas Mesa site include gully erosion, wind erosion, and surface water runoff. Basalt boulders and cobbles provide a natural armoring for the steeper sideslopes of Lucas Mesa making them resistant to erosion. It is estimated that the surface will be stable in excess of 10,000 years (GCS, 1982).

Some headward migration of drainage systems into the surface of the mesa from the steeper bordering slopes is occurring, but, because of the cobbles and boulders, it is not strongly developed and does not result in significant drainage areas. Gullies which have formed drain the mesa surface and not surrounding areas. The dominant erosion pattern occurs by sheet wash and wind as evidenced by bare soil areas at the site. There is some minor transport by ephemeral streams and limited soil creep; however, there is no evidence of active processes degrading the mesa surface.

D.4 SEISMICITY

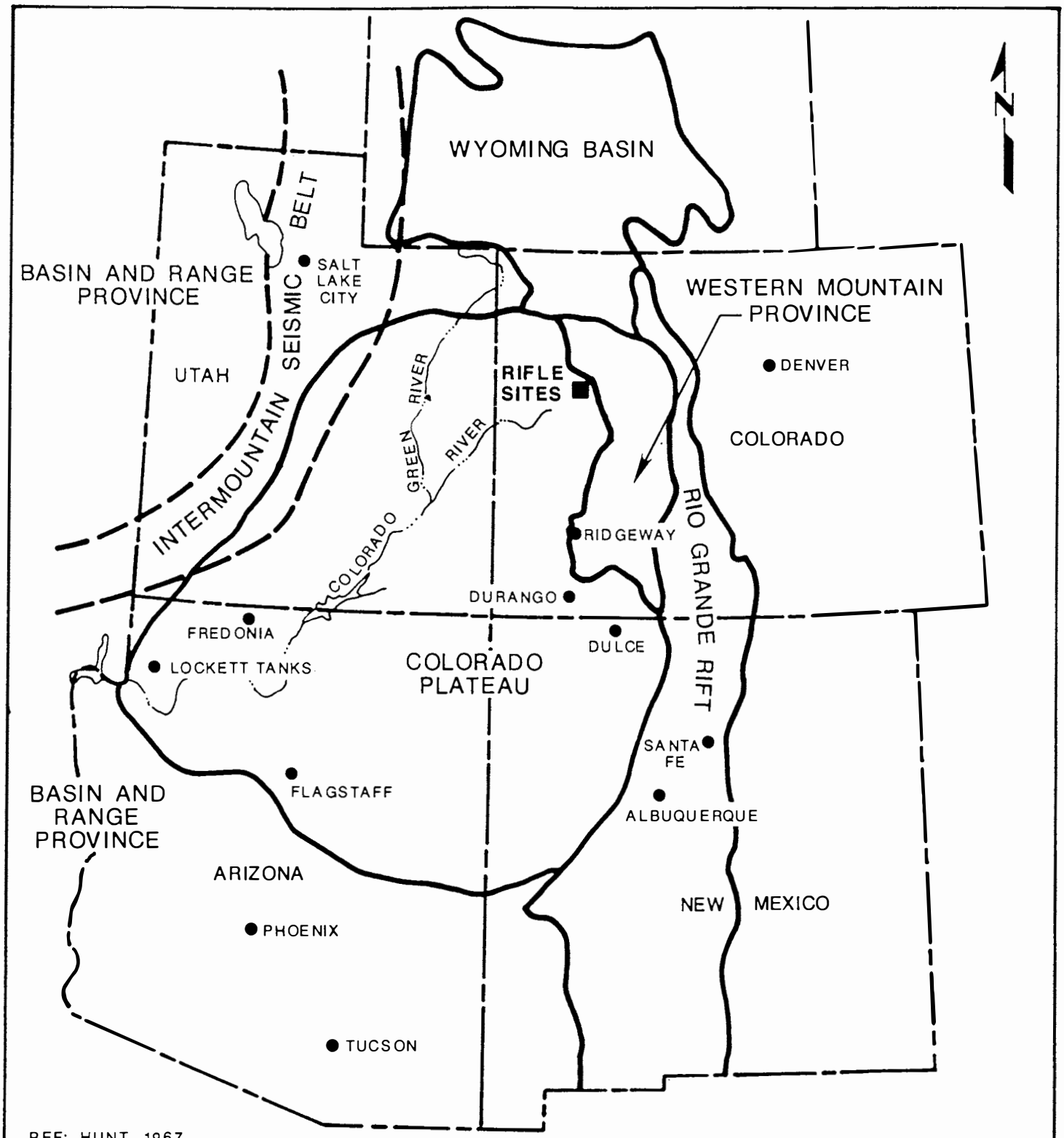
D.4.1 REGIONAL SEISMOTECTONIC SETTING

Seismic hazard studies in much of the southwestern United States are hampered by the lack of a reliable long-term historical record. Movements on major fault systems in the region may have recurrence intervals on the order of tens to hundreds of thousands of years; however, the historical record dates back only to the middle or late nineteenth century. The historical record for Arizona dates back to 1776 (DuBois et al., 1982), for Utah to 1850 (Arabasz et al., 1979), for Colorado to 1870 (Kirkham and Rogers, 1981), and for New Mexico to 1849 (Sanford et al., 1981). Reliable and reasonably complete instrumental records generally date back only to the early 1960s. As a general rule, the historical record is probably reliable for moderate to large earthquakes since about 1900 to 1910, while the instrumental record is probably reliable for earthquakes of magnitude 4.5 or greater since the early 1960s (Von Hake, 1984).

In the absence of a reliable long-term historical record, probabilistic analyses of seismic risk are of limited use. Therefore, seismic risk analyses are largely based on studies of the geologic and seisomotectonic setting, Cenozoic geologic history, and geomorphic evidence of late Tertiary and Quaternary fault movements. Fortunately, erosion rates are slow and vegetation is generally sparse in the arid to semiarid climates that prevail in most of the region. Long faults, which are necessary for large earthquakes, will not remain undetected if careful geologic investigations are made (Krinitzsky and Chang, 1975).

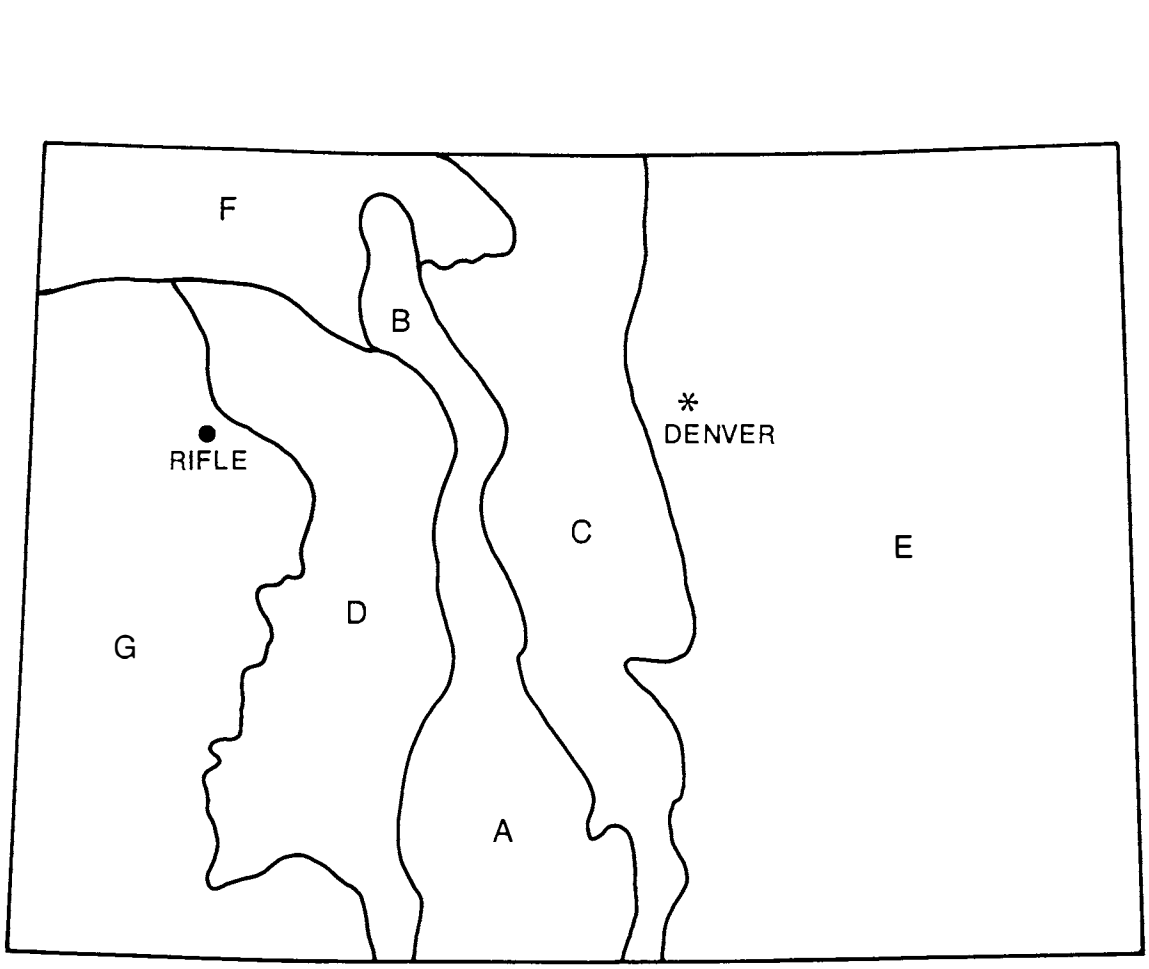
The Rifle tailings sites are located near the northeast edge of the Colorado Plateau physiographic and seismotectonic province. The boundaries of seismotectonic provinces in the site region, as defined for this document, are shown on Figure D.4.1. They are determined on the basis of published studies of Neogene faulting, regional seismicity trends, areas of Cenozoic igneous activity, geophysical data, and the distribution of major physiographic provinces. Seismotectonic provinces in Colorado are shown on Figure D.4.2. Shown on Figure D.4.3 is a plot of historical and instrumentally located earthquake epicenters for events of magnitude greater than or equal to 4.0 and modified Mercalli intensity greater than or equal to V for the Colorado Plateau region. The epicentral data for Figure D.4.3 were provided by the National Oceanic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colorado, and are available in the DOE UMTRA Project Office, Albuquerque, New Mexico.

The Colorado Plateau, Basin and Range, Rio Grande Rift, and Sierra Nevada provinces appear to be part of an interrelated system that has experienced major uplift and extension during the last 20 million years. Within the Basin and Range and Rio Grande Rift provinces bounding the Colorado Plateau are found geologic and geomorphic evidence of repeated surface faulting events associated with large earthquakes during



REF: HUNT, 1967.
KELLEY AND CLINTON, 1960.
KIRKHAM AND ROGERS, 1981.
MENGES AND PEARTHREE, 1982.
NEW MEXICO GEOLOGICAL SOCIETY, 1982.
PEARTHREE, et al., 1983.
SMITH AND SBAR, 1974.

FIGURE D.4.1
REGIONAL SEISMOTECTONIC PROVINCES



REF: KIRKHAM AND ROGERS, 1981.

LEGEND

A - SOUTHERN RIO GRANDE RIFT SUBPROVINCE
B - NORTHERN RIO GRANDE RIFT SUBPROVINCE
C - EASTERN MOUNTAIN PROVINCE
D - WESTERN MOUNTAIN PROVINCE
E - PLAINS PROVINCE
F - UINTA-ELKHEAD PROVINCE
G - COLORADO PLATEAU PROVINCE

FIGURE D.4.2
SEISMOTECTONIC PROVINCES IN COLORADO

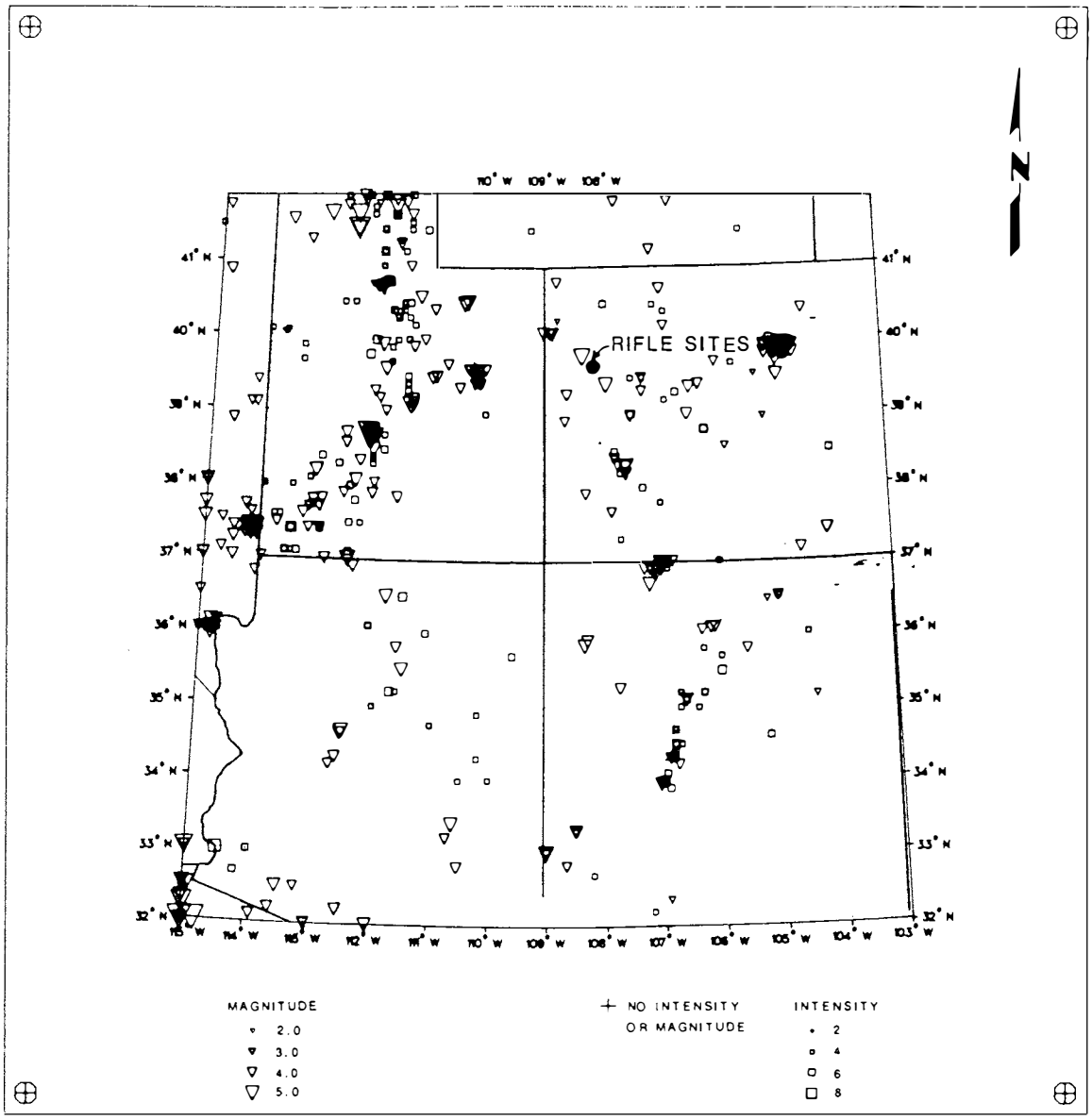


FIGURE D.4.3
EARTHQUAKE EPICENTERS OF THE SOUTHWESTERN UNITED STATES

Quaternary time. They have experienced some of the largest historical earthquakes in the entire United States. These regions are characterized by large volumes of Cenozoic intrusive rock, thinner crust, higher heat flow, and stress fields oriented differently than the modern stress field in the interior of the Plateau (Thompson and Zoback, 1979). The boundary of the Colorado Plateau and the Basin and Range province on the west is marked by the Wasatch Frontal fault system in Utah which forms a major segment of the Intermountain Seismic Belt (Smith and Sbar, 1974). Some of the largest historical earthquakes of the Colorado Plateau have occurred in the border zone in northern and central Arizona along the edge of the Arizona Basin and Range province. The Rio Grande Rift and the eastern Colorado Plateau border zone in New Mexico and southwestern Colorado and the border zone of the Colorado Plateau and Western Mountain provinces in western Colorado have also been the locus of elevated seismicity in historical times. To the north, the Colorado Plateau is bordered by the Wyoming Basin, a series of broad basins and uplifts that are structurally and tectonically similar to the Plateau. This transition zone is not marked by elevated seismicity. Seismotectonic characteristics of the Colorado Plateau and adjacent provinces are provided in Table D.4.1.

Colorado Plateau province

The modern Colorado Plateau is composed of a stable interior portion bounded on the east, south, and west by more highly active border zones. For this document, the interior and border zones are defined as separate subprovinces, and the boundary is drawn at the 40-kilometer (km) crustal thickness contour. The border zones lie within the physiographic boundary of the Colorado Plateau but are characterized by elevated seismicity, thinner crust, higher heat flow, common normal faulting, and elevated levels of Tertiary and Quaternary volcanism relative to the interior. Nearly all of the larger historical earthquakes of the Plateau have occurred within the border zones.

The Colorado Plateau is a major continental block which has been uplifted since late Tertiary time at a low rate of between two to three millimeters per year (Gable and Hatton, 1980). The plateau block has experienced little internal distortion in contrast with the more tectonically active regions of the Rio Grande Rift, the Arizona Basin and Range province, and the Intermountain Seismic Belt. Major seismotectonic characteristics of the Colorado Plateau interior province are listed in Table D.4.1.

Neogene faulting is generally rare within the interior portion of the Colorado Plateau except for faulting associated with the Uncompahgre Uplift and the collapsed salt anticlines of the Paradox Valley. Earthquakes are rare. The historical seismicity of the interior portion has been classified by Wong (1984) as very low level, having events of small to moderate magnitude with diffusely distributed epicenters. The largest instrumentally recorded earthquakes within the interior portion have fallen in the magnitude range of 4.5 to 5.0.

Table 0.4.1 Seismotectonic characteristics of the Colorado Plateau and adjacent provinces

Province	Crustal thickness[a,b] (kilometers)	Lithosphere thickness[a,c] (kilometers)	Earthquake focal depth (kilometers)	Direction of least principal horizontal stress[c,d]	Primary mode of faulting[b,d]	Maximum recorded earthquake magnitude[e]	Maximum earthquake magnitude[f]	Floating earthquake magnitude[g]
Colorado Plateau interior (northern Arizona)	40	80	5-26[h]	NNE	Strike-slip and thrust	5.5[i]	6.5	6.2
Basin and Range (central and north central Arizona)	30	60	10-15[j]	WNW to E-W	Normal	5.75[i]	6.5	6.2
Intermountain Seismic Belt (southern Utah)	25	30	15[k]	ENE	Normal	6.5[l,m]	7.5	6.2
Rio Grande Rift (northwestern New Mexico)	40	60	20-44[n]	WNW	Normal	6.3	6.5	6.2
Western Mountain	45-50	100	--	E-W	Normal	5.5[m]	6.5[m]	6.2

[a]Ref. Thompson and Zoback, 1979.
[b]Ref. Smith, 1978.
[c]Ref. Keller et al., 1979.
[d]Ref. Zoback and Zoback, 1980.
[e]Based on historical earthquake records.
[f]Based on earthquake intensity-fault length relationships.
[g]Based on the maximum event that would not cause ground rupture.
[h]Ref. Giardina, 1977.
[i]Ref. Dubois et al., 1981.
[j]Ref. Eberhart-Phillips et al., 1981.
[k]Ref. Smith and Sbar, 1974.
[l]Ref. Arabasz et al., 1979.
[m]Ref. Wong et al., 1982.
[n]Ref. Kirkham and Rogers, 1981.

The largest historical earthquakes recorded within the Colorado Plateau have occurred in the border zones. These earthquakes include:

- Events of estimated magnitudes 5.5 to 5.75 at Lockett Tanks, Arizona, in 1912, and Fredonia, Arizona, in 1959 (DuBois et al., 1982). These events occurred within the Arizona border zone separating the Colorado Plateau from the Basin and Range province to the south.

- The Dulce, New Mexico, earthquake of January 23, 1966, with a magnitude of 5.5. This event occurred in the zone of transition between the Colorado Plateau and Rio Grande Rift (Herrmann et al., 1980).

- The earthquake of October 11, 1960, with a magnitude of 5.5 located northeast of Ridgway, Colorado, which was strongly felt in the Ridgway-Montrose area. This event may be associated with the Ridgway fault which terminates the southeastern end of the Uncompahgre Uplift, marks the northwestern boundary of the San Juan volcanic field, and may be the boundary between the Colorado Plateau and Western Mountain provinces (Sullivan and Martin, 1981; Kirkham and Rogers, 1981).

Recurrence intervals have not been established for large earthquakes within the Colorado Plateau. They may be on the order of tens or hundreds of thousands of years.

Kirkham and Rogers (1981) have identified several faults with apparent Quaternary movement associated with the Uncompahgre Uplift and the salt anticline regions of the Colorado Plateau. Along the northeast flank of the Uncompahgre Uplift, an east-west trending fault offsets Quaternary pediment gravels by about four feet and underlying Mancos Shale by about 10 feet. Other faults along the northeastern flank of the uplift appear to be no younger than Laramide age. Faults expressing Quaternary movement also occur along the southwestern flank of the Uncompahgre Uplift. Faults bounding the Ute Creek graben appear to have been active during the late Pliocene and Pleistocene and may be active today. Other faults have indications of Quaternary movement, most important of which is the Ridgway fault bounding the southern end of the uplift. The Ridgway fault offsets Quaternary gravels and is associated with historical earthquakes. Faults associated with the collapse of salt anticlines in the Paradox Basin are the result of salt flowage and are unlikely to generate earthquakes larger than magnitude 4.0 or 5.0. These faults, however, may be associated with deep-seated subsurface faults capable of producing larger magnitude events.

Arizona Basin and Range province

The Arizona Basin and Range province lies south and west of the Colorado Plateau rim (see Figure D.4.1). It is characterized by block-faulted mountain ranges and intervening alluvial valleys. Formation of the landscape has been the result of large-scale faulting, folding, and

volcanic activity associated with the Laramide and Basin and Range orogenics (Giardina, 1977). The region is generally subsiding, relative to the Colorado Plateau, at a rate of about 0.018 to 0.08 millimeter per year over the past 12 million years (Gable and Hatton, 1980). The Sonoran Desert region of the province in southwestern Arizona has been tectonically stable since the Quaternary. The region along the western and southern edge of the Colorado Plateau has experienced high-angle faulting continuing in places into the late Pleistocene and perhaps into early Holocene (Morrison et al., 1981). Tectonic deformation began about 10 to 17 million years ago in Arizona. Deformation along the edge of the Colorado Plateau ceased about four to six million years ago. Initial development of a compression stress field later changed to regional extension oriented east-west to west-northwest. Current horizontal distension is estimated at 0.3 to 1.5 centimeters per year (Gable and Hatton, 1980). The dominant structural style is high-angle normal faulting which has produced horsts and grabens with a wide range of displacements. Most faults are oriented northwest to north to northeast.

Most earthquake activity has occurred in a broad arc around the edge of the Colorado Plateau. In Arizona, major earthquakes have occurred north of the Grand Canyon near Flagstaff and in the Chino Valley region south of Williams. The maximum recorded earthquake occurred near Fredonia, Arizona, with a magnitude of 5.75. Historical earthquake intensities for the Arizona Basin and Range province range from II to VII (Dubois et al., 1981). The only definite association of earthquake epicenters and major tectonic structures is along the central Arizona-Utah border.

Neotectonic faulting has occurred in a broad northwest trending zone across central Arizona and along major active structures extending south from the edge of the Intermountain Seismic Belt in Utah. Although the province has only moderate seismicity with no large historical events, it is believed capable of large magnitude earthquakes (Menges and Pearthree, 1982; Pearthree et al., 1983). Ages of neotectonic displacement range from late Pliocene to possibly Holocene. Recurrence intervals of neotectonic fault displacement along the major active systems along the Arizona-Utah border are estimated on the order of hundreds to thousands of years (Gable and Hatton, 1980).

Intermountain Seismic Belt province

Most major faults in the Intermountain Seismic Belt trend north to northwest. The current stress regime of northwest-southwest extension appears to control historic surface faulting.

The entire belt has experienced more than 15 earthquakes of magnitude 6.0 or greater since the mid-1800s. The largest recorded event was the Hebgen Lake, Montana, earthquake of magnitude 7.1 in 1959. Seismicity near Salt Lake City is anomalously low. In southern Utah, historic earthquake intensities have ranged from III to VI. Earthquake epicenters generally have poor correlation with late Cenozoic faults.

This may be caused by listric faulting and the occurrence of earthquakes on curved fault surfaces at depth. Offset of Quaternary deposits along some fault zones is evident. The maximum recorded earthquake in southern Utah was a magnitude 6.5 event near Richfield in 1901 (Wong et al., 1982).

The Intermountain Seismic Belt includes the Wasatch Frontal Fault System and other major potentially active faults of northern and central Utah. This zone is highly seismic and capable of large earthquakes up to a magnitude of 7.5. Historical earthquake data for the Wasatch Front suggest expected return periods of 22 to 25 years for a magnitude of greater than or equal to 6.0, 111 to 115 years for a magnitude of greater than or equal to 7.0, and 232 to 263 years for a magnitude of greater than or equal to 7.5 (Arabasz et al., 1979).

Rio Grande Rift province

The Rio Grande Rift section of the border zone lies in western New Mexico along the eastern edge of the Colorado Plateau (see Figure D.4.1). It extends from Chihuahua, Mexico, through west Texas, New Mexico, and most of central Colorado almost to the Wyoming border. The present rift originated in the Miocene in response to regional extension and uplift that reactivated the Rocky Mountains (Wong et al., 1982). Regional uplift within the last 10 million years has been about 1.2 to 1.5 millimeters per year (Gable and Hatton, 1980). The southern Rocky Mountain region of Colorado and New Mexico was strongly uplifted between four and seven million years ago, but the rate has since decreased. The rift is characterized by broad, north-south trending basins in which mafic flows and volcanic ash beds are intercalated with alluvial fill. Rifting appears to be continuing as evidenced by fault scarps cutting Pleistocene deposits, high heat flow, ongoing elevation changes, and active magmatism. Most faults within the rift zone have north-south orientations and normal slip movement. In the northern Rio Grande Rift, north-south epicentral trends appear to be related to areas of uplift and arching (Wong et al, 1982).

A high percentage of all the potentially active faults in Colorado and New Mexico lie within this province. The rift has been subdivided into northern and southern subprovinces in Colorado by Kirkham and Rogers on the basis of young faulting. Well-defined evidence of repeated late Quaternary movements is abundant on several faults in the southern subprovince, whereas such evidence is obscure in the northern subprovince. Several major faults are present in the northern subprovince, some of which were active as early as the Precambrian. Of the major faults in this region, only the Frontal fault on the east flank of the Gore Range has possible early Quaternary activity (Kirkham and Rogers, 1981).

Western Mountain province

The mountainous areas to the west of the Rio Grande Rift province form the Western Mountain province of Colorado (see Figure D.4.2).

Included in this province are the San Juan Mountains, Elk and West Elk Mountains, west flank of the Sawatch Range, White River Uplift, and Gunnison Uplift. The Sawatch and White River uplifts lack pre-Laramide expression; however, their borders may be controlled, in part, by older basement faults (Tweto, 1980b). Neogene faults are scarce in this province. Most faults expressing Neogene movement are associated with evaporite flowage or caldera collapse. Despite the apparent absence of major Neogene faults, numerous earthquakes have been recorded within the province. The largest historical earthquake felt in the province was a magnitude 5.5 event near Montrose (Kirkham and Rogers, 1981). No major tectonic faults have been proven to have had Quaternary activity.

D.4.2 SEISMIC HAZARDS

Several probabilistic earthquake maps which plot contours of maximum horizontal accelerations, velocities, and intensities for various return periods have been prepared for the contiguous United States. Examples of such studies are those by Liu and DeCapua (1975), Algermissen and Perkins (1976), the Applied Technology Council (1978), and Algermissen et al. (1982). These studies indicate that an earthquake with a return period of 475 years would induce a ground-motion acceleration of 0.04 to 0.05g in the region of the Rifle sites. The accelerations predicted by calculations for the preferred source-zone set, omitting man-induced earthquakes in the region, are between 0.05 and 0.10g for the 475-year earthquake. If an acceleration of 0.075g (midpoint of the range) is scaled to the 1000-year earthquake, the resulting effective acceleration is 0.1g.

The scope of capable fault analysis for the site seismic evaluations depends on the initial determination of a floating earthquake location and magnitude for the seismotectonic province containing the tailings site. The floating earthquake within a specific seismotectonic province is an earthquake event which is not associated with a known tectonic structure. For outlying provinces, the maximum earthquake is placed at the closest distance along the boundary of each province to the site for calculation of the attenuated on-site acceleration from these provinces.

The maximum earthquake and floating earthquake magnitudes (Table D.4.1) are used to determine the on-site peak horizontal ground accelerations using the attenuation relationship of Campbell (1981). Campbell's constrained relationship between earthquake magnitude and distance to the site is used as the mean plus one standard deviation value (84th percentile). The peak horizontal acceleration is defined as the mean of the peaks of the two horizontal components of an accelerogram record. The site design value is considered a nonamplified, free-field, peak horizontal acceleration.

Following determination of the maximum and floating earthquake magnitudes and the on-site attenuated accelerations, a search was made to determine whether any faults exist in the 65-km (40-mile) radius region which could be the source of earthquakes which would produce on-site acceleration in excess of the value derived from the controlling

maximum earthquake or floating earthquake. The fault length to magnitude relationship of Bonilla et al. (1984) was used to determine the estimated magnitude for suspected capable faults. All fault systems that could not produce accelerations in excess of the floating earthquake value were not analyzed further. A relationship was developed between mapped total fault length and site-distance relationships for potential earthquake magnitudes capable of producing the on-site design accelerations in excess of that produced by the floating earthquake. Based on this relationship, any faults that would produce on-site accelerations equal to or greater than that of the floating earthquake were investigated further. Faults producing on-site accelerations less than the floating earthquake were eliminated from further study.

Floating earthquake analysis

The term floating earthquake employed in UMTRA Project seismic hazard evaluations is defined as "an earthquake within a known tectonic structure." A floating earthquake differs from the maximum earthquake derived for a seismotectonic province in that the latter is typically a large magnitude event usually associated with ground breakage on a known tectonic structure. It is generally accepted that floating earthquakes are events of low to moderate magnitude. Krinitzsky and Chang (1975) state that "Long faults, which are necessary for large earthquakes, would not remain undetected if careful geologic investigations were made." They further observe that uncertainties in the correlation of faults and earthquakes occur with small events of magnitude 4.0 or 5.0. Thus, the magnitude of the floating earthquake cannot exceed that of the maximum earthquake.

In the eastern and central United States, the maximum floating earthquake is considered to be a magnitude 5.75 to 6.0 event (Slemmons et al., 1982), a value presumably equal to the threshold magnitude at which ground breakage will occur. In the Basin and Range Province of the western United States, earthquakes of magnitude greater than approximately 6.0 normally produced fault scarps (Wallace, 1982).

The threshold magnitude is not precisely known for the Colorado Plateau because there are no recorded seismic events associated with ground breakage. The largest recorded earthquakes in the Colorado Plateau have all fallen in the approximate magnitude range of 5.5 to 5.8. It is conceivable that this range may represent the maximum earthquake value for the prevailing stress field. Thompson and Zoback (1979) state that the lack of major faulting and/or seismicity within the Plateau interior indicates low differential (shear) stresses. This range is considerably lower than the maximum earthquake value of 6.5 used for some UMTRA Project sites in the Colorado Plateau. The large value is adopted in part because of the limitations of the historical data base. The magnitude range 5.5 to 5.8 may be a reasonable value for the floating earthquake magnitude, but again a more conservative value is advisable considering the lack of a long-term data base. Since all earthquakes of magnitude 6.5 should be associated with ground breakage (i.e., be associated with a known tectonic structure) and the largest historical events fall in the range of 5.5. to 5.8, the

floating earthquake magnitude probably falls somewhere within the range of 5.8 to 6.5.

An estimate can be made by evaluating the threshold magnitude at which ground breakage occurs from the appropriate fault length to magnitude relationship. The relationship of Bonilla et al. (1984) for plate interiors is:

$$M_S = 6.02 + 0.729 \log L$$

where

M_S = surface wave magnitude.
L = mapped fault rupture length.

The threshold magnitude can be estimated by setting L equal to zero. The resulting magnitude is equal to about 6.0. This is in general agreement with the arguments of Slemmons et al. (1982), Krinitzsky and Chang (1975), and Wallace (1982), cited above. Allowing for possible errors and variability in the determinations discussed above, the more conservative value of magnitude 6.2 is recommended for the maximum magnitude of the floating earthquake in the Colorado Plateau.

In accordance with seismic design procedures commonly used in the siting of nuclear power plants, this event is assumed to occur at a radial distance of 15 km from the site. Using the acceleration to attenuation relationship of Campbell (1981), this results in an on-site peak horizontal acceleration of 0.21g at an 84th percentile level of confidence.

Analysis of significant faulting

Within a 70-mile radius of the Estes Gulch site to the north of the Rifle sites and Lucas Mesa site to the southwest, no known capable faults have been identified by a search of literature for previously mapped faults. The search radii associated with these two sites resulted in total coverage of the Old and New Rifle tailings sites. No field investigations were conducted to verify the age of the identified faults.

Tables D.4.2 and D.4.3 summarize the mapped faults within the search radii and describe their relative age. Faults for which no age could be identified from literature are considered capable of producing an earthquake for the purposes of this document. The Campbell (1981) attenuation relationship was used to derive on-site accelerations. Accelerations for the Old and New Rifle sites would be between those derived for the alternate disposal site. As can be seen by the estimated on-site accelerations presented in the tables, none of the site accelerations derived from faults considered capable exceed the floating earthquake acceleration of 0.21g.

Table O.4.2 Mapped faults and lineaments, Estes Gulch site[a]

Reference for fault/lineament	Fault/lineament length (kilometers)	Distance from site (kilometers)	Estimated maximum earthquake magnitude	Estimated on-site acceleration[b] (g)	Remarks
Tweto, 1976	8.0	51.0	6.7	0.08	
Tweto, 1976	11.0	76.0	6.8	0.05	
Tweto, 1976	8.0	98.0	6.7	0.03	
Tweto, 1976	5.0	56.0	6.5	0.06	
Tweto, 1976	9.0	58.0	6.7	0.07	
Kirkham and Rogers, 1981	19.0	84.0	7.0	0.06	Youngest offset is in late Tertiary igneous rocks
Cashion, 1973	13.0	58.0	6.8	0.08	
Cashion, 1973	9.0	53.0	6.7	0.08	
Cashion, 1973	5.0	48.0	6.5	0.08	
Cashion, 1973	18.0 (26)[c]	38.0 (31)[c]	6.9 (7.0)[c]	0.14 (0.19)[c]	
Cashion, 1973	15.0	34.0	6.9	0.16	
Tweto et al., 1978	3.0	39.0	6.4	0.09	
Tweto et al., 1978	5.0	37.0	6.5	0.11	
Tweto et al., 1978	11.0	27.5	6.8	0.18	
Tweto et al., 1978	10.0	39.0	6.7	0.12	
Kirkham and Rogers, 1981	10.0	76.0	6.7	0.05	Pre-Bull Lake age Quaternary deposits offset
Tweto et al., 1978	20.0	14.0	7.0	0.35	Youngest unit offset is Cretaceous Mesa Verde Group
Tweto et al., 1978	15.0	10.0	6.9	0.41	Youngest unit offset is Pennsylvanian
Tweto et al., 1978	6.5	15.0	6.6	0.28	Youngest unit offset is Pennsylvanian
Tweto et al., 1978	14.0	15.0	6.9	0.31	Youngest unit offset is Pennsylvanian
Tweto et al., 1978	41.0	16.0	7.2	0.35	Youngest unit offset is Pennsylvanian
Tweto et al., 1978	21.0	66.0	7.0	0.08	Youngest unit offset is Pennsylvanian
Kirkham and Rogers, 1981	25.0	66.0	7.0	0.08	Youngest offset is late Tertiary igneous rocks
Kirkham and Rogers, 1981	5.0	67.0	6.5	0.05	Offset in Quaternary deposits
Tweto et al., 1978	4.0	4.0	6.4	0.53	Youngest unit offset is Tertiary Wasatch Formation
Tweto et al., 1978	27.0	4.0	7.0	0.60	Youngest unit offset is Cretaceous Mancos Shale

Table 0.4.2 Mapped faults and lineaments, Estes Gulch site[a] (Concluded)

Reference for fault/lineament	Fault/lineament length (kilometers)	Distance from site (kilometers)	Estimated maximum earthquake magnitude	Estimated on-site acceleration[b] (g)	Remarks
Kirkham and Rogers, 1981	7.0	38.0	6.6	0.11	Pre-Bull Lake age Quaternary deposits offset
Kirkham and Rogers, 1981	5.0	49.0	6.5	0.07	Pre-Bull Lake age Quaternary deposits offset
Kirkham and Rogers, 1981	5.0	66.0	6.5	0.05	Pre-Bull Lake age Quaternary deposits offset
Tweto et al., 1978	47.0	66.0	7.2	0.10	
Tweto et al., 1978	6.0	72.0	6.6	0.05	
Tweto et al., 1978	8.0	70.0	6.7	0.05	
Tweto et al., 1978	4.0	51.0	6.5	0.07	
Tweto et al., 1978	3.0	45.0	6.4	0.07	
Tweto et al., 1978	5.0	55.0	6.5	0.06	
Tweto et al., 1978	3.0	62.0	6.3	0.05	
Tweto et al., 1978	45.0	65.0	7.2	0.10	
Tweto et al., 1978	10.0	65.0	6.7	0.06	
Tweto et al., 1978	27.0	74.0	7.0	0.07	
Cashion, 1973	10.0	49.0	6.7	0.09	
Cashion, 1973 Kirkham and Rogers, 1981	16.0	95.0	6.9	0.04	Redlands fault complex; offset in Quaternary deposits

[a]Mapped faults and lineaments within a 70-km radius of the site.
[b]Values were calculated using the equation of Campbell (1981).
[c]Values in parentheses are based on the fault extending one mile further east.

Table D.4.3 Mapped faults and lineaments, Lucas Mesa site[a]

Reference for fault/lineament	Fault/lineament length (kilometers)	Distance from site (kilometers)	Estimated maximum earthquake magnitude[b]	Estimated on-site acceleration[c] (g)	Remarks
Cashion, 1973	17.0	76.0	6.9	0.06	South Douglas Creek Anticline
Cashion, 1973	8.0	67.0	6.7	0.06	San Arroyo Anticline
Cashion, 1973	33.0	79.0	7.1	0.07	Dolores River Fault
Tweto et al., 1978	23.0	89.0	7.0	0.05	Kirkham and Rogers, 1981; offset in Quaternary deposits
Tweto et al., 1978	16.0	55.0	6.9	0.09	Glade Park, Ladder, Creek, and Bangs Canyon Faults. Kirkham and Rogers, 1981; offset in Quaternary deposits
Tweto et al., 1978	14.0	64.0	6.9	0.07	
Tweto et al., 1978	15.0	72.0	6.9	0.06	
Tweto et al., 1978	10.0	57.0	6.7	0.08	Kirkham and Rogers, 1981; offset in Quaternary deposits
Tweto et al., 1978	13.0	64.0	6.8	0.07	Kirkham and Rogers, 1981; offset in Quaternary deposits
Tweto et al., 1978	4.0	97.0	6.5	0.03	
Tweto et al., 1978	5.0	100.0	6.5	0.03	
Tweto et al., 1978	11.0	73.0	6.8	0.06	
Cashion, 1973	10.0	8.0	6.7	0.44	Youngest unit offset is Tertiary Wasatch Formation

[a]Mapped faults and lineaments within a 70-km radius of the site.
[b]Calculated using the equation of Bonilla et al., 1984.
[c]Calculated using the equation of Campbell, 1981.

D.5 MINERAL RESOURCES

Abundant mineral resources occur within the Rifle region. Known mineral and fossil fuel deposits in the region are sand and gravel, aggregate, uranium, vanadium, oil, natural gas, oil shale, and coal.

Sand and gravel resources are relatively abundant in the region. Such resources occur in terraces and modern alluvium along the Colorado and Gunnison Rivers and in pediment deposits along the Book Cliffs, Grand Mesa, and Battlement Mesa. In general, the most sound sources of riprap are pediment deposits shed from Battlement and Grand Mesas. These deposits contain well indurated clasts of basalt that have excellent engineering characteristics (DOE, 1983). Pediment gravels from the Book Cliffs or river terraces and modern alluvium often contain an abundance of shale and sandstone clasts, although these sources are most often used for construction purposes. In some areas, acceptable materials may also be obtained by quarrying various sandstone formations.

Gravel from alluvial terraces of the Grand Mesa Formation along the Colorado River and Plateau Creek has been used on gravel roads and asphalt highway foundations. Talus and block rubble deposits of basalt bordering Grand Mesa have been used as crushed aggregate. At two localities, the basalt blocks were cemented with ice below depths of about 15 feet, necessitating blasting for removal (Yeend, 1969). Gravel has been obtained from moraine deposits but is of poor quality due to poor sorting and a high degree of fines. Crushed marlstone from the Green River Formation has been used on secondary roads. The Grand Mesa and Lands End Formations are sources of sand and gravel for concrete aggregate. The composition, sorting, and grain size of the deposits are highly variable. Local gravel deposits on pediments and older alluvial surfaces on Battlement Mesa are of poor quality because of their high percentage of friable, nondurable sedimentary rocks (Yeend, 1969).

Uranium and vanadium deposits are known to occur in the Burro Canyon Formation, Dakota Sandstone, Morrison Formation, Entrada Sandstone, and Wingate (or Navajo) Sandstone (Schwochow, 1978; Fischer, 1960). These formations occur throughout most of the region.

The Piceance Creek Basin contains oil, natural gas, and a majority of the United State's oil shale. The principal petroleum-bearing formations include, in order of increasing age, the Wasatch Formation, Mesa Verde Group, Dakota Sandstone, Burro Canyon Formation, Morrison Formation, and Entrada Sandstone. At least one of these formations underlies the entire region. Thick oil shale deposits occur in the Parachute Creek Member of the Green River Formation.

D.5.1 OLD AND NEW RIFLE SITES

Potential mineral resources beneath the Old and New Rifle sites include sand and gravel, oil, natural gas, and coal. Sand and gravel deposits beneath the sites appear to be about 18 to 23 feet thick. Sand and gravel have been and are being mined for aggregate along the Colorado River floodplain in the vicinity of the New Rifle site.

Therefore, the sand and gravel beneath either of the tailings piles could also be economically recovered if the tailings were moved and the adjacent milling facilities disassembled and removed from the sites.

Oil and natural gas (mostly gas) have been produced from the Pennsylvanian Weber Sandstone of the Eocene Green River (oil shale) Formation. The nearest gas fields are located two miles west of the New Rifle site on Webster Mesa. Other gas fields include the more distant Rulison and Mamm Creek fields (Dunn, 1974). If found beneath the tailings piles, the resources could be recovered by slant-drilling techniques. Coal in the basin is mainly of the highly volatile bituminous type B or C, which occurs in the Mancos Shale and the Mesa Verde Group (Speltz, 1974). These coals are at least 2500 feet below the surface and cannot be mined economically at present (Murray and Haun, 1974; Tweto et al., 1978).

D.5.2 ESTES GULCH SITE

Economically important deposits of mineral resources have not been recognized beneath the Estes Gulch site. Sand and gravel exploitation possibilities are low. No deposits of clean alluvial sand and gravel, talus deposits, or eolian sand are present at the site. Therefore no potential hazard exists at the site due to future aggregate resource development.

Uranium-vanadium deposits occur in the Wingate (Navajo) and Entrada Sandstones in the Rifle Creek area (Fischer, 1960). The closest developed deposit is about two miles east of the Estes Gulch site. No known uranium deposits occur close enough to the site to affect future mining activity and site stability.

Oil, natural gas, and oil shale deposits are known to occur in the region in the Wasatch Formation, Mesa Verde Group, Dakota Sandstone, Burro Canyon Formation, Morrison Formation, and Entrada Sandstone. Although economically important deposits may occur in these formations, no deposits have been recognized at the site. Therefore no hazard to site stability is anticipated.

No economic coal deposits have been recognized in the site area. The closest developed coal deposit is an inactive mine about two miles southeast of the site.

D.5.3 LUCAS MESA SITE

The pediment material at the Lucas Mesa site contains a large quantity of aggregate composed of basaltic gravel, cobbles, and boulders. The granular materials on the site have potential as an aggregate resource. However, there are more readily available sand and gravel deposits along the Colorado River that have not yet been exploited. Therefore, the value of the Lucas Mesa aggregate at the present time is minimal.

The Lucas Mesa site is located in the same stratigraphic unit as the Old and New Rifle sites. Therefore, the potential for oil, gas, and coal exists at the site, and, in fact, coal from the Mesaverde Formation has been mined in the general vicinity. However, at the present time, coal beneath Lucas Mesa is too deep to be an economical resource.

D.5.4 BORROW SITES

The Second Street, New Rifle, and Glenwood Springs borrow sites are all existing, commercial borrow operations. Mineral resources present or possibly present at the Second Street and New Rifle borrow sites are the same as those discussed for the New Rifle tailings site (Section D.5.1). The Glenwood Springs borrow site is a source of limestone aggregate for gravel and riprap. No other mineral resources are known to exist at the site.

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APPENDIX E

HYDROLOGY

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E.1 SURFACE WATER

E.1.1 SURFACE WATER FEATURES

E.1.1.1 Old and New Rifle tailings sites

The elevation of the edge of the Old Rifle tailings pile varies between 5310 and 5330 feet above mean sea level (MSL), and the streambed of the Colorado River in the vicinity of the Old Rifle site is about 5300 feet above MSL. The tailings pile at the New Rifle site is on the north side of the Colorado River 2.5 miles downstream from the Old Rifle site. The elevation of the edge of the New Rifle tailings pile varies between 5261 and 5272 feet above MSL. The streambed of the Colorado River is about 5245 feet above MSL south of the New Rifle pile and about 5260 feet above MSL to the east of the pile.

The floodplain surface occupied by the Old Rifle tailings site is about five to 10 feet above the Colorado River surface during normal flow. The river now flows parallel to and in contact with the elevated Denver & Rio Grande Western (D&RGW) Railroad grade, which separates the tailings site from the river. The southern flank of the railroad grade is protected by sandstone and basalt riprap. The floodplain at the Old Rifle site has been artificially narrowed at the site from over 1200 feet to 800 feet by the construction of the Interstate 70 (I-70) embankment south of the river. The floodplain is also constricted by the Taughenbaugh Boulevard Bridge 0.4 mile downstream of the site.

The surface water features at the Old Rifle site (Figure E.1.1) include a drainage ditch from U.S. Highway 6 that discharges just north of the tailings pile, a drainage ditch just east of the tailing pile, and areas where there is occasional ponding of water around the eastern and the southwestern edges of the site.

At the New Rifle site, the Colorado River is 1000 feet east and 600 feet south of the tailings pile. The mill and ore storage areas lie between the pile and the river to the east. The main channel of the Colorado River has been artificially channeled northward by blocking alternative river channels upstream of the site. This has caused the river to swing north and erode the northern portion of a dike that protects the tailings site. Further downstream, the channel passes under an I-70 bridge and subsequently flows along the upland that forms the southern boundary of the valley floor. The embankment of I-70 protects the southern boundary of the pile from the Colorado River, and the construction of I-70 has narrowed the natural floodplain to virtually the channel.

The major surface water features at the New Rifle site include the vanadium ponds east of the pile and evaporation

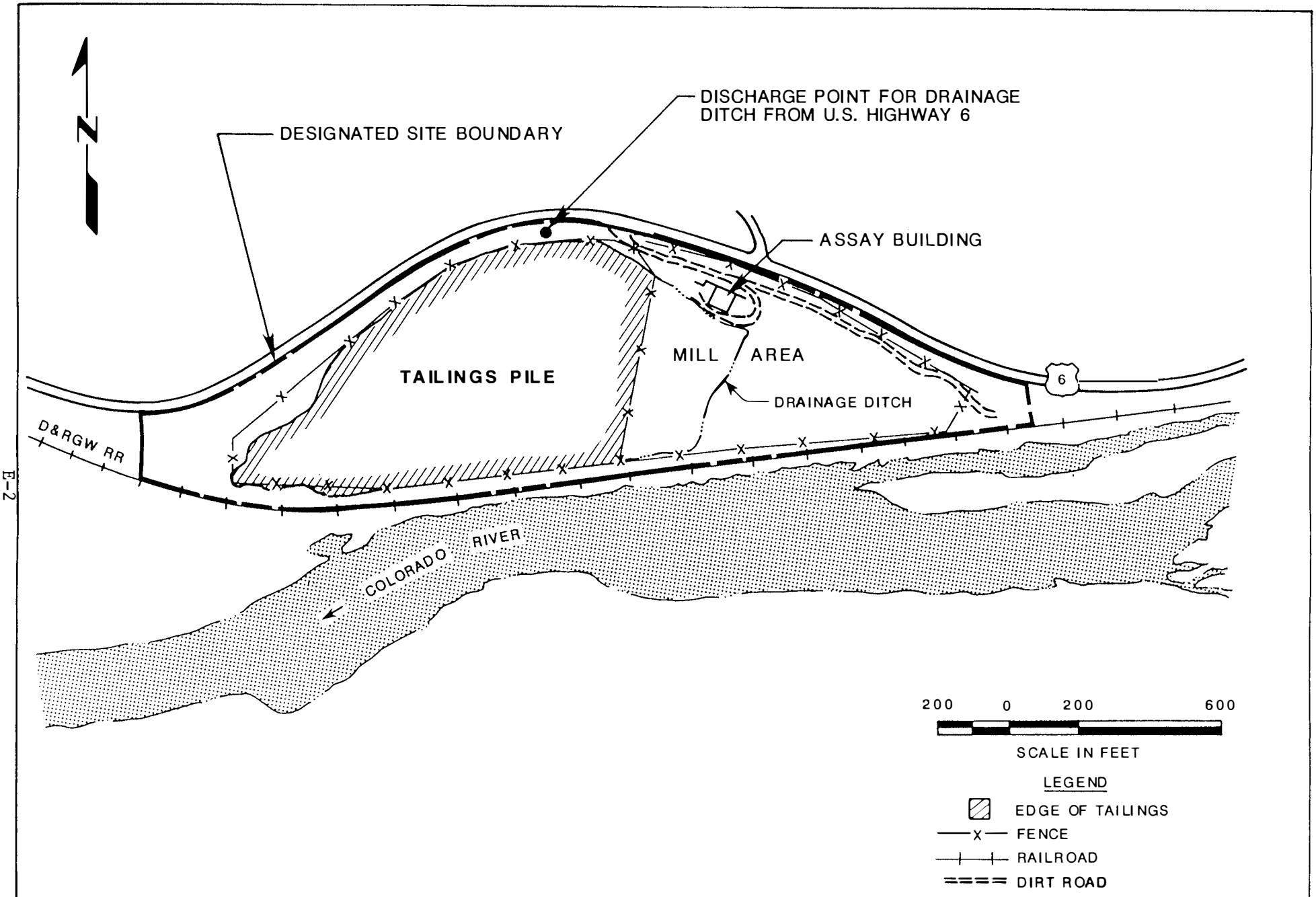


FIGURE E.1.1
SURFACE WATER FEATURES, OLD RIFLE SITE

ponds north and southeast of the pile (Figure E.1.2). In addition, there are various drainage ditches and several areas throughout the site where there is occasional ponding of water.

The watershed upstream of Rifle is 6950 square miles of steeply sloped terrain. The basin is bounded on the north side by basins of the White and North Platte Rivers, on the east by basins of the South Platte and Arkansas Rivers, and on the south by the Gunnison River basin. Watershed boundaries are shown in Figure E.1.3. Major tributaries to the upper Colorado River include the Roaring Fork, Eagle, and Blue Rivers. Elevations in the basin range from 5260 feet at Rifle to more than 14,000 feet in the highest headwater areas. Approximate drainage areas, channel lengths, and slopes for the rivers in the watershed are presented in Table E.1.1.

The U.S. Army Corps of Engineers (COE) conducted its latest flood study of the Colorado River near Rifle in 1977 and 1978 and concluded that the flows for the 100-year and 500-year floods would be 45,000 and 65,000 cubic feet per second (cfs), respectively (COE, 1977). The flows for the 200-year and 1000-year floods (53,000 and 74,000 cfs, respectively) were calculated from these values by interpolation and

Table E.1.1 Selected characteristics for subbasins of the Colorado River above Rifle, Colorado[a]

Watershed	Area (square miles)	Channel length (miles)	Elevation (feet above MSL)	Slope (feet/foot)
Colorado River above Kremmling	1648	56.8	7,200-10,100	0.009
Blue River	668	56.8	7,200-12,500	0.017
Colorado River between Kremmling and Dotsero	1147	56.0	6,250-7,200	0.003
Eagle River	965	54.8	6,250-10,200	0.013
Roaring Fork	1450	60.0	5,700-13,000	0.022
Colorado River between Dotsero and Rifle	1072	42.0	5,300-6,250	0.004
TOTAL	6950			

[a]Data taken from U.S. Geological Survey topographic maps.

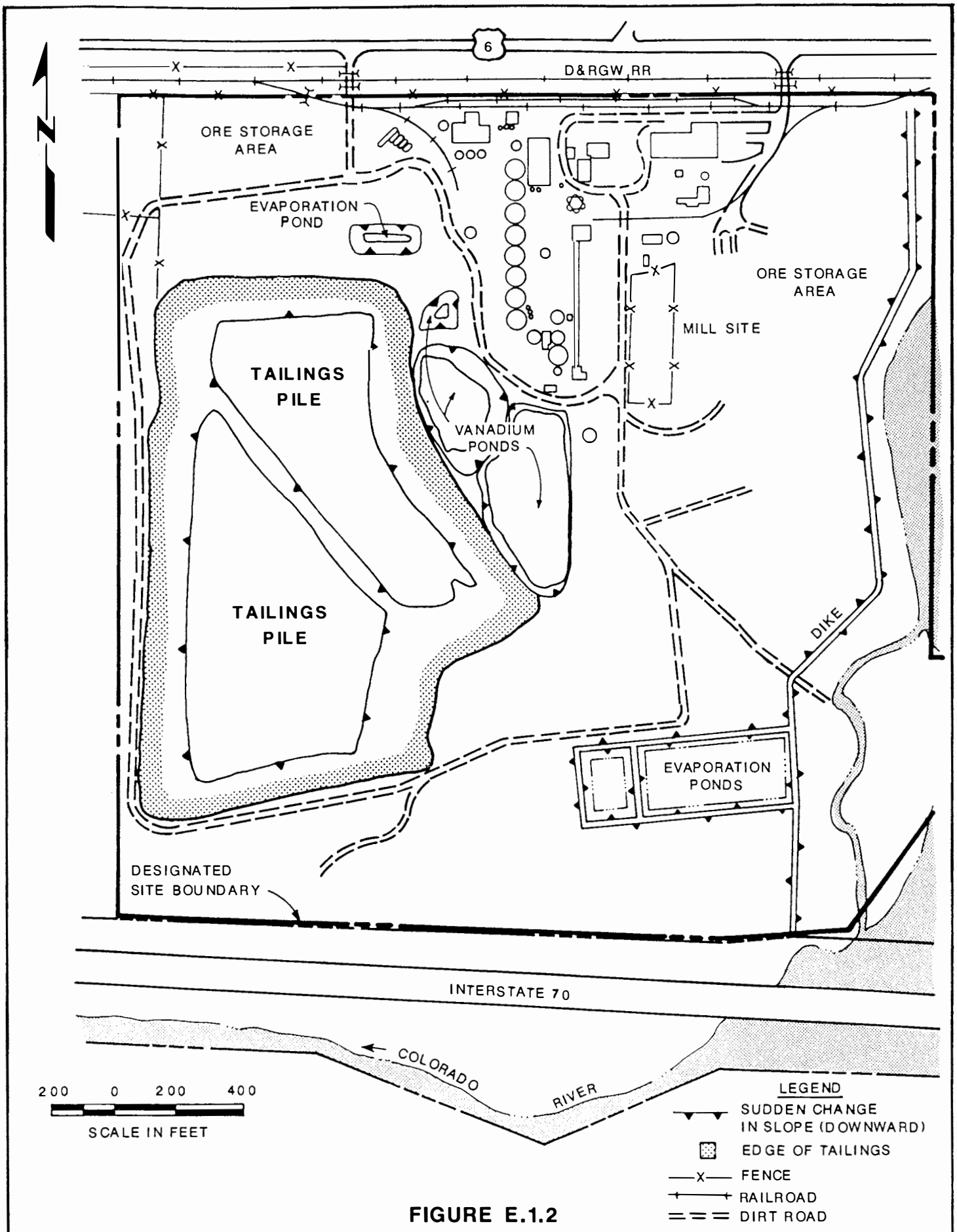


FIGURE E.1.2
SURFACE WATER FEATURES, NEW RIFLE SITE

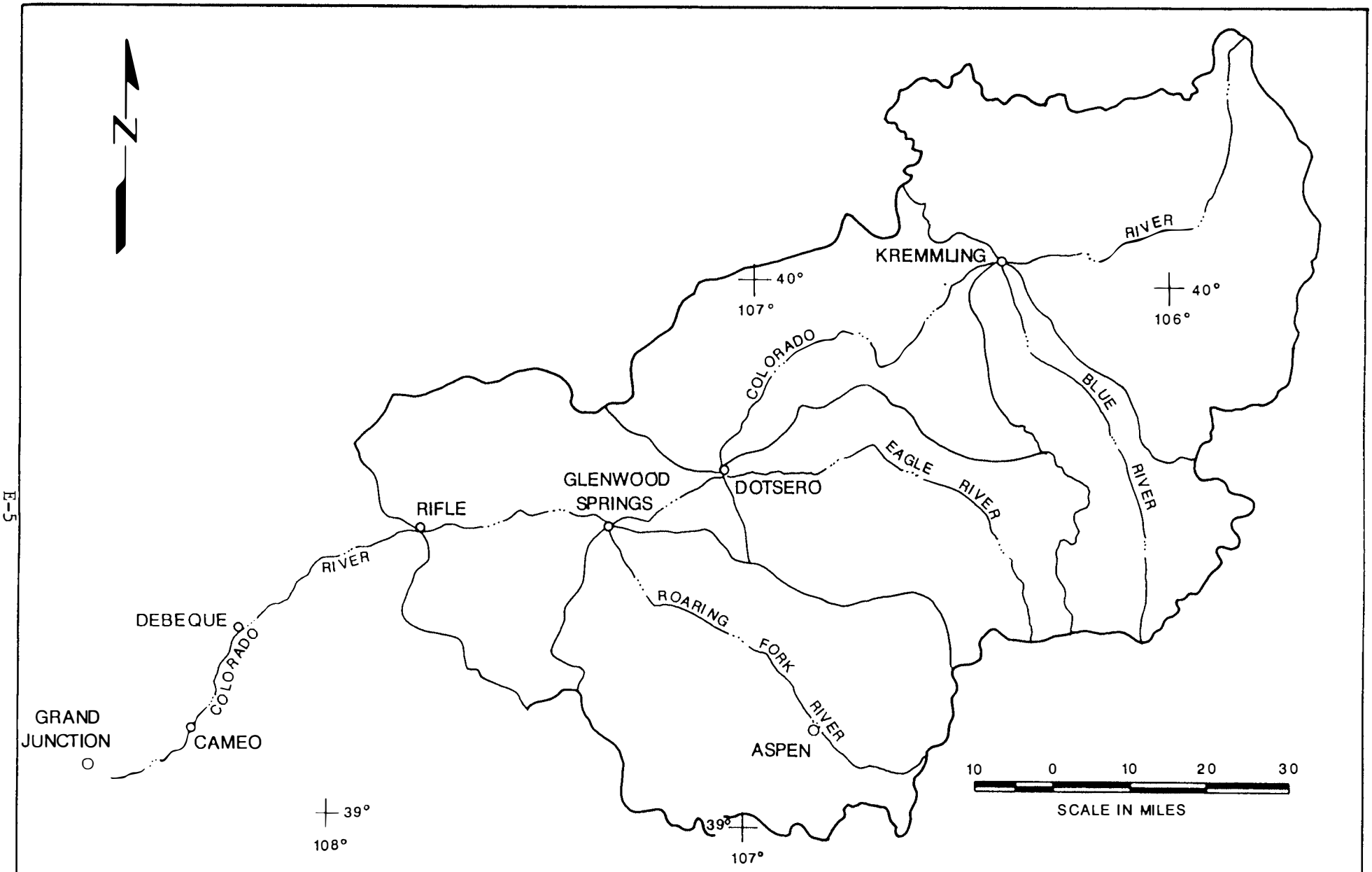


FIGURE E.1.3
COLORADO RIVER WATERSHED ABOVE RIFLE, COLORADO

extrapolation. The maximum flood elevations at the Old Rifle tailings site would be 5312 and 5314 feet above MSL for the 200- and 1000-year floods, respectively. The maximum flood elevations at the New Rifle site would be 5274 and 5278 feet above MSL for the 200- and 1000-year floods, respectively (DOE, 1983). Revised 100-year and 500-year discharges for both the Old and New Rifle sites were estimated using McCain and Jarrett (1976) and are presented in Section E.1.2 of this appendix.

The average monthly river flows adjacent to the tailings sites can be estimated from flow measured at U.S. Geological Survey (USGS) gauging stations on the Colorado River at Glenwood Springs approximately 25 miles upstream of the sites and at DeBeque approximately 30 miles downstream of the sites. The average maximum monthly flows in the late spring at Glenwood Springs and DeBeque from 1966 through 1985 were 9990 and 11,210 cfs, respectively, and the average minimum monthly flows were 1460 and 1580 cfs, respectively. The average flows at DeBeque are generally 100 cfs higher than those at Glenwood Springs and reflect the input of the many creeks entering the Colorado River between these stations (DOE, 1983).

Most of the annual precipitation in the higher regions of the basin is snow that accumulates into deep snowpacks. General rainstorms covering large areas for extended periods can occur during spring and summer. Convective-type cloudbursts of limited areal extent occur during summer and fall. However, rapid melting of mountain snowpacks in spring and early summer accounts for the major floods in the Colorado River. Flooding is most severe when snowmelt is augmented by general rainstorms. Ice jams are not a flooding problem for the Colorado River in the vicinity of Rifle (DOE, 1983).

The flooding of June and July 1884 is considered to be the most severe known on the upper Colorado River (COE, 1976). This flood resulted from rapid melting of the snow pack and concurrent heavy rains. In recent times, the floods of 1983 and 1984 were the most severe. The 1884 flood peak at Rifle was approximately 65,000 cfs if discharge versus area relationships for the 1984 flood are representative. Information relative to these past floods is shown in Table E.1.2. Other floods on the Colorado River were recorded in 1917, 1920, 1921, 1935, 1952, and 1957.

There are no domestic users of Colorado River water for 20 miles downstream of the city of Rifle. Water for the city of Rifle is pumped directly from the Colorado River approximately 0.5 mile upstream of the Old Rifle site and treated at the city water plant. At the present, there are no alternate sources for municipal water.

Table E.1.2 Maximum recorded peak flows for the Colorado River near Rifle, Colorado[a]

Station name	Watershed area (square miles)	Period of record	Maximum recorded peak flow cfs	Maximum recorded peak flow Date
Colorado River near Colorado-Utah border	17,843	1951-present	68,000	June 1984
Colorado River near Fruita	17,100	1884, 1957-1983	125,000	July 1884
Colorado River near Cameo	8,080	1933-present	39,300	June 1984
Colorado River below Glenwood Springs	6,813	1966-present	31,200	June 1984

[a]Ref. COE, 1976.

Water from Rifle Creek and the Colorado River is diverted into the Pioneer and Last Chance Ditches upgradient from both tailings sites. This water is used for gravity-fed irrigation at farms within the Colorado River valley. There are no withdrawals for irrigation for at least five miles downstream of the New Rifle site.

E.1.1.2 Estes Gulch alternate disposal site

The Estes Gulch site (Figure E.1.4) has almost no upland drainage because of the deeply cut drainages to the east and west. Two ridges protect the site from these drainages; therefore, the potential for flooding is very low. Relief across the disposal site is 150 feet. The principal landform is a dissected alluvial fan surface which slopes gently toward Government Creek from the foot of the Grand Hogback to the north. This alluvial fan surface is mantled with wind-deposited silty sand.

Drainage on the site flows into an ephemeral creek in Estes Gulch 0.5 mile southeast of the site. This creek joins Government Creek one mile below the site (Figure E.1.4). There is a small earthen pond south of the site that is used to hold intermittent surface runoff for livestock watering. No data on surface water flows or historical floods exist for the Estes Gulch site.

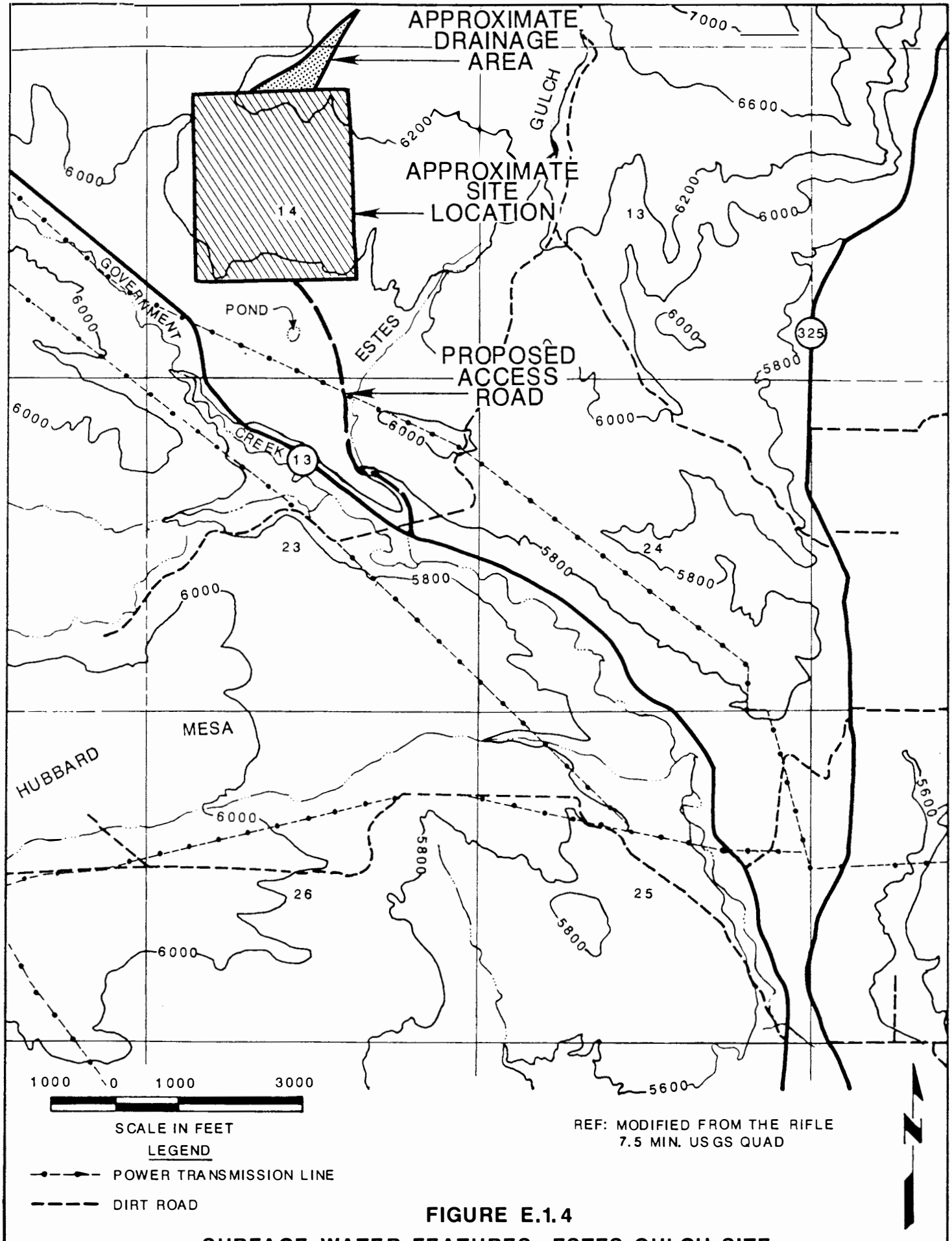


FIGURE E.1.4

SURFACE WATER FEATURES, ESTES GULCH SITE

E.1.1.3 Lucas Mesa alternate disposal site

The Lucas Mesa site is on a mesa that rises 1000 feet above the surrounding terrain. The surface materials at the site are 10 feet thick and consist of silty clay and basaltic rock.

The site is at the head of a drainage divide and has virtually no drainage basin above it; therefore, the potential for flooding is very low (Figure E.1.5). Drainages on the site flow into ephemeral creeks in Smith Gulch to the east, Moffat Gulch to the west, and into the Bluestone Valley irrigation ditch 1.5 to two miles north of the site. The creeks in both gulches join the Colorado River one to two miles below the site.

The Lucas Mesa site contains water catchment basins which, through a series of pipes, feed several stock watering tanks in the area. A more detailed description of this livestock watering system is provided in Section A.4.4.4 of Appendix A, Engineering Designs, and Section J.1.3 of Appendix J, Land Use and Socioeconomics.

No data on surface water flows or historical floods exist for the Lucas Mesa site.

E.1.1.4 Borrow sites

The Second Street borrow site is on the north side of the Colorado River and 0.2 mile north of the New Rifle tailings site. The site is 60 to 90 feet above the river surface and is drained by an ephemeral channel to the west and Pioneer Ditch to the south.

The New Rifle borrow site is on the north bank of the Colorado River 0.5 mile west of the New Rifle tailings site and is four to six feet above the river surface.

The Glenwood Springs borrow site is two miles north of Glenwood Springs, 30 miles west of Rifle, and 0.3 mile north of the Colorado River. The site is 1200 feet above the river surface and is drained by ephemeral Cascade Creek to the west. No data on the surface water flows or historical floods exist for the Glenwood Springs borrow site.

E.1.2 FLOOD ANALYSIS

E.1.2.1 Old and New Rifle tailings sites

A flood analysis has been performed to assure that the remedial action design for the uranium mill tailings sites at Rifle, Colorado, satisfactorily addresses short-term and

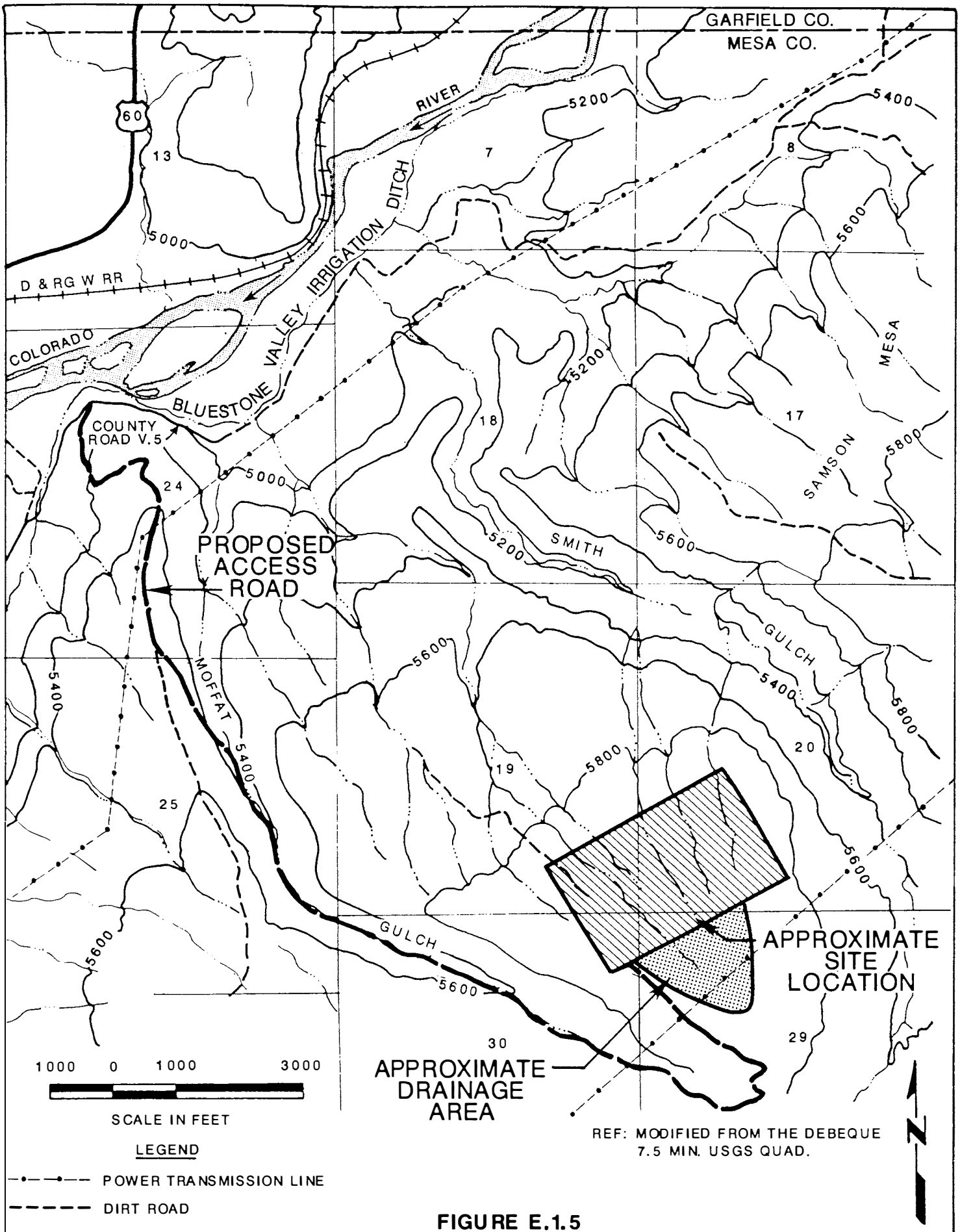


FIGURE E.1.5

SURFACE WATER FEATURES, LUCAS MESA SITE

long-term flood protection. Short-term flood protection defines the extent of the 100-year and 500-year floods and the impacts, if any, on the stabilized tailings or on remedial action construction activities. The primary reason for completing this analysis is to comply with the floodplain environmental review requirements of Title 10, Code of Federal Regulations (CFR), 1022. To accomplish the objective of long-term flood protection, the standard design approach is to determine the magnitude and potential impacts resulting from a Probable Maximum Flood (PMF). If a design is not practical, then alternative design events or solutions are assessed. For the Rifle tailings, the half-PMF was also evaluated.

The U.S. Environmental Protection Agency (EPA) standards require that control of the uranium tailings must be effective for 1000 years to the extent reasonably achievable and, in any case, for at least 200 years. The standards do not specifically state that a PMF event must be used for design in order to achieve the stated containment life. An analysis of exceedence probabilities for various events with respect to the containment life (Junge and Dezman, 1983) suggests that design events with a very long return period (e.g., 10,000 years) must be used to meet a long-term containment objective. However, the limited statistical data that are available cannot be extrapolated accurately to such long return periods. The generally accepted alternative, therefore, is to use maximum credible events such as the PMF for design purposes. Since a maximum credible event, by definition, should not be exceeded, a tailings disposal system designed to withstand such an event would have no risk of failure and, thus, would meet both the intent and long-term containment objective of the EPA standards.

The PMF analysis for the Rifle sites involves the use of Hydrometeorological Report (HMR) No. 49 (DOC, 1977) to determine the appropriate Probable Maximum Precipitation (PMP) that could occur over the contributing drainage basins. The analysis then involves the consecutive use of the HEC-1 (COE, 1981) and HEC-2 (COE, 1982) models. The HEC-1 model is designed to simulate the runoff response (i.e., PMF) of a river basin to precipitation (i.e., PMP) by representing the basin as an interconnected system of hydrologic and hydraulic components. Then, using the HEC-2 model, a determination of stream hydraulics, resulting in water-surface elevations and velocity gradients, is developed for the PMF.

The 100-year and 500-year flood discharges were estimated using McCain and Jarrett (1976). As in the PMF analysis, water-surface elevations and velocities were estimated with the HEC-2 model.

100-year and 500-year floods

Estimates of the 100-year and 500-year floods were prepared in order to comply with 10 CFR 1022 and to compare major historic and predictable floods with the PMF estimate. Peak discharges or depths for various return intervals were approximated by use of a multiple regression analysis of flood data from stream gauges in the vicinity of the tailings site (McCain and Jarrett, 1976). The method is based on correlating results of Log Pearson III analysis for 90 gauging stations in the region. Of the 90 gauging stations used, only eight stations were for basin areas greater than 1000 square miles. The results of the approximations are, therefore, expected to overestimate the flood peaks for large watersheds because discharge versus area ratios increase as the size of the area decreases. Predicted peak flows or depths for selected recurrence intervals for the Colorado River at Rifle are presented in Table E.1.3.

A 100-year flow of 55,040 cfs and a 500-year flow of 75,200 cfs were used for the Colorado River at the Rifle tailings sites. These flows are slightly larger than the results of the COE flood study in which the 100-year and 500-year flood flows were estimated to be 45,000 and 65,000 cfs, respectively (COE, 1977). The COE is revising its flood study for the Colorado River near Rifle; however, it will not be completed in time to be used for this environmental impact statement (EIS). However, cross section data prepared for the COE study have been used in the HEC-2 model for this analysis and the PMF analysis.

Table E.1.3 Peak flows or depths of selected recurrence intervals for the Colorado River at Rifle, Colorado

Regression equation[a]	Standard error of estimate[a] (percent)	Peak flow (cfs)	Peak depth (feet)
$Q_{10} = 59.7A^{0.709}$	47	31,620	--
$Q_{50} = 89.1A^{0.709}$	50	47,190	--
$Q_{100} = 103A^{0.710}$	53	55,040	--
$Q_{500} = 137A^{0.713}$	65	75,200	--
$D_{10} = 1.25A^{0.261}$	25	--	12.6
$D_{50} = 1.54A^{0.254}$	34	--	14.6
$D_{100} = 1.64A^{0.254}$	36	--	15.5
$D_{500} = 1.98A^{0.239}$	44	--	16.4

[a]Ref. McCain and Jarrett, 1976. Q is the peak flow in cfs for the specified recurrence interval (e.g., Q_{10} is the peak flow for the 10-year flood); D is the peak depth for the specified recurrence interval; A is the area of the drainage basin in square miles (6950 square miles for the Colorado River at Rifle).

Values of Manning's roughness coefficients (n) were varied in the HEC-2 model in order to bracket probable conditions. One condition of roughness was to assume "n" values of 0.025 for areas covered by five feet of water or more and 0.050 for overbank areas with less than five feet of water. A second condition modeled for the 100-year and 500-year events was to assume "n" values which would produce flow depths shown in Table E.1.3. Published values of "n" for the Colorado River near Rifle are 0.017 to 0.040 for the main channel and 0.035 to 0.070 for the floodplain (FEMA, 1982). The intent of varying the "n" values listed for the 100- and 500-year events is to represent extreme conditions for these floods. Water-surface elevations discussed in the following sections were selected based on the higher "n" values while main channel velocities and main channel discharge rates are based on the lower "n" values.

As shown in Figures E.1.6 and E.1.7, it was found that the tailings piles at both the Old and New Rifle sites encroach on the 100- and 500-year floodplains.

At the Old Rifle site, the 100- and 500-year floodwater surfaces would be above the railroad tracks; however, the tailings pile would have little impact on the capacity of the floodplain. In the vicinity of the Old Rifle site, the I-70 embankment and the Taughenbaugh Boulevard Bridge significantly constrict the floodplain. The 100-year water surface is below the top of the I-70 embankment so the flood would be confined to the floodplain north of the freeway. The 500-year flood would top the I-70 embankment.

At the New Rifle site, the 100-year flood would be on both the north and south sides of the I-70 embankment but below the top of the embankment. The 500-year flood would top over the I-70 embankment. The dike that presently protects the eastern edge of the New Rifle tailings site from normal annual floods is not considered adequate to prevent large floods from encroaching on the site nor is this structure considered to be permanent. The constriction caused by the New Rifle tailings pile in its present location would raise the 100-year flood water surface elevation one foot at the site and 0.5 foot upstream of the site from what it would be with no tailings. It would also raise the 500-year flood water surface elevation up to two feet at the site and a little over one foot upstream of the site.

The maximum water level at the Old Rifle tailings site during a 100-year flood event was determined to be 5311 feet above MSL with a mean velocity of 12 feet per second (fps). During a 500-year flood event, the water level at the site would be 5314 feet above MSL with a mean velocity of 12 fps. The expected elevation of scour is 12 feet below the present

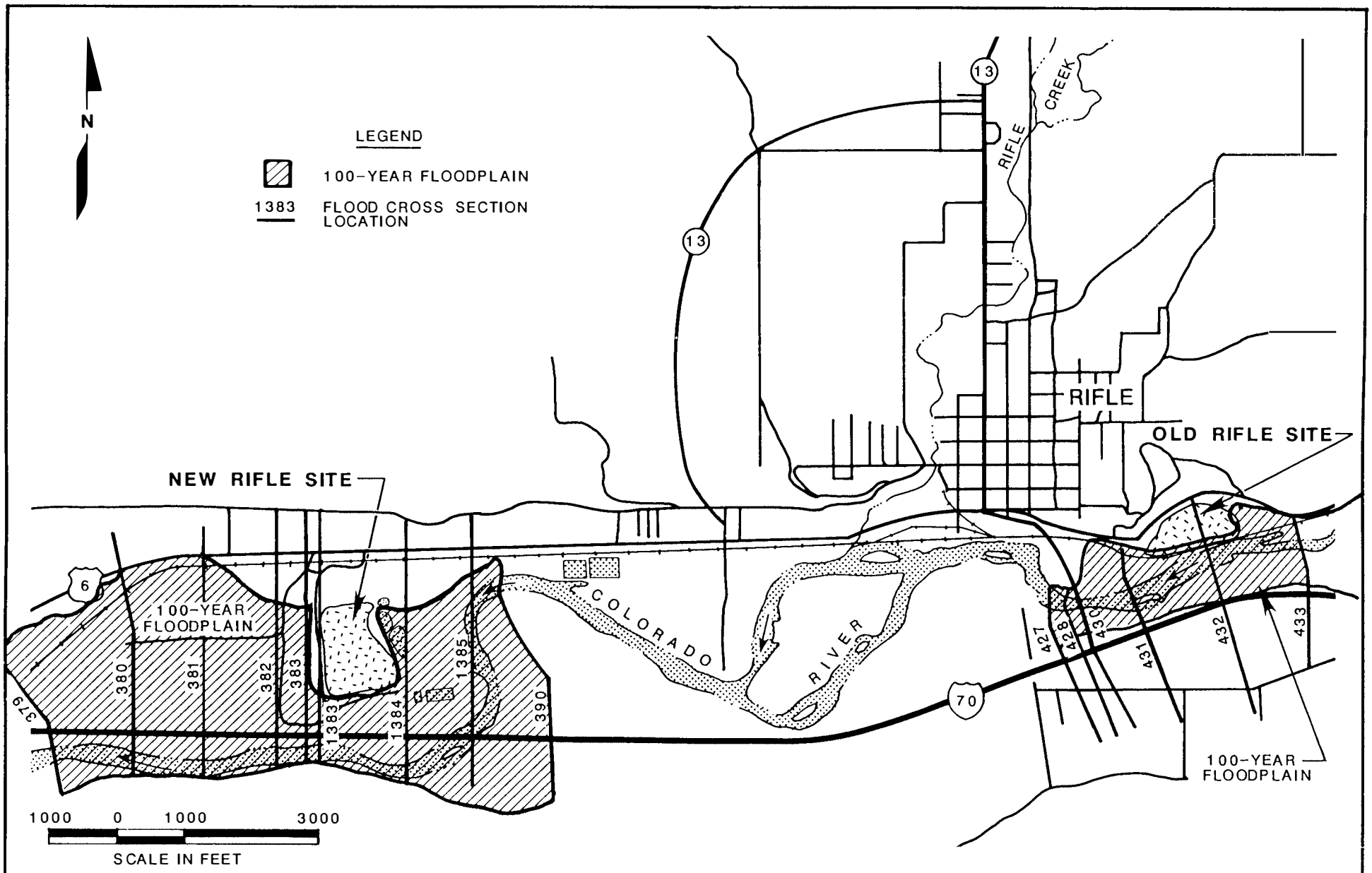


FIGURE E.1.6
100-YEAR FLOODPLAIN, OLD AND NEW RIFLE SITES

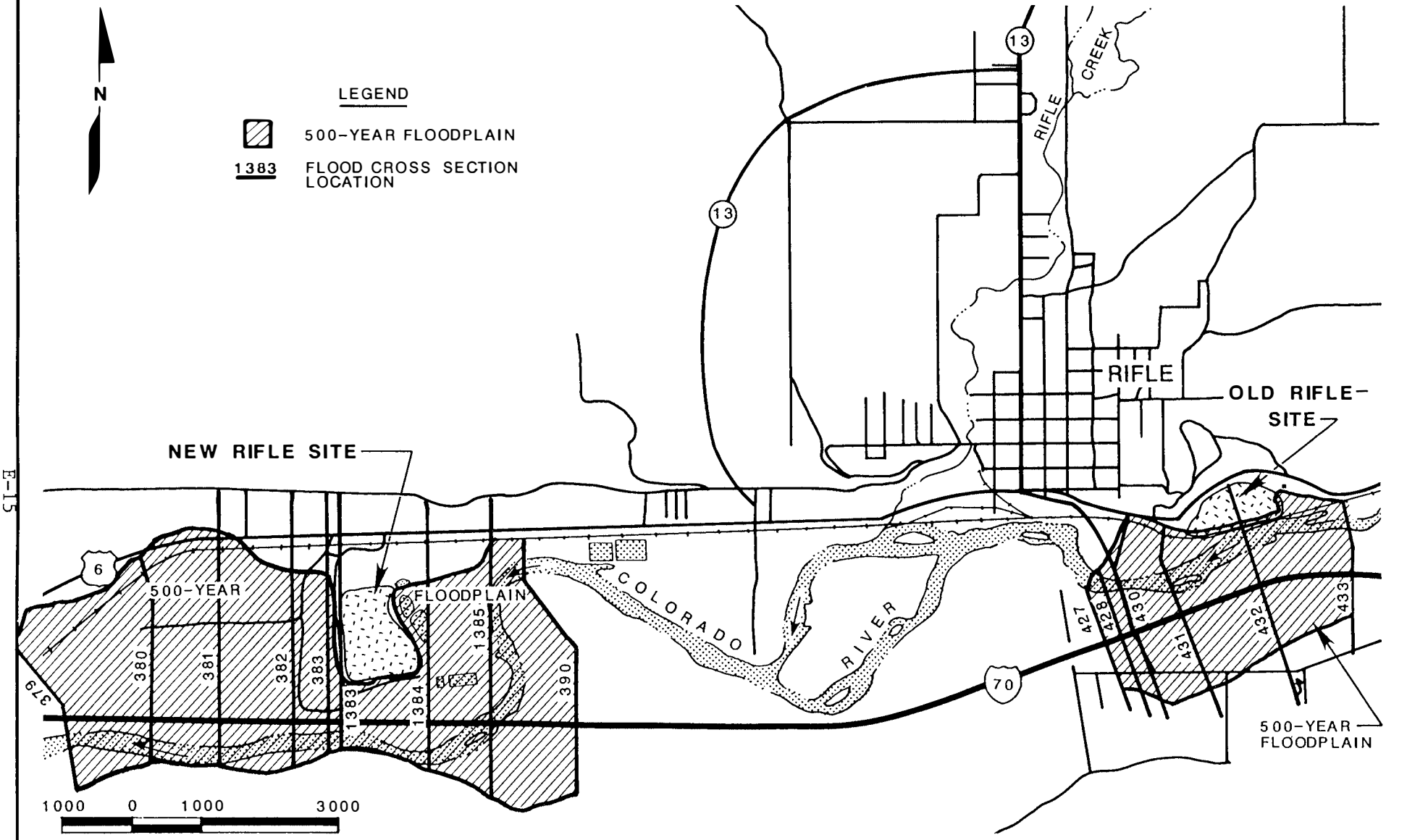


FIGURE E.1.7

500-YEAR FLOODPLAIN, OLD AND NEW RIFLE SITES

channel bottom for the 500-year event. The maximum water level at the New Rifle tailings site during a 100-year event was determined to be from 5270 to 5275 feet above MSL with mean velocities of 10 to 17 fps. During a 500-year flood event, the water level at the site would vary from 5272 to 5278 feet above MSL with mean velocities of 10 to 18 fps. The expected elevation of scour ranges from about 13 to 18 feet below the present channel bottom for the 500-year event.

PMF hydrologic analysis

The PMF estimate is based on a HEC-1 model of the Colorado River watershed above Rifle. The PMF was determined according to procedures outlined in HMR No. 49 (DOC, 1977). The PMP had to be extrapolated for the 6950 square mile basin above Rifle because these procedures are for watersheds with areas less than 5000 square miles.

The month with the highest 72-hour precipitation was found to be June with 13.4 inches, indicating that rainfall could occur on snow or on a very wet watershed. The PMP was distributed temporally by arranging three-hour incremental amounts in a sequence such that they decrease progressively to either side of the greatest three-hour increment. Since the total volume of flow is not critical in this study, only the greatest 24-hour increment of the 72-hour storm was modeled.

Lag times were computed by assuming bank-full velocities. Each subbasin was assumed to have three conveyance components:

- Overland flow and upland channel flow with velocities of 3.5 and eight fps for slopes of 12 to 15 percent, respectively (DOI, 1973); allowance was also made for retention time due to lakes and ponds.
- Secondary channels draining areas of 42 to 103 square miles with velocities of 10 to 12 fps.
- Primary channels with velocities varying from 12 to 14 fps.

Estimated lag times for each subbasin are shown in Table E.1.4. The shortest lag time (T) is 3.8 hours, which corresponds to a time of concentration (T_C) of 6.3 hours. The selection of a computation interval, "T", of one hour meets the criterion that it be less than 0.25 of T_{PEAK} (COE, 1981) where

$$1.7 \times (T_{PEAK}) = T + T_C$$

Soils in the Rifle watershed are classified by the Soil Conservation Service (SCS) as hydrologic group B interspersed with some C soils and traces of A and D soils (SCS, 1983; 1982,

Table E.1.4 Estimated lag times for subbasins of the Colorado River above Rifle, Colorado

Watershed	Time of overland flow (hrs)	Secondary channel[a] L (mi)	Secondary channel[a] v (fps)	Secondary channel[a] t (hrs)	Main channel[a] L (mi)	Main channel[a] v (fps)	Main channel[a] t (hrs)	T_C[a] (hrs)	T_L[a] (hrs)
Colorado River above Kremmling	1.6	25	10	3.7	30	12	3.7	9.0	5.4
Blue River	2.1	15	12	1.8	45	14	4.7	8.6	5.1
Colorado River between Kremmling and Dotsero	0.9	24	16	2.2	35	11	4.7	7.8	4.7
Eagle River	0.6	29	12	3.5	29	12	3.5	7.6	4.5
Roaring Fork	0.7	23	11	3.1	40	14	4.2	8.0	4.8
Colorado River near Rifle	0.5	25	11	3.3	22	13	2.5	6.3	3.8

[a]Length = L; velocity = v; flow time = t. Velocities were estimated using Manning's equation (DOI, 1973): $T_L = 0.6 \times T_C$, where T_C = time of concentration and T_L = lag time.

1978). The B and C soils have moderate to slow infiltration rates (0.08 to 0.30 inch per hour) when thoroughly wetted.

Although actual major floods are the result of rainfall on the snowpack, the volume of runoff resulting from snowmelt is small in comparison to the volume of runoff resulting from the intense rainfall. However, the presence of the snowpack creates severe hydrologic soil conditions by limiting infiltration. Therefore, runoff resulting from snowmelt was not estimated in the analysis because the magnitude of the PMP would make snowmelt a minor component of the flood. To account for the severe hydrological conditions created by the presence of snow, no initial loss of precipitation was assumed, and a uniform loss rate based on saturated "B-C" soils of 0.20 inch per hour was selected (DOI, 1973). This value was also selected by the COE for the "C" soils in the lower basin (COE, 1976).

Flows were routed through primary channels by use of the modified Puls method available in the HEC-1 model. Channel characteristics were determined by field inspection and from topographic maps. Impacts from ice jams were not considered in the flood analysis since ice jams are not a flooding problem for the Colorado River in the vicinity of Rifle (DOE, 1983).

The PMF at Rifle was calculated to be 795,200 cfs. This value is 10 times the 500-year flood, and 12 times the maximum recorded peak flow. Crippen and Bue (1977) prepared curves that envelop maximum measured flood flows for regions in the conterminous United States. Rifle is in Region 13, and the maximum flood peak in the Colorado River near Rifle is given as 360,000 cfs. This value is less than half the PMF at Rifle.

PMF hydraulic analysis

Hydraulic characteristics of the river at flood stage are important design considerations for stabilization of the tailings. Water-surface profiles were estimated with the HEC-2 model to obtain flow depths and velocities during flood stage. These values were used to estimate scour depths and rock erosion protection requirements. An empirical formula suitable for the Colorado River was used to calculate the scour depth (Pemberton and Lara, 1984):

$$D_S = Z \times d_{fo}$$

where

D_S = depth of scour below the minimum elevation (from HEC-2) in feet.
Z = 0.6, the coefficient developed by the Bureau of Reclamation for use on moderate river bends.
d_{fo} = depth for zero bed sediment transport in feet.

In the above equation, d_{fo} is determined by the equation

$$d_{fo} = \frac{(q_f)^{2/3}}{(F_{bo})^{2/3}}$$

where

q_f = design discharge per unit width in cubic feet per second per foot.
F_{bo} = Blench's "zero bed factor" in square feet per second.

The Colorado River banks were extended beyond the normal bank locations to account for a dramatically different river regime during PMF conditions. As a rule, the banks for the PMF were located so that the main channel bed was covered with more than five feet of flow. Manning's roughness coefficients of 0.025 and 0.050 were assumed for areas covered by five feet of water or more and for overbank areas with less than five feet of water, respectively.

Summary

The effects of the PMF and half-PMF events on the channel of the Colorado River would be catastrophic. Bridges would be destroyed, and I-70 would be inundated and largely washed away as would the D&RGW railroad and many residential and industrial structures (Figures E.1.B and E.1.9). At the Old Rifle site, velocities and depths at the site are influenced by the highway and bridge embankments downstream. The Taughenbaugh Boulevard Bridge was assumed to be gone during the flood, but the constriction of the abutment and approach embankments were considered in the modeling. The railroad tracks would be overtopped by a calculated 25 and 15 feet of water during the PMF and half-PMF, respectively. At the Old Rifle site, scour depths were calculated to be approximately 19 and 13 feet below the minimum channel elevation during the PMF and half-PMF, respectively. At the New Rifle site, scour depths were calculated to be 32 and 22 feet below the minimum channel elevation during the PMF and half-PMF, respectively. The tailings pile at the New Rifle site would have flowing water on all sides, and the main channel flow would likely be directed at the pile.

Cross sections showing maximum water surface elevations for selected floods of the Colorado River at the Old Rifle site are shown in Figure E.1.10 and at the New Rifle site are shown in Figure E.1.11. Calculated maximum water surface elevations, mean channel velocities, and scour depths for the 100-year, 500-year, PMF, and half-PMF are presented in Table E.1.5 for the Old Rifle site and Table E.1.6 for the New Rifle site.

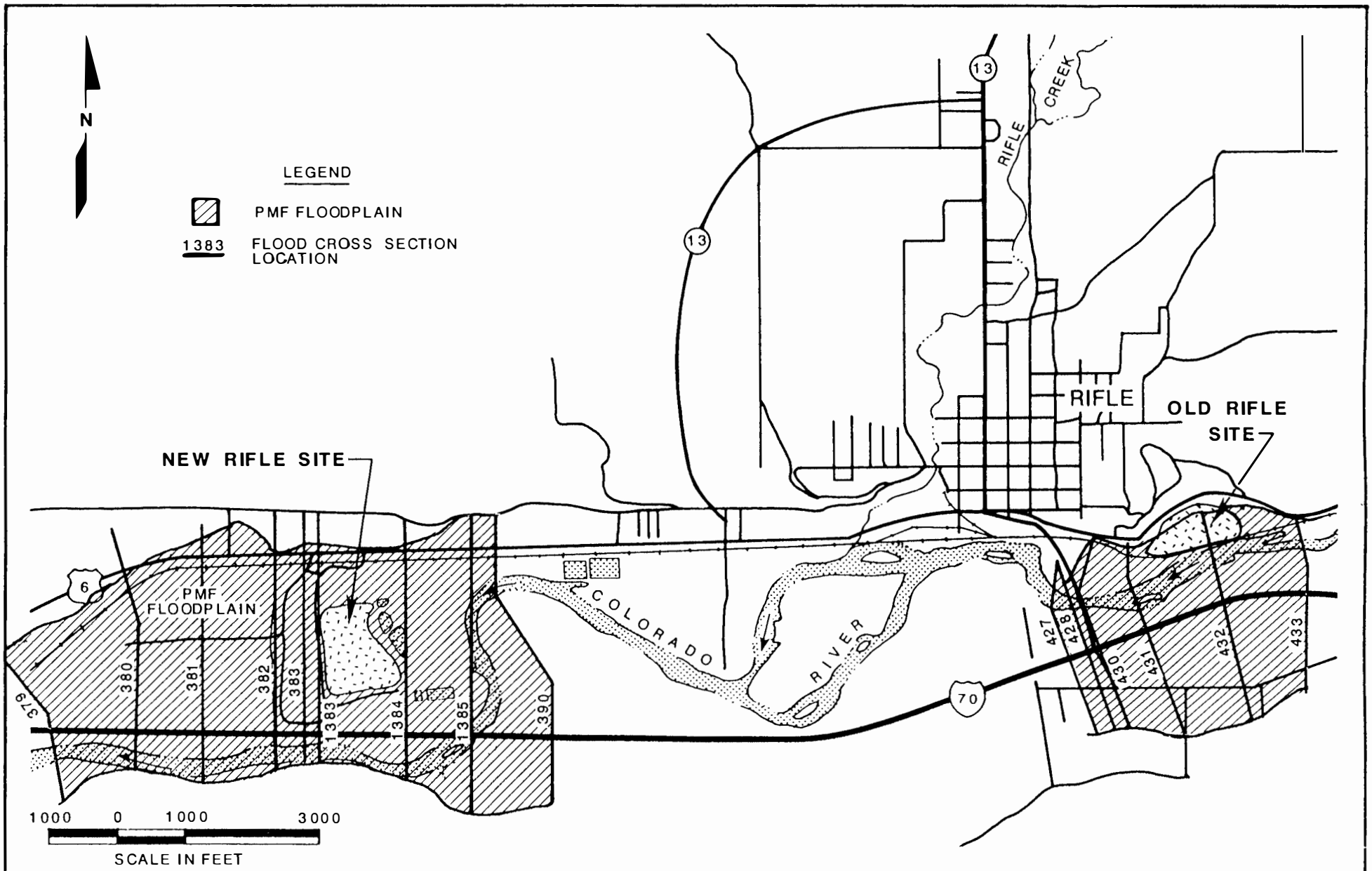


FIGURE E.1.8

PMF FLOODPLAIN, OLD AND NEW RIFLE SITES

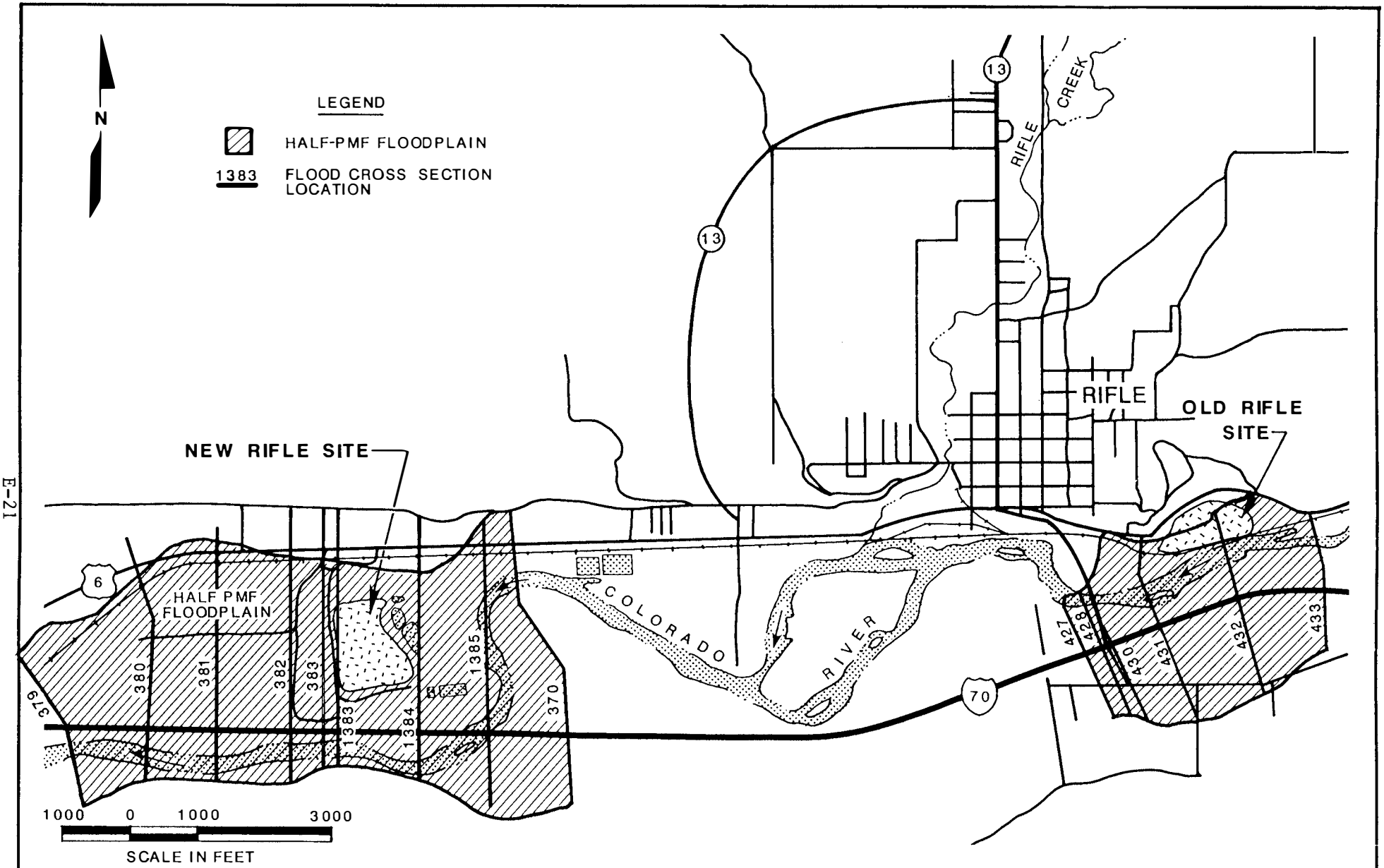


FIGURE E.1. 9

HALF-PMF FLOODPLAIN, OLD AND NEW RIFLE SITES

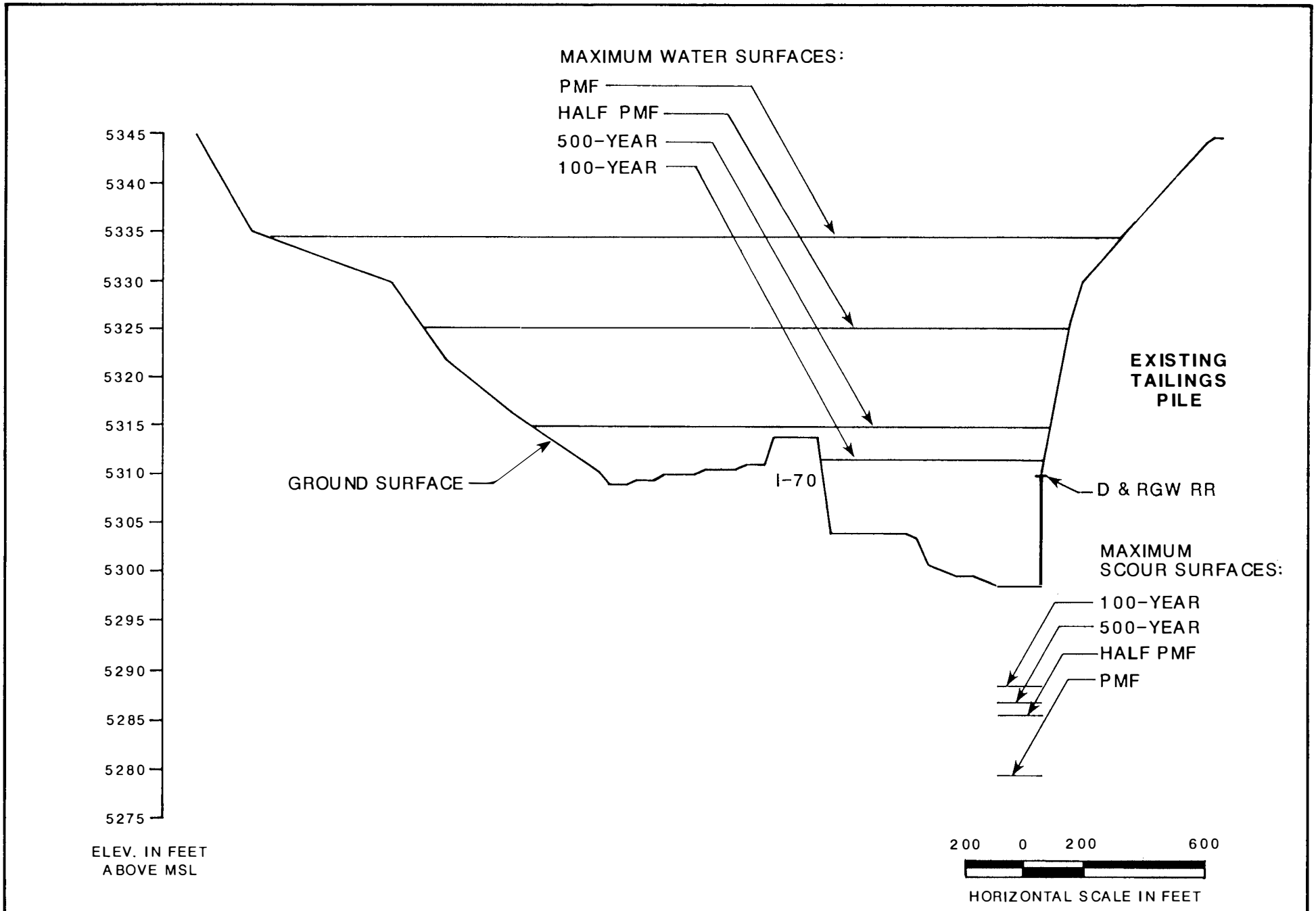


FIGURE E.1.10

FLOOD CROSS SECTION 432, OLD RIFLE SITE

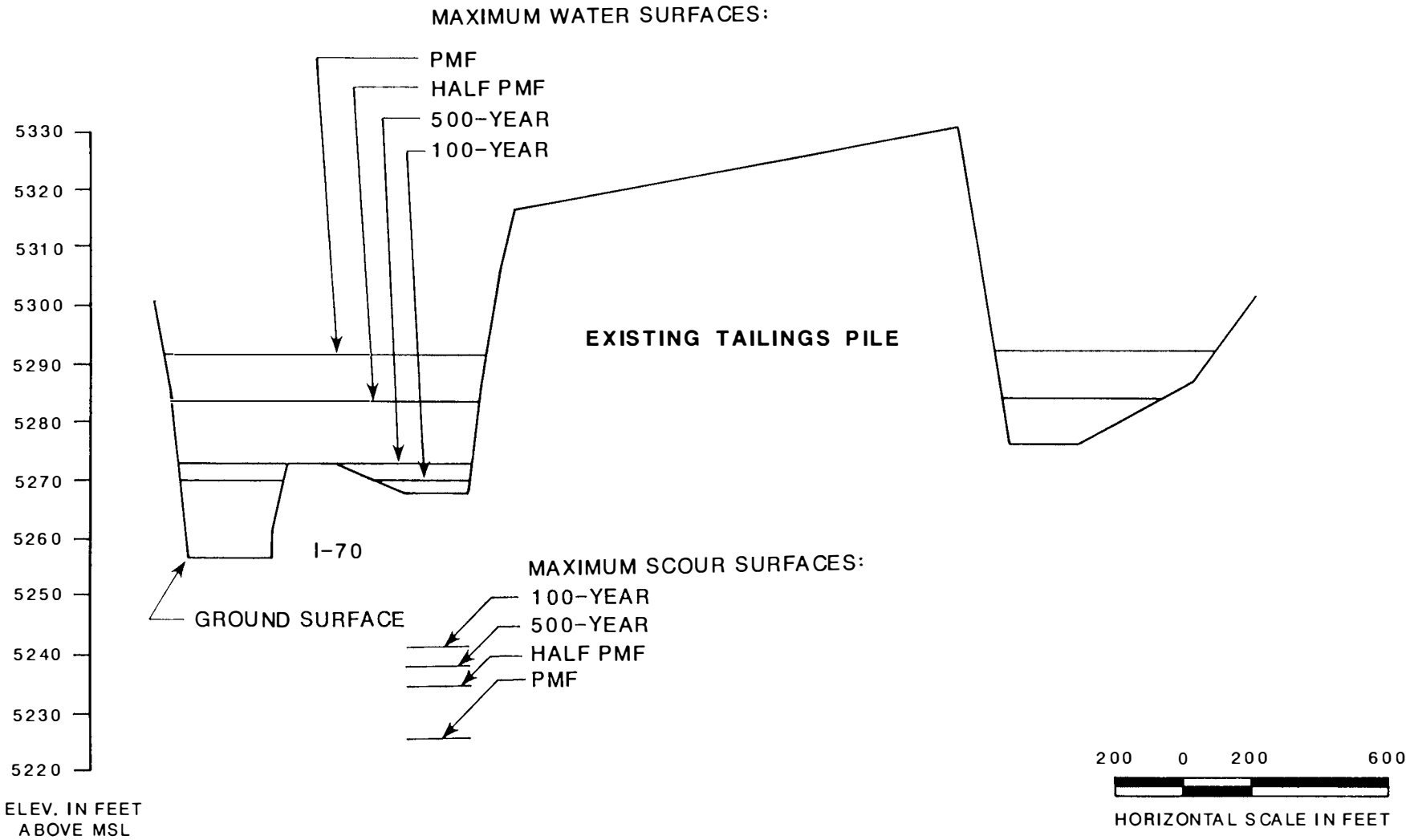


FIGURE E.1.11

FLOOD CROSS SECTION 1383, NEW RIFLE SITE

Table E.1.5 Summary of maximum water surface elevations, mean channel velocities, and scour depths, Old Rifle site

Cross section location[a]	Flood event	Elevation (feet above mean sea level) Toe of tailings pile	Maximum water surface	Maximum scour depth	Average channel velocity (fps)[b]
432	100-year	5305	5311	5288	12
	500-year	5305	5314	5287	12
	PMF	5305	5335	5279	13
	Half-PMF	5305	5325	5286	11

[a]Cross section locations are shown on Figures E.1.6 through E.1.9.
[b]fps = feet per second.

Table E.1.6 Summary of maximum water surface elevations, mean channel velocities, and scour depths, New Rifle site

Cross section location[a]	Flood event	Elevation (feet above mean sea level) Toe of tailings pile	Maximum water surface	Maximum scour depth	Average channel velocity (fps)[b]
383	100-year	5266	5270	5242	16
	500-year	5266	5272	5239	17
	PMF	5266	5290	5224	26
	Half-PMF	5266	5282	5235	21
1383	100-year	5267	5271	5241	17
	500-year	5267	5273	5239	18
	PMF	5267	5291	5225	26
	Half-PMF	5267	5283	5235	21
1384	100-year	5270	5275	5248	10
	500-year	5270	5278	5246	10
	PMF	5270	5301	5237	16
	Half-PMF	5270	5290	5243	13

[a]Cross section locations are shown on Figures E.1.6 through E.1.9.
[b]fps = feet per second.

The final tailings pile configuration for stabilization at the New Rifle site would not vary significantly from the existing pile. Hence, the velocities, depth to scour, and water surface elevation previously presented for the New Rifle site were considered applicable for the New Rifle stabilized pile.

E.1.2.2 Estes Gulch alternate disposal site

Drainage from the Estes Gulch site flows into an ephemeral creek in Estes Gulch 0.5 mile southeast and 150 feet below the site. This creek joins Government Creek one mile and 280 feet below the site. At its closest point, the Colorado River is six miles away and 730 feet below the site.

No data on historical floods exist for the Estes Gulch site. Because of the site's distance from and elevation above any major surface drainage, the site would not be subject to flooding.

The effects of a PMP on the stabilized tailings pile and the contributing drainage areas were analyzed in order to design erosion protection requirements for the pile. Using very conservative assumptions, preliminary calculations for the Estes Gulch site indicate that the flow resulting from the occurrence of a PMP (7.6 inches in one hour) over the Estes Gulch watershed would be in excess of 3300 cfs. Details on the PMP analysis are provided in Section A.3.7 of Appendix A, Engineering Designs.

E.1.2.3 Lucas Mesa alternate disposal site

Drainage from the Lucas Mesa site flows into Smith Gulch to the east, Moffat Gulch to the west, and into the Bluestone Valley irrigation ditch 0.5 to two miles below the site. Smith Gulch is 0.5 mile and 600 feet below the site, and Moffat Gulch is 0.5 mile and 300 feet below the site. The creeks in both gulches join the Colorado River one to two miles below the site. At its closest point, the Colorado River is two miles away and 900 feet below the site.

No data on historical floods exist for the Lucas Mesa site. Because of the site's distance from and elevation above any major surface drainage, the site would not be subject to flooding.

As with the Estes Gulch site, the effects of a PMP were analyzed to determine erosion protection requirements. Preliminary calculations indicate that a flow in excess of 3500 cfs would result from the occurrence of a PMP (7.6 inches in one hour) over the Lucas Mesa watershed. Details on the PMP analysis are provided in Section A.4.7 of Appendix A, Engineering Designs.

E.1.2.4 Borrow sites

The Second Street borrow site is not within the 100- or 500-year floodplains of the Colorado River. The New Rifle borrow site is within the 100- and 500-year floodplains of the Colorado River; however, the potential for flooding of this site during the short time it would be used for the remedial action is low. The operator of this borrow site would be required to comply with the Colorado Mined Land Reclamation Division's permit requirements for flood protection. The Glenwood Springs borrow site is 1200 feet above the Colorado River and would not be affected by flooding of the river.

E.1.3 SURFACE WATER QUALITY

The parameters of interest in characterizing the water quality of the Colorado River in the vicinity of the Rifle tailings site are those that might be elevated because of uranium processing and tailings disposal (NRC, 1980). The applicable Colorado River water quality standards for these parameters are presented in Table E.1.7 (CWQCC, 1983). The state of Colorado does not have a surface water quality standard for uranium. Instead, the state recommends that uranium concentrations in drinking water supplies do not exceed 0.06 milligrams per liter (mg/l) (40 picocuries per liter (pCi/l)).

The Colorado water quality standards vary with river segment. Two segments extend from the tailings site to the Colorado-Utah Border; the segments are established from the Roaring Fork River to Parachute Creek and from Parachute Creek to the Gunnison River. The water quality standards appropriate for the Rifle reach of the Colorado River are those listed for the Roaring Fork-Parachute Creek segment of the river. Both segments are classified for "Agricultural" and "Water Supply" use. Surface waters with a "Water Supply" designation are considered suitable as domestic water supplies after special treatment.

Snowmelt provides most of the surface runoff water to Colorado rivers and streams (Iorns et al., 1965). Rising temperatures in the late spring and early summer rapidly melt the snow and cause streamflow to peak and then slowly subside as the supply of snow is exhausted. The highest levels of runoff occur when snowmelt is augmented by heavy rainstorms during the late spring and early summer. Usually by late July, the streams have subsided to base flow conditions, which prevail until the cycle is repeated the following spring. The seasonal pattern of the Colorado River is illustrated in Figure E.1.12.

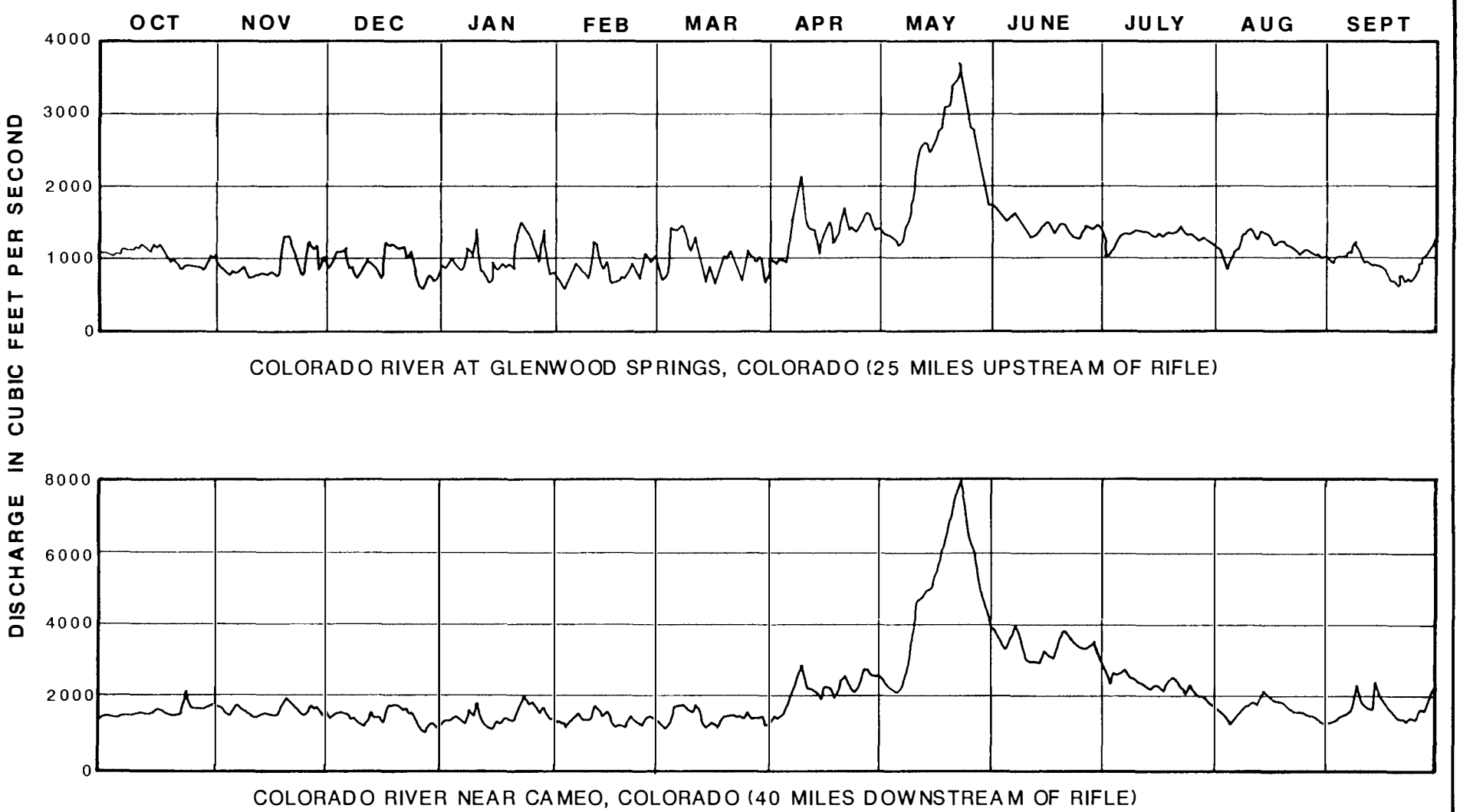
The chemical quality of surface water in the Colorado River is directly related to the source of recharge waters which, in turn, varies seasonally. During most of the year, the river is recharged by groundwater which introduces high concentrations of dissolved metals and inorganics that have been leached from the soil. During spring and summer high flow periods, the river is recharged primarily by surface runoff, which carries a greater volume of suspended solids; thus, the relative concentration of dissolved species decreases. This seasonal

Table E.1.7 State of Colorado standards for surface water quality[a]

Constituent	Colorado River between Roaring Fork River and Parachute Creek	Colorado River between Parachute Creek and Gunnison River	Colorado River between Gunnison River and Colorado-Utah state line	Tributaries between Parachute Creek and Colorado-Utah state line[b]
Aluminum, soluble	0.1[c]	0.1[c]	0.1[c]	--
Ammonia, un-ionized	0.02	0.06	0.06	--
Arsenic	0.05	0.05	0.05	0.1[d]
Cadmium	0.001	0.0017	0.001	0.01[d]
Chloride	250.0	250.0	--	--
Copper	0.01	0.018	0.012	0.2[d]25
Soluble	0.3	0.3	--	--
Total	1.0	1.0	1.5	--
Lead	0.025	0.025	0.025	0.1[d]
Manganese				
Soluble	0.05	0.05	--	--
Total	1.0	1.0	1.0	0.2[d]
Mercury	0.00005	0.00005	0.00005	--
Selenium	0.01	0.02	0.02	0.02[d]
Sulfate	250.0	250.0	--	--
Zinc	0.07	0.07	0.085	2.0[d]
pH	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0

[a]No numerical standards have been established by the state of Colorado for calcium, carbonate, molybdenum, sodium, vanadium, and total dissolved solids. All concentrations are in milligrams per liter except pH which is given in standard pH units. A dash indicates that the permissible concentration is to be established on a case-by-case basis.
[b]Except Wallace, Roan, Plateau, and Rapid Creeks and Little Dolores River.
[c]Colorado Water Quality Standards, Part 1, Table III, Aquatic Life Class I, April, 1981.
[d]Colorado Water Quality Standards, Part 1, Table III, Agricultural Uses, April, 1981.

Ref. CWQCC, 1983; DOE, 1983.



NOTE: 1954 WATER YEAR.

REF: IORNS et al., 1965

FIGURE E.1.12
SEASONAL RUNOFF PATTERN OF THE COLORADO RIVER

variation in water quality is exhibited in analyses of water samples taken from the Colorado River at New Castle and Parachute (Tables E.1.8 and E.1.9, respectively).

E.1.3.1 Old and New Rifle tailings sites

Old Rifle site

Surface water quality sampling has been performed during both high flow and low flow seasons. The Colorado River was sampled during the fall of 1983 by Markos and Bush (1983) and again in the late spring of 1986 by the U.S. Department of Energy (DOE). In the course of sampling the river, samples were taken from points upgradient, crossgradient, and downgradient of the Old Rifle tailings pile. Whenever possible, the Marcos and Bush sampling locations were resampled by the DOE. The sampling locations are illustrated in Figure E.1.13.

Analytical results indicate that the presence of the tailings is not causing degradation of the surface waters in the Colorado River. No health-threatening chemical species were found to be in excess of the Colorado standards. The analytical data used to support this conclusion are presented in Table E.1.10.

Concentrations of sodium, magnesium, sulfate, and uranium are elevated above background at sampling station 539 (Table E.1.10). However, these anomalous concentration values are not due to uranium processing activities at the Old Rifle site, as the samples were collected several thousand feet upstream of the processing site. The source of these elevated concentrations of constituents is unknown.

New Rifle site

Surface water quality sampling has been performed during both high flow and low flow seasons in conjunction with the sampling effort at the Old Rifle tailings site. The Colorado River was sampled at points upgradient, crossgradient, and downgradient of the New Rifle tailings pile during the fall of 1983 by Markos and Bush (1983) and again in the late spring of 1986 by the DOE (1986). Whenever possible, the Markos and Bush sampling locations were resampled by the DOE. The sampling locations are illustrated in Figure E.1.13.

Analytical results indicate that the presence of the tailings is not causing degradation of the surface waters in the Colorado River. None of the contaminant parameters identified by the U.S. Nuclear Regulatory Commission (NRC) (1980) were found to be elevated in the vicinity of the site. Moreover, none of the water quality standards regulated by the state of Colorado were exceeded. The analytical data used to support these conclusions are presented in Table E.1.11.

Table E.1.8 Colorado River water quality at New Castle, Colorado

Constituent[a]	03 Nov 1981	16 Dec 1981	28 Jan 1982	23 Feb 1982	15 Mar 1982	15 Apr 1982
Alkalinity	133.0	131.0	120.0	123.0	117.0	115.0
Aluminum	<0.1	NA	<0.1	NA	NA	<0.1
Arsenic	<0.01	NA	<0.01	NA	NA	<0.01
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	68.0	74.0	68.0	73.0	64.0	59.0
Chloride	170.0	201.0	170.0	192.0	175.0	106.0
Chromium	<0.01	NA	<0.01	NA	NA	<0.01
Copper	<0.01	NA	<0.01	NA	NA	<0.01
Iron (total)	0.10	<0.02	0.14	0.19	0.28	0.22
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium	13.0	12.0	10.0	13.0	15.0	11.0
Manganese	0.03	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury[b]	<0.5	NA	<0.5	NA	NA	<0.5
Molybdenum	<0.1	NA	<0.1	NA	NA	<0.1
Nickel	<0.05	NA	<0.05	NA	NA	<0.05
pH[c]	8.4	8.3	8.3	8.0	8.2	7.9
Potassium	15.0	3.4	18.0	2.1	2.8	2.2
Selenium	<0.01	NA	<0.01	NA	NA	<0.01
Sodium	110.0	147.0	132.0	128.0	124.0	74.0
Solids (dissolved)	700.0	792.0	710.0	742.0	681.0	492.0
Solids (suspended)	16.0	5.0	14.0	12.0	68.0	367.0
Sulfate	115.0	131.0	130.0	121.0	129.0	85.0
Conductivity[d]	1075.0	1295.0	1165.0	1055.0	1025.0	780.0
Discharge[e]	1650.0	1400.0	1365.0	1500.0	1650.0	2550.0

Table E.1.8 Colorado River water quality at New Castle, Colorado (Concluded)

Constituent[a]	28 May 1982	17 Jun 1982	14 Jul 1982	24 Aug 1982	27 Sep 1982	12 Oct 1982
Alkalinity	NA	94.0	90.0	126.0	115.0	178.0
Aluminum	NA	NA	<0.1	NA	NA	NA
Arsenic	NA	NA	<0.01	NA	NA	NA
Cadmium	NA	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	NA	38.0	42.0	56.0	61.0	64.0
Chloride	NA	28.0	48.0	98.0	118.0	12.0
Chromium	NA	NA	<0.01	NA	NA	NA
Copper	NA	NA	<0.01	NA	NA	NA
Iron (total)	NA	0.16	0.12	<0.02	<0.02	0.10
Lead	NA	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium	NA	5.1	5.0	10.0	10.0	11.0
Manganese	NA	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury[b]	NA	NA	<0.5	NA	NA	NA
Molybdenum	NA	NA	<0.1	NA	NA	NA
Nickel	NA	NA	<0.05	NA	NA	NA
pH[c]	NA	8.2	7.9	8.2	8.2	8.3
Potassium	NA	0.79	1.2	1.9	2.1	2.1
Selenium	NA	NA	<0.01	NA	NA	NA
Sodium	NA	22.0	34.0	69.0	84.0	85.0
Solids (dissolved)	NA	249.0	297.0	363.0	521.0	470.0
Solids (suspended)	NA	60.0	18.0	54.0	18.0	<5.0
Sulfate	NA	28.0	39.0	65.0	84.0	177.0
Conductivity[d]	NA	350.0	465.0	600.0	670.0	730.0
Discharge[e]	8475.0	10400.0	6250.0	1460.0	2700.0	2550.0

[a]All values are in milligrams per liter unless otherwise noted. No data available is indicated by NA.
[b]Values are in micrograms per liter.
[c]Values are in standard pH units.
[d]Values are in micromhos per centimeter.
[e]Values are in cubic feet per second.

Ref. Mobil, 1982.

Table E.1.9 Colorado River water quality at Parachute, Colorado

Constituent[a]	03 Nov 1981	16 Dec 1981	28 Jan 1982	23 Feb 1982	15 Mar 1982	15 Apr 1982
Alkalinity	131.0	120.0	140.0	141.0	123.0	123.0
Aluminum	<0.1	NA	<0.1	NA	NA	<0.1
Arsenic	<0.01	NA	<0.01	NA	NA	<0.01
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	72.0	76.0	70.0	76.0	63.0	59.0
Chloride	162.0	196.0	170.0	186.0	133.0	96.0
Chromium	<0.01	NA	<0.01	NA	NA	<0.01
Copper	<0.01	NA	<0.01	NA	NA	<0.01
Iron (total)	0.14	<0.02	0.09	0.77	0.72	0.23
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium	17.0	16.0	14.0	18.0	16.0	17.0
Manganese	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury[b]	<0.5	NA	<0.5	NA	NA	<0.5
Molybdenum	<0.1	NA	<0.1	NA	NA	<0.1
Nickel	<0.05	NA	<0.05	NA	NA	<0.05
pH[c]	8.5	8.3	8.4	8.1	8.2	7.9
Potassium	2.3	2.6	4.1	5.1	3.1	2.4
Selenium	<0.01	NA	<0.01	NA	NA	<0.01
Sodium	110.0	130.0	134.0	134.0	111.0	74.0
Solids (dissolved)	700.0	781.0	760.0	804.0	684.0	500.0
Solids (suspended)	22.0	11.0	55.0	145.0	266.0	571.0
Sulfate	131.0	143.0	150.0	164.0	157.0	93.0
Conductivity[d]	1060.0	1225.0	1200.0	975.0	1100.0	760.0
Discharge[e]	1710.0	1470.0	1430.0	1570.0	1730.0	2680.0

Table E.1.9 Colorado River water quality at Parachute, Colorado (Concluded)

Constituent[a]	28 May 1982	17 Jun 1982	14 Jul 1982	24 Aug 1982	27 Sep 1982	12 Oct 1982
Alkalinity	NA	98.0	92.0	134.0	130.0	129.0
Aluminum	NA	NA	<0.1	NA	NA	NA
Arsenic	NA	NA	<0.01	NA	NA	NA
Cadmium	NA	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	NA	45.0	43.0	60.0	63.0	67.0
Chloride	NA	26.0	49.0	97.0	107.0	118.0
Chromium	NA	NA	<0.01	NA	NA	NA
Copper	NA	NA	<0.01	NA	NA	NA
Iron (total)	NA	0.12	0.33	0.10	0.39	0.70
Lead	NA	<0.05	<0.05	<0.05	<0.05	<0.05
Magnesium	NA	3.0	6.0	11.0	12.0	13.0
Manganese	NA	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury[b]	NA	NA	<0.5	NA	NA	NA
Molybdenum	NA	NA	<0.1	NA	NA	NA
Nickel	NA	NA	<0.05	NA	NA	NA
pH[c]	NA	8.1	8.0	8.2	8.2	8.4
Potassium	NA	1.9	1.1	2.1	2.1	2.1
Selenium	NA	NA	<0.01	NA	NA	NA
Sodium	NA	17.0	34.0	73.0	84.0	85.0
Solids (dissolved)	NA	256.0	312.0	388.0	542.0	493.0
Solids (suspended)	NA	79.0	19.0	119.0	374.0	<5.0
Sulfate	NA	24.0	46.0	80.0	115.0	116.0
Conductivity[d]	NA	300.0	480.0	600.0	805.0	620.0
Discharge[e]	9570.0	10900.0	3720.0	1570.0	2750.0	2600.0

[a]All values are in milligrams per liter unless otherwise noted. No data available is indicated by NA.
[b]Values are in micrograms per liter.
[c]Values are in standard pH units.
[d]Values are in micromhos per centimeter.
[e]Values are in cubic feet per second.

Ref. Mobil, 1982.

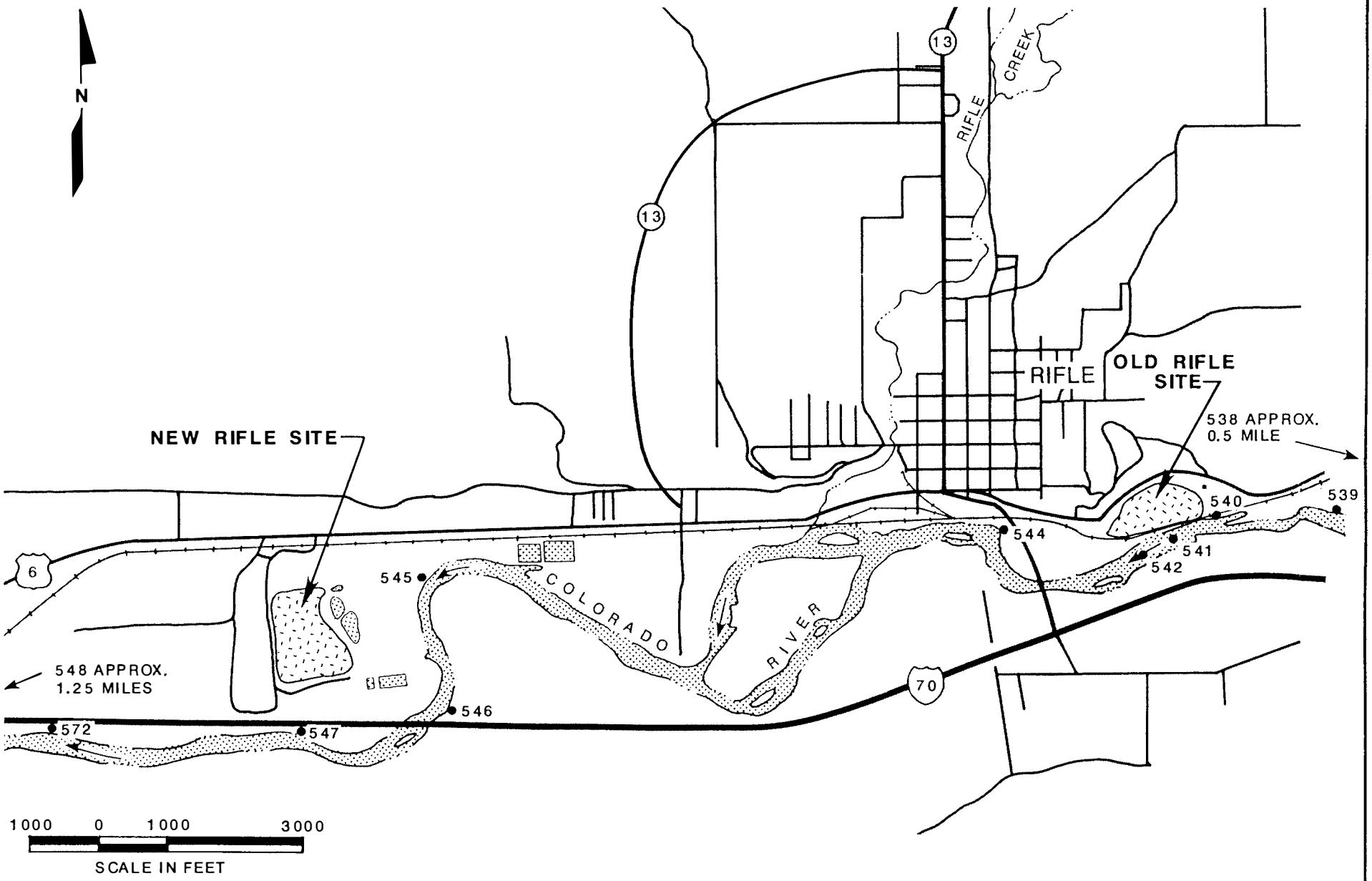


FIGURE E.1.13

SURFACE WATER QUALITY SAMPLING LOCATIONS, OLD AND NEW RIFLE SITES

Table E.1.10 Colorado River water quality, Old Rifle site

Constituent[a]	Surface water-quality sampling station[b]					
	538	539	540	541	542	544
Aluminum	0.170	0.220	<0.03	0.030	0.290	<0.03
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	0.056	0.075	0.075	0.043	0.032	0.053
Cadmium	<0.0005	<0.0005	0.0006	<0.0005	<0.0005	<0.0005
Calcium	130.0	130.0	48.0	47.0	43.0	43.0
Chloride	50.0	170.0	52.0	50.0	50.0	50.0
Chromium	<0.02	<0.02	0.07	<0.02	<0.02	<0.02
Cobalt	<0.03	<0.03	0.014	<0.03	<0.03	<0.03
Iron	<0.02	<0.02	0.27	0.31	<0.02	<0.02
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Magnesium	12.0	84.0	12.0	12.0	11.0	11.0
Manganese	<0.01	1.80	0.07	0.08	<0.01	<0.01
Molybdenum	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Nickel	<0.04	<0.04	<0.55	<0.04	<0.04	<0.04
pH	7.9	7.7	7.8	7.6	7.6	7.6
Potassium	<1.0	7.40	3.30	1.40	<1.0	1.10
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon	5.60	5.70	4.70	4.60	4.50	4.50
Silver	<0.04	0.05	NA	<0.04	<0.04	<0.04
Sodium	44.0	360.0	54.0	33.0	43.0	47.0
Strontium	0.371	1.360	0.334	0.327	0.307	0.346
Sulfate	79.0	885.0	83.0	76.0	69.0	73.0
Uranium	0.0025	0.0180	0.0032	0.0050	0.0028	<0.04
Vanadium	<0.04	<0.04	0.150	<0.04	<0.04	<0.04

[a]All values are in milligrams per liter except pH which is given in standard pH units.
[b]Station locations are shown on Figure E.1.13. Samples were taken during September, 1983 (Markos and Bush, 1983).

Table E.1.11 Colorado River water quality, New Rifle site

Constituent[a]	Surface water quality sampling station[b]				
	545	546	547	548	572
Aluminum	<0.03	<0.03	NA	<0.03	<0.03
Arsenic	<0.01	<0.01	<0.01	<0.01	<0.01
Barium	0.063	0.061	0.055	0.056	0.055
Cadmium	<0.0005	<0.0005	0.0005	<0.0005	<0.0005
Calcium	47.0	47.0	46.0	48.0	45.0
Chloride	48.0	47.0	50.0	48.0	50.0
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02
Cobalt	<0.03	<0.03	<0.03	<0.03	<0.03
Iron	0.16	0.19	<0.02	<0.02	<0.02
Lead	<0.005	<0.005	<0.005	<0.005	<0.005
Magnesium	12.0	12.0	11.0	11.0	12.0
Manganese	0.03	0.03	<0.01	<0.01	<0.01
Molybdenum	0.05	<0.04	<0.04	<0.04	<0.04
Nickel	<0.04	<0.04	<0.04	<0.04	<0.04
pH	7.9	7.8	7.6	7.6	7.8
Potassium	<1.0	<1.0	<1.0	<1.0	<1.0
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01
Silicon	4.90	5.00	4.90	5.10	5.10
Silver	<0.04	<0.04	NA	<0.04	<0.04
Sodium	64.0	56.0	<20.0	56.0	<20.0
Strontium	0.367	0.374	0.357	0.366	0.362
Sulfate	76.0	73.0	76.0	73.0	79.0
Uranium	<0.01	0.0021	0.0022	0.0028	0.0200
Vanadium	<0.04	<0.04	<0.04	<0.04	<0.04

[a]All values are in milligrams per liter except pH which is given in standard pH units.
[b]Station locations are shown on Figure E.1.12. Samples were taken during September, 1983 (Markos and Bush, 1983).

E.1.3.2 Estes Gulch alternate disposal site

Drainage from the Estes Gulch site flows into ephemeral streams in Estes Gulch 0.5 mile below the site. In turn, Estes Gulch joins Government Creek one mile southeast of the site. The Colorado River is six miles due south of the site.

The ephemeral streams in Estes Gulch were not sampled. The water quality of Government Creek and one of its tributaries, Thirty-two Mile Gulch, is described from samples obtained by Markos and Bush (1983) (Table E.1.12). Thirty-two Mile Gulch was sampled 2.5 miles southwest of its confluence with Government Creek, upstream of the Estes Gulch site. Government Creek was sampled along State Highway 13, three miles north of Rifle, downstream of the Estes Gulch site. Analytical results from the Thirty-two Mile Gulch samples exhibited low levels for all dissolved constituents. The Government Creek samples exhibited high levels of sulfate and calcium. Except for the sulfate analysis, all results were within state of Colorado standards.

E.1.3.3 Lucas Mesa alternate disposal site

Drainage from the Lucas Mesa site flows into ephemeral streams in Smith Gulch or Moffat Gulch or into the Bluestone Valley irrigation ditch 0.5 to two miles to the north. The creeks in both gulches join the Colorado River two miles directly north of the site.

The ephemeral streams in Smith and Moffat Gulches were not sampled. Water quality measurements are available only from the USGS sampling station on the Colorado River at DeBeque. The results of the limited water quality sampling at DeBeque (Table E.1.13) indicate that average values are within the State of Colorado standards.

E.1.3.4 Borrow sites

Second Street borrow site

The Second Street borrow site is an active borrow operation approximately one mile north of the Colorado River. There are no surface drainages leading directly from the site to the river. Activities related to supplying borrow materials for the remedial action would be similar to those currently being performed at the site. Thus, the present surface water quality in the vicinity of the site would not be affected by the proposed borrow activities.

Table E.1.12 Surface water quality near the Estes Gulch site[a]

Constituent	Thirty-two Mile Gulch[b]	Government Creek[c]
Aluminum	<0.03	<0.03
Arsenic	<0.01	<0.01
Barium	0.054	0.065
Cadmium	<0.0005	<0.0005
Calcium	43.0	963.0
Chloride	50.0	11.0
Chromium	<0.02	<0.02
Cobalt	<0.03	<0.03
Iron	<0.02	<0.02
Lead	<0.005	<0.005
Magnesium	13.0	53.0
Manganese	<0.01	<0.01
Molybdenum	<0.04	<0.04
Nickel	<0.04	<0.04
pH	8.0	8.3
Potassium	<1.0	1.5
Selenium	<0.01	<0.01
Silicon	5.70	6.50
Silver	<0.04	<0.04
Sodium	26.0	130.0
Strontium	0.36	0.96
Sulfate	76.0	370.0
Uranium	0.0020	0.0070
Vanadium	<0.04	<0.04

[a]All values are in milligrams per liter except pH, which is given in standard pH units. Samples were taken during September 1983 (Markos and Bush, 1983).

[b]Sample location was approximately three miles southwest and upstream of the Estes Gulch site.

[c]Sample location was approximately three miles southeast and downstream of the Estes Gulch site.

Table E.1.13 Colorado River water quality measurements near DeBeque, Colorado[a]

Constituent[b]	Number of measurements	Concentration (mg/l) Mean	Maximum
Aluminum	2	0.10	0.10
Carbonate	54	0.17	4.00
Chloride, total	84	137	280
Fluoride	84	0.26	0.80
Iron	84	0.38	0.21
Manganese	84	0.02	0.06
Sodium	84	98	190
Sulfate, total	84	117	190
Total dissolved solids	83	518	865
pH[c]	88	8.0	9.1[d]

[a]Measurements were made by the USGS at latitude 039°21'00" N, longitude 108°09'07" W, at various times.
[b]Unless otherwise indicated, constituents were measured in the form of dissolved concentrations.
[c]Measurements are in standard pH units.
[d]The minimum pH measured was 7.1.

Ref. DOE, 1983.

New Rifle borrow site

The New Rifle borrow site is an active borrow operation with an existing pond created by the current operations, which have intercepted the water table. The borrow site is 0.5 mile north of the Colorado River; however, there is no surface drainage to the river from the site. Analyses of water samples from the pond at the site are similar to those for groundwater samples from nearby monitor wells (see Section E.2.3.5, Groundwater Quality). The surface water quality of the pond and Colorado River would not be affected by the proposed borrow activities necessary to supply borrow materials for the remedial action.

Glenwood Springs borrow site

The Glenwood Springs borrow site is an active quarry operation approximately two miles north of the Colorado River. Surface drainages to the river are ephemeral streams. Activities related to supplying rock materials for the remedial action would be similar to those currently being performed at the site. Thus, the present surface water quality in the vicinity of the site would not be affected by the proposed borrow activities.

E.2 GROUNDWATER

E.2.1 INTRODUCTION

The EPA has established health and environmental regulations to correct and prevent groundwater contamination resulting from former uranium processing activities at inactive milling sites (40 CFR 192). According to the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), the DOE is responsible for assessing the inactive uranium processing sites. The DOE has decided that each assessment shall include:

- Definition of the hydrogeologic characteristics of the environment including hydrostratigraphy, aquifer parameters, areas of aquifer recharge and discharge, potentiometric surfaces, and groundwater velocities.
- Comparison of the existing water quality with background water quality and applicable EPA and state water quality standards.
- Evaluation of the physical and chemical characteristics of the contaminant source.
- Description of water resource utilization including availability, current and future use and value, and alternate water supplies.
- Evaluation of current and future impacts to the groundwater systems resulting from uranium processing activities and remedial actions.

Under the UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

Water quality at the Old and New Rifle tailings sites was characterized by comparing it with background water quality and with hazardous constituents listed or referenced in the EPA's proposed groundwater protection standards for inactive (Title I) uranium processing sites (Table E.2.1). All further discussions of water quality in this appendix will refer to only these standards.

Table E.2.1 Proposed EPA groundwater protection standards

Constituent	MCL
Inorganic Chemical	mg/l
Arsenic	0.05
Barium	1.00
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Molybdenum	0.10
Nitrate (as NO_3)	44
Selenium	0.01
Silver	0.05
Inorganic Chemical	pCi/l
Ra-226 & Ra-228	5
U-234 & U-238	30 (0.044/mg/l)
Gross alpha (excluding uranium & radon)	15
Organic Chemical	mg/l
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.10
Toxaphene	0.005
2, 4-D	0.10
2, 4, 5-TP	0.01
Appendix IX Chemicals	
Antimony	(No concentration limit specified, but must not exceed background)
Beryllium	
Carbon disulfide	
Cobalt	
Copper	
Cyanide	
Fluorene	
Nickel	
Sulphide	
Thallium	
Tin	
Vanadium	

Proposed EPA Groundwater Protection Standards - UMTRA, 52 FR 36,000. See Appendix IX, 40 CFR 264 for complete list of hazardous organic and inorganic constituents. See Tables E.2.7, E.2.8, E.2.15 and E.2.16 for the site specific background values used as standards for the Appendix IX constituents.

E.2.2 SUMMARY OF HYDROGEOLOGICAL SITE CHARACTERIZATION

The DOE has characterized the hydrogeology, water quality, and water resources at the Old and New Rifle tailings sites and the Estes Gulch and Lucas Mesa disposal sites. Major points are summarized below.

Old and New Rifle sites

- Both the Old and New Rifle sites are underlain by a dual aquifer system consisting of a shallow, unconfined aquifer in the alluvium lining the Colorado River and a semiconfined aquifer in the Wasatch Formation (bedrock) beneath the alluvium.

- Groundwater flow in the alluvium and the Wasatch Formation is toward the west, roughly parallel to the flow in the Colorado River.

- Hydraulic conductivities at the Old Rifle site average 200 feet per day (ft/day) in the alluvium and 0.03 ft/day in the Wasatch Formation. Average linear groundwater velocities are 840 feet per year (ft/yr) in the alluvium and 0.3 ft/yr in the Wasatch Formation.

- Hydraulic conductivities at the New Rifle site average 70 ft/day in the alluvium and 0.46 ft/day in the Wasatch Formation. Linear groundwater velocities average 280 ft/yr in the alluvium and 3.0 ft/yr in the Wasatch Formation.

- Background water quality in the alluvium at the Old Rifle site is characterized by concentrations of molybdenum, selenium, uranium, and gross alpha activity that exceed the maximum concentration limits (MCLs) of the proposed EPA groundwater protection standards. Background groundwater quality in the Wasatch Formation at the Old Rifle site is characterized by concentrations of molybdenum, selenium, and gross alpha activity that exceed the proposed EPA MCLs.

- Background groundwater quality in the alluvium at the New Rifle site is characterized by concentrations of molybdenum, selenium, uranium, and gross alpha activity that exceed the proposed EPA MCLs. Background groundwater quality in the Wasatch Formation at the New Rifle site is characterized by concentrations of barium, molybdenum, and selenium and activities of gross alpha and radium-226 and -228 combined that exceed the proposed EPA MCLs.

- Major contaminants introduced by tailings seepage at both sites include arsenic, molybdenum, selenium, uranium, vanadium, and iron. The alluvium and the Wasatch Formation at both sites are contaminated from tailings seepage.

- Hazardous constituents (from Appendix IX of 40 CFR 264) identified in the tailings at the Rifle processing sites include arsenic, chromium, molybdenum, selenium, uranium, radium-226 and -228 combined, beryllium, vanadium, benzene, diethyl phthalate, benzo [a] anthracene, benzo [a] pyrene, chrysene, fluoranthene, indeno (1,2,3-ed) pyrene, pyrene, acrylonitrile, 2,4-D, and Silvex (2,4,5-TP). The proposed concentration limits for these constituents are the MCLs (if they exist for the constituent) or background concentrations, whichever are higher.

- Most of the contamination at the Old Rifle site discharges to the Colorado River approximately 200 feet downgradient of the tailings, where weathered Wasatch Formation claystone pinches out much of the alluvium.

- Although upward potentiometric gradients from the Wasatch Formation to the alluvium occur naturally at the Old Rifle site, groundwater mounding in the alluvium resulting from a culvert discharging on site, has driven contaminants downward into the Wasatch Formation. The extent of contamination in the Wasatch Formation is less than in the alluvium due to the lower hydraulic conductivity of the Wasatch Formation.

- At the Old Rifle site, groundwater in the alluvium onsite and downgradient of the tailings contains concentrations of arsenic, molybdenum, selenium, and uranium and activities of gross alpha and radium-226 and -228 combined that exceed the proposed EPA groundwater protection standard MCLs. In addition, tailings seepage at the Old Rifle site has generated concentrations of the Appendix IX (40 CFR 264) constituents sulfide and vanadium that are elevated above background.

- Limited sampling for organic contaminants in alluvial groundwater at the Old Rifle site revealed low concentrations of the solvents acetone and toluene and the herbicide alpha-BHC. Although these chemicals were not used in the milling process per se, they may have been used on site during the milling operation.

- Groundwater from monitor wells completed on the Old Rifle site in the Wasatch Formation contains concentrations of selenium that exceed the proposed EPA groundwater protection standard MCLs. In addition, tailings seepage has resulted in elevated concentrations of the Appendix IX constituents vanadium and zinc that are elevated above background in the Wasatch Formation.

- At the New Rifle site, a perched groundwater system of tailings fluids partially recharges the underlying alluvium with contaminated seepage. The total seepage flux from the tailings pile is approximately 3.8 gallons per minute (gpm).

- The contaminant plume at the New Rifle site extends more than 8,000 feet downgradient in the alluvium. Contaminant concentrations are generally higher than at the Old Rifle site and are greatest beneath the vanadium ponds and the tailings pile.

- Groundwater in the alluvium onsite and downgradient of the tailings at the New Rifle site contains concentrations of arsenic, cadmium, chromium, lead, molybdenum, nitrate, selenium, uranium, and gross alpha activity that exceed the proposed EPA MCLs. In addition, concentrations of the Appendix IX constituents antimony, cobalt, copper, nickel, thallium, tin, vanadium and zinc are elevated above background concentrations.

- Limited sampling for organic contaminants in monitor wells completed in the alluvium at the New Rifle site revealed low concentrations of the solvents acetone and toluene and the herbicide 2,4,5-TP. These chemicals were believed to have been used onsite during the milling operation.

- Groundwater in the Wasatch Formation onsite and downgradient of the tailings at the New Rifle site contains concentrations of barium, molybdenum, selenium, uranium, and activities of radium-226 and -228 combined and gross alpha which exceed the proposed EPA MCLs. Tailings seepage has also resulted in concentrations of the Appendix IX constituents cobalt, nickel, sulfide, tin, vanadium and zinc that are elevated above background in Wasatch Formation groundwater.

- Low concentrations of the solvents acetone and toluene have been detected in one monitor well completed in the Wasatch Formation at the New Rifle site.

- Contamination in the Wasatch Formation at the New Rifle site extends more than 3,500 feet downgradient to a depth of at least 90 feet.

Estes Gulch alternate disposal site

- The Estes Gulch site is underlain by the Wasatch Formation. Groundwater beneath the site flows to the southeast along the strike of the steeply dipping beds of the Wasatch Formation.

- The average hydraulic conductivity of the Wasatch Formation at Estes Gulch is 6×10^{-5} ft/day (2×10^{-8} centimeters per second (cm/s)), and the average linear groundwater velocity is less than 0.1 ft/yr.

- Background groundwater quality in the Wasatch Formation beneath the Estes Gulch site is poor. Water quality from three monitor

wells near the disposal site contained TDS ranging from 8,260 to 24,300 mg/l and concentrations of barium, cadmium, lead, molybdenum, and selenium that exceeded EPA standards.

- Because the average groundwater velocities beneath the site are so low, it is unlikely that contamination will migrate beyond the toe of the pile within the 1000-year design life of the pile; therefore, the proposed EPA groundwater protection standards will be met.

- Groundwater at Estes Gulch could be classified as Class III, based on the low yield of the Wasatch Formation and the poor quality of the groundwater.

Lucas Mesa alternate disposal site

- The Lucas Mesa site lies on a remnant pediment surface underlain by the Shire Member of the Wasatch Formation. The pediment consists of approximately 30 to 90 feet of sands, gravels, cobbles, and boulders in a clay, silt matrix. The underlying Wasatch Formation consists of 200 to 400 feet of predominantly shale and claystone.

- No groundwater has been encountered in the unconsolidated materials of the pediment, although localized perched zones may occur in the pediment materials or at the bedrock interface.

- The average saturated hydraulic conductivity of the unconsolidated materials is 0.02 ft/day and the average hydraulic conductivity of the Wasatch Formation is probably on the order of 10^{-5} ft/day.

- Groundwater velocities in the Wasatch Formation are low.

- Groundwater quality in the Wasatch Formation beneath the Lucas Mesa site is undetermined, but most likely it is similar to that of the Wasatch Formation beneath the Estes Gulch site. Consequently, groundwater in the Wasatch Formation at the Lucas Mesa site would be Class III in terms of quality.

E.2.3 HYDROGEOLOGIC SITE CHARACTERIZATION

E.2.3.1 Previous investigations

Several hydrologic and geologic studies have been completed for the Old and New Rifle tailings sites. These investigations varied in scope and detail.

In 1977, Ford, Bacon & Davis Utah Inc. (FBDU, 1977) prepared a preliminary, reconnaissance-level investigation of the hydrology and geology at the uranium mill tailings sites at Rifle. This investigation included a general characterization of the local geology and surface and groundwater hydrology and a summary of water use for the region. The investigation concluded that groundwater had been affected by milling activities at the sites but did not delineate the shape or extent of the contaminant plumes in the alluvium. It also concluded that contamination of the Wasatch Formation beneath the sites was virtually impossible due to the formation's low hydraulic conductivity and its confined potentiometric surface.

Ford, Bacon & Davis Utah Inc. (FBDU, 1981) also prepared an engineering assessment of the Old and New Rifle tailings sites that included a brief review of the hydrology and geology of the area. The assessment again concluded that there was groundwater contamination within the alluvium and that the upper siltstones and claystones in the Wasatch Formation prevented downward migration of contamination.

The Colorado Geologic Survey (CGS, 1982) conducted a regional search for sites that were suitable for the relocation and reprocessing of the Rifle and Grand Junction uranium mill tailings. The CGS evaluated the hydrogeology of nine potential sites for possible disposal of tailings from both sites.

Markos and Bush (1983) performed a geochemical study of the Old and New Rifle tailings sites. Groundwater from several background Wasatch Formation wells and surface water from onsite and offsite sampling locations were analyzed, and geochemical acid- and water-extracts from tailings samples were evaluated. The analytical data were published, but no interpretive report was released.

The NUS Corporation issued a preliminary environmental impact statement (DOE, 1983) for the Rifle tailings sites. This statement included a hydrogeologic study based on data from 10 newly installed monitor wells at each of the Old and New Rifle tailings sites and pumping tests conducted on these wells. However, the complete extent of contamination in the alluvium at both sites was not defined, and contamination within the Wasatch Formation was not adequately addressed.

E.2.3.2 Recent investigations

The Uranium Mill Tailings Remedial Action (UMTRA) Project site characterization program conducted by the DOE at the Rifle tailings sites and the Estes Gulch and Lucas Mesa alternate disposal sites has included extensive hydrogeological investigations. These investigations consisted of the following activities:

- The installation of 12 additional monitor wells in the alluvium and 13 monitor wells in the Wasatch Formation at the Old Rifle site in 1985.

- The installation of 21 additional monitor wells in the alluvium and 28 monitor wells in the Wasatch Formation at the New Rifle site in 1985.

- The installation of 13 monitor wells at the Estes Gulch alternate disposal site.

- The installation of five monitor wells in the unconsolidated (debris-flow) material at the Lucas Mesa alternate disposal site.

- Borehole drilling and lithologic sampling at all sites.

- Slant borehole drilling and packer tests on five boreholes to determine hydraulic conductivity at the Estes Gulch disposal site.

- Packer testing of six boreholes at the Lucas Mesa site to determine the saturated hydraulic conductivity of the pediment materials.

- Borehole geophysical logging (gamma, self-potential, resistivity, neutron porosity, caliper, and temperature logs) at all sites.

- Surveying of all well locations including ground surface and casing elevations.

- Conducting pump tests on four Old Rifle and ten New Rifle alluvial monitor wells and slug tests on three Old Rifle and 12 New Rifle Wasatch Formation monitor wells.

- Measuring the groundwater elevations in monitor wells at the Old and New Rifle tailings sites and at the Estes
  Gulch site.

- Groundwater sampling at the Rifle tailings sites in June and December of 1985, May of 1986, and October of 1987 and conducting field measurements of temperature, pH, and alkalinity for the samples.

- Performing laboratory analyses of the samples for major ions, trace elements, metals, uranium, radium, and other radionuclides.

- Sampling and analyzing groundwater and tailings at the Old and New Rifle processing sites for Appendix IX organic constituents.

- o Installation and sampling of lysimeters in the tailings piles to characterize tailings pore fluids.

All field and laboratory procedures, data analyses, and calculations were performed according to the standard operating procedures developed for the UMTRA Project (DOE, 1985). Figure E.2.1 depicts the typical construction details for the monitor wells installed by the DOE at the Rifle tailings sites and alternate disposal site. Figures E.2.2 through E.2.7 show the locations of all of the monitor wells at both mill processing sites and the proposed Estes Gulch and Lucas Mesa disposal sites.

E.2.3.3 Regional hydrostratigraphy

Geology

The Rifle UMTRA Project sites are located on the southeastern flank of the asymmetric Piceance Creek Basin, a structural and sedimentary downwarp containing relatively horizontal sedimentary and volcanic rocks. The Old and New Rifle tailings sites rest on the Colorado River floodplain alluvium (Figure E.2.8), which is comprised of silts, sands, gravels, and cobbles. The Colorado River valley is incised into the Wasatch Formation and is bordered on the north by the Book Cliffs and the Grand Hogback monocline and on the south by the Roan Cliffs.

The Wasatch Formation at Rifle consists of a series of interbedded shales and lenticular sandstone units dipping five to ten degrees to the west-southwest. The formation contains the Shire, Molina, and Atwell Gulch Members. The upper Shire Member is 1,600 feet thick near Rifle and consists of variegated claystones, siltstones, and some lenticular sandstones. The middle Molina Member is 500 feet thick and consists primarily of sandstone with thin, interbedded claystones and siltstones. The lower Atwell Gulch Member is approximately 600 feet thick and contains a series of shales and sandstones with thin, discontinuous interbeds of lignite and carboniferous shale.

The Estes Gulch alternate disposal site, six miles north of Rifle, lies on the southwestern flank of the Grand Hogback monocline and is underlain by the Shire Member of the Wasatch Formation. Beneath the site, the bedding planes of the Wasatch Formation are nearly vertical, dipping from 65 to 75 degrees toward the south-southwest.

The Lucas Mesa alternate disposal site lies 35 miles southwest of Rifle near the town of DeBeque. It lies on a 30- to 90-foot-thick pediment surface underlain by the Shire

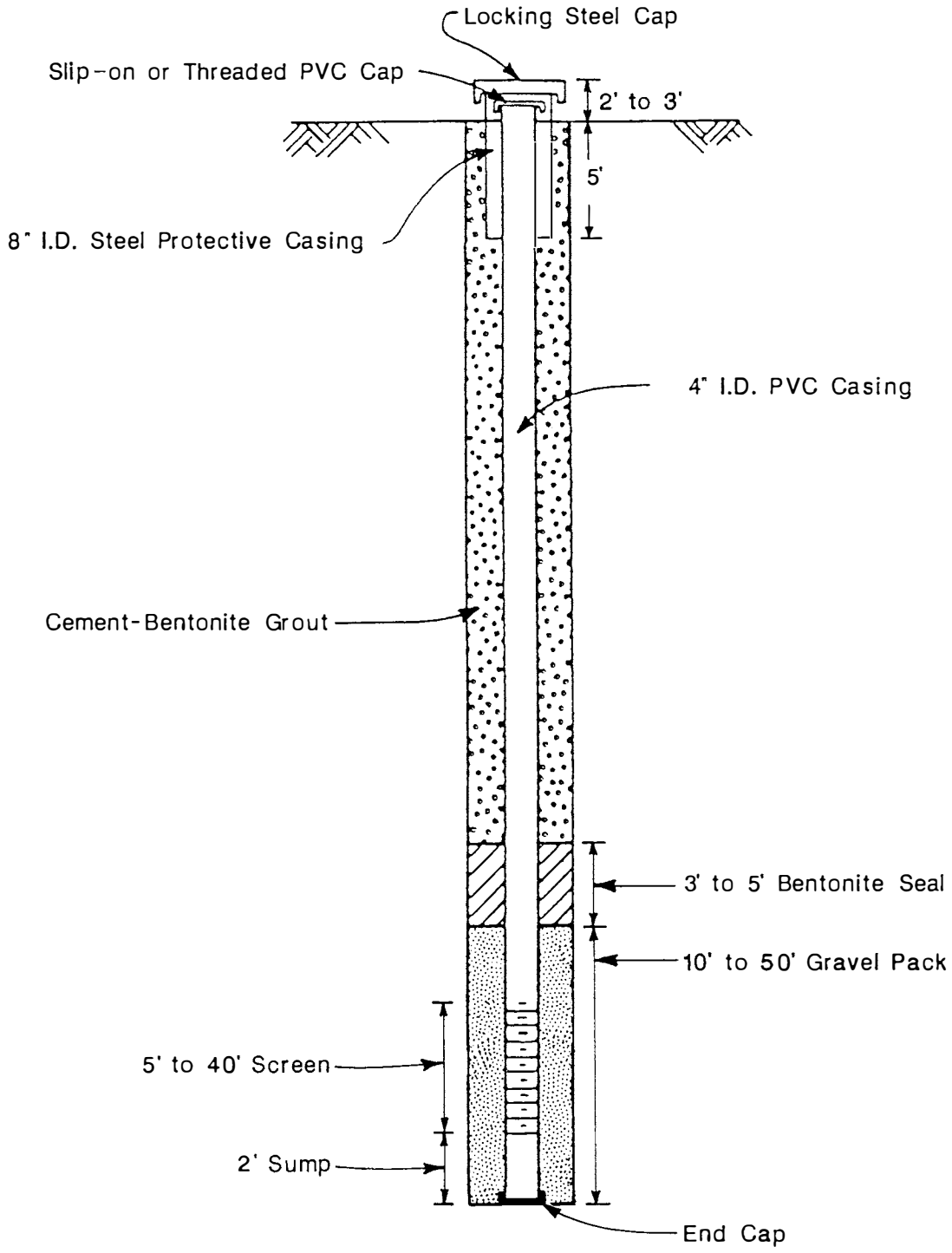


FIGURE E.2.1
TYPICAL MONITOR WELL INSTALLATION

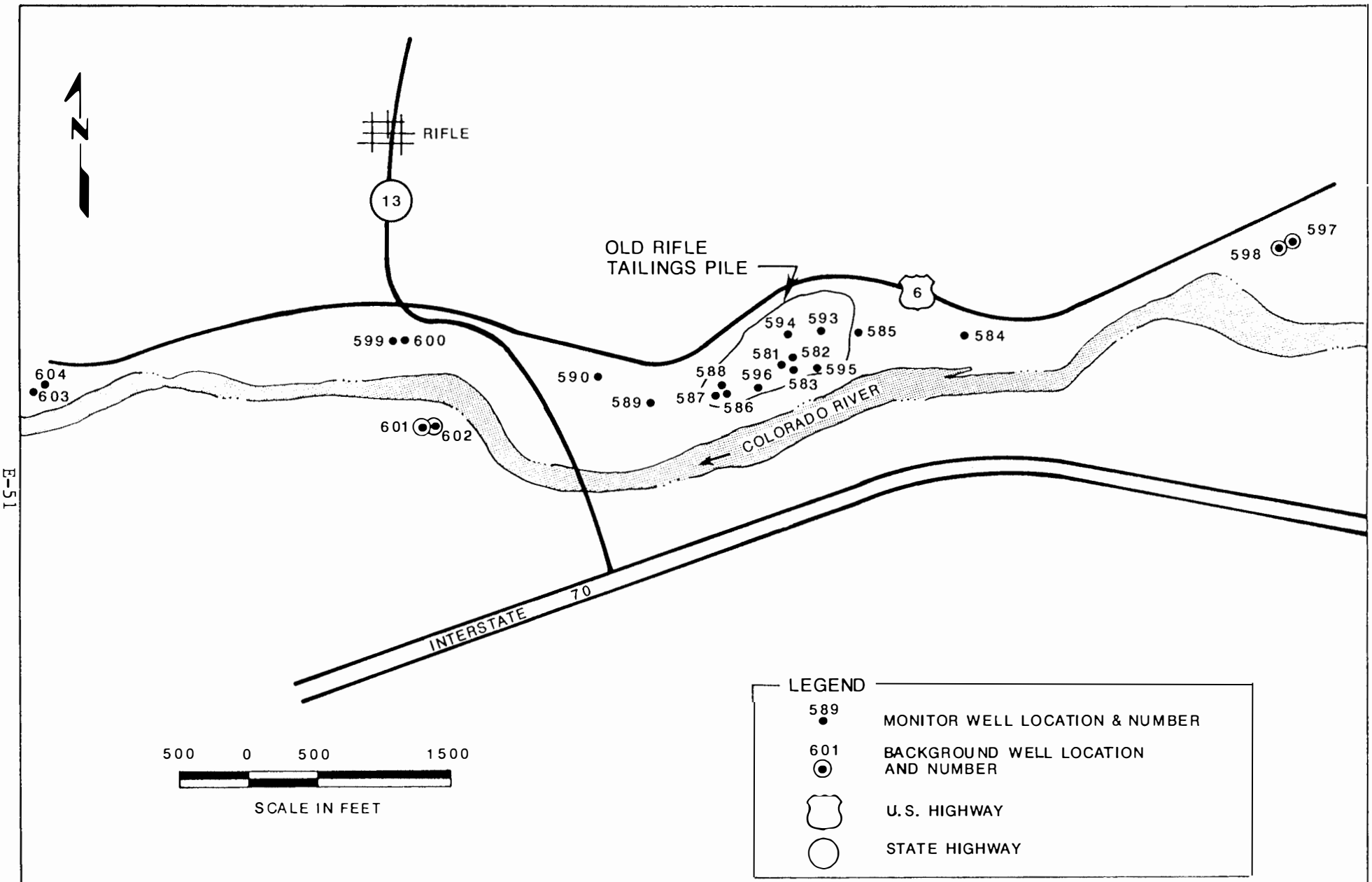


FIGURE E.2.2

LOCATIONS OF ALLUVIAL MONITOR WELLS, OLD RIFLE SITE

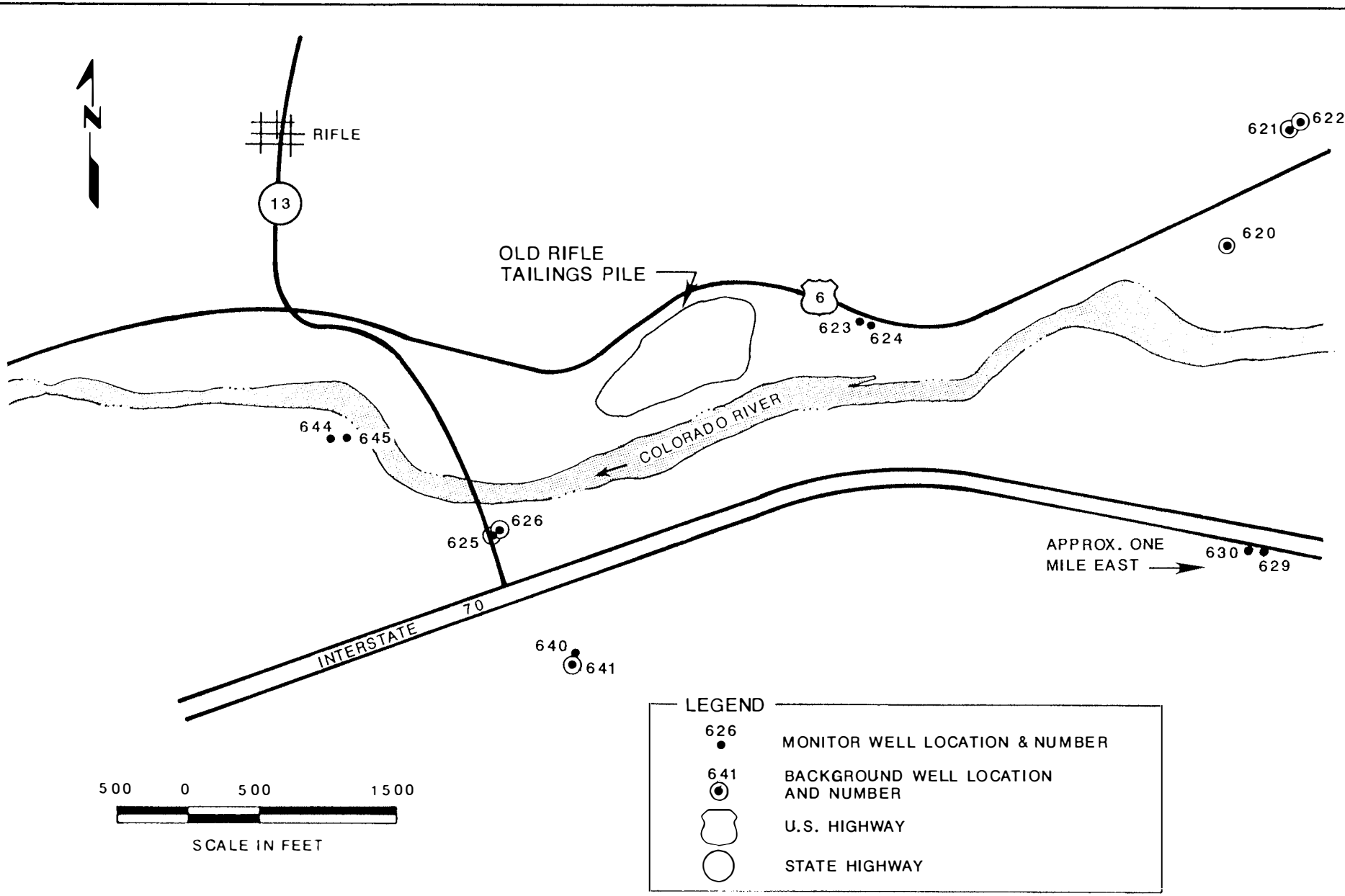


FIGURE E.2.3

LOCATIONS OF WASATCH FORMATION MONITOR WELLS, OLD RIFLE SITE

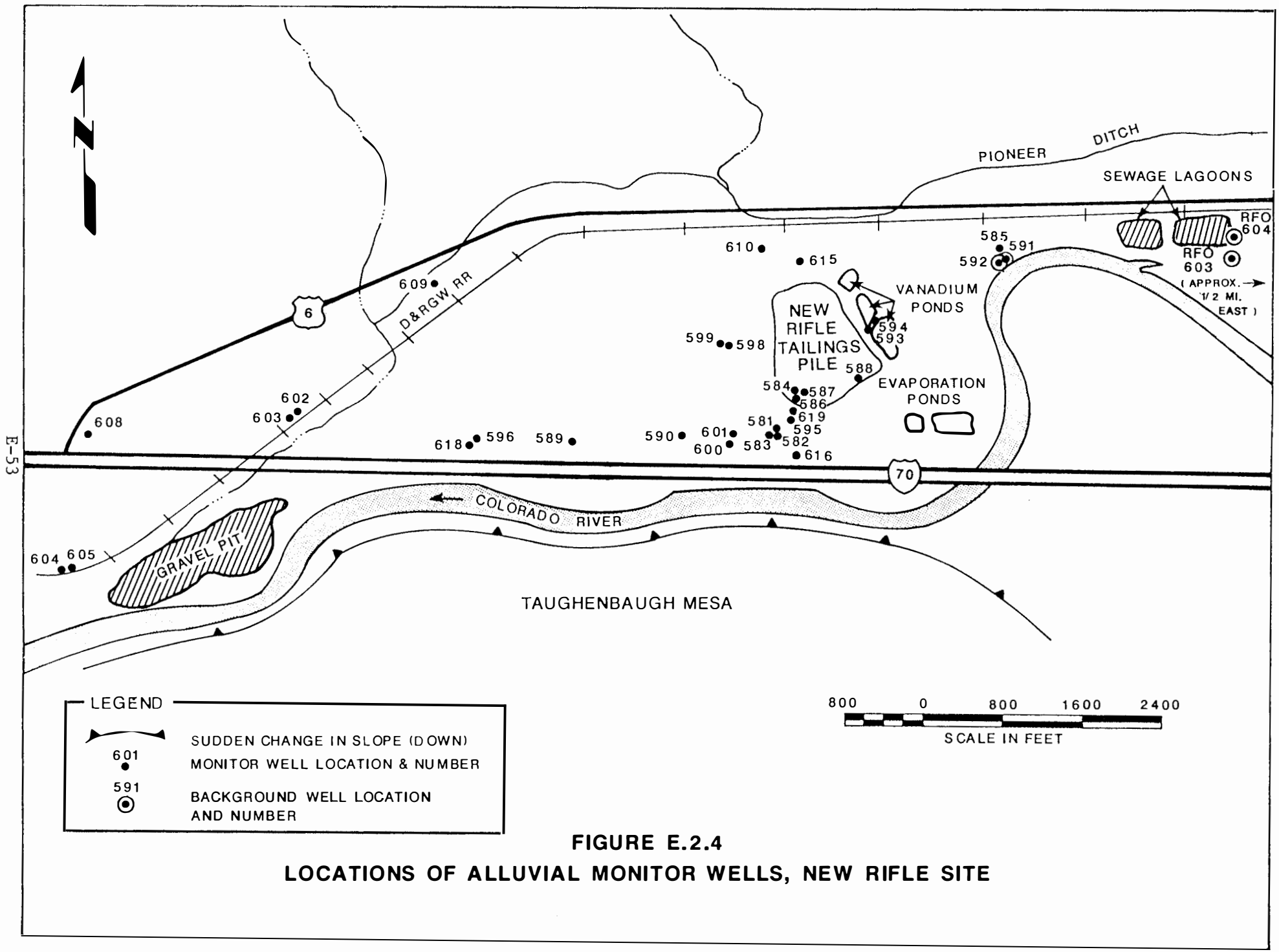


FIGURE E.2.4

LOCATIONS OF ALLUVIAL MONITOR WELLS, NEW RIFLE SITE

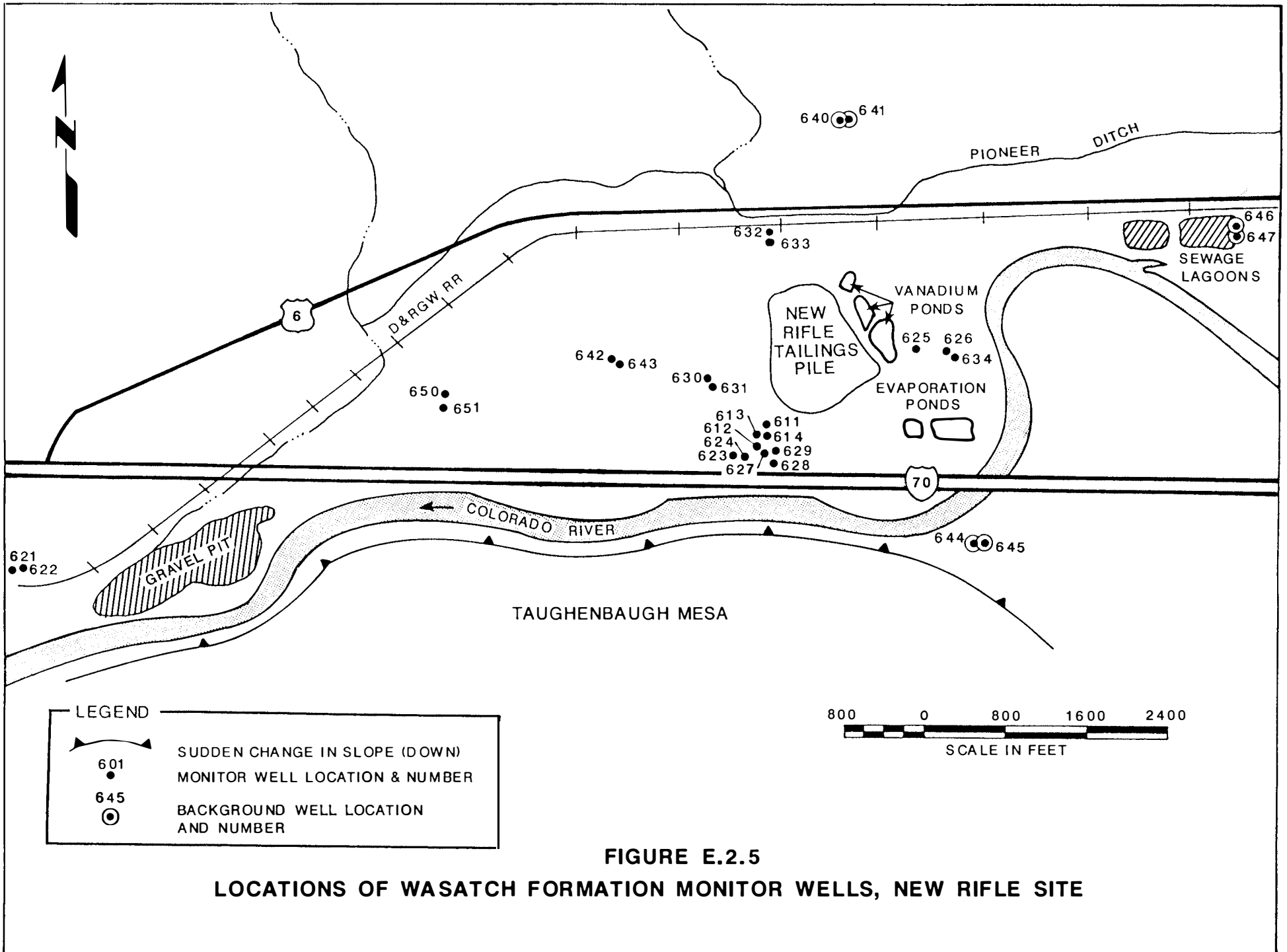


FIGURE E.2.5

LOCATIONS OF WASATCH FORMATION MONITOR WELLS, NEW RIFLE SITE

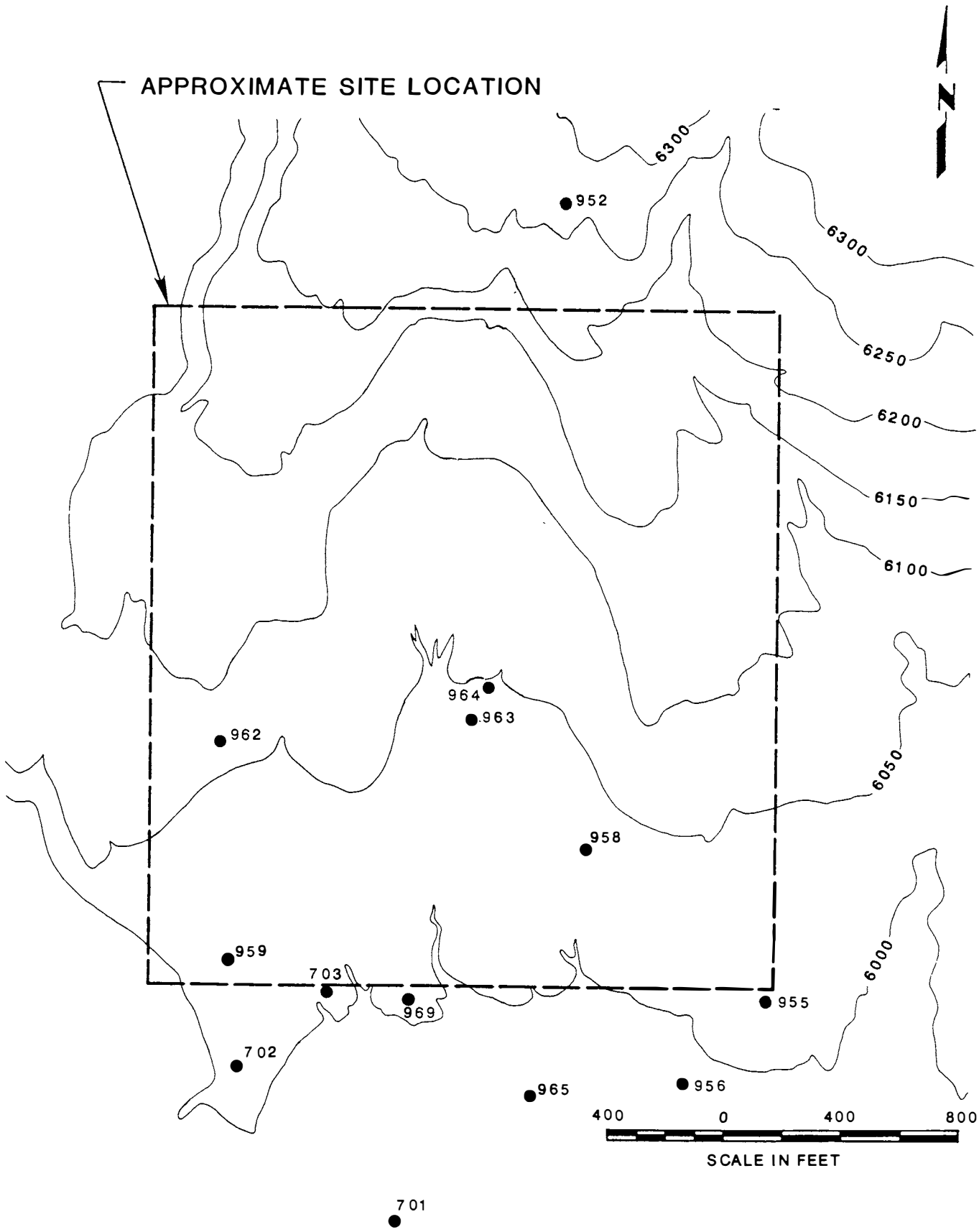


FIGURE E.2.6
MONITOR WELL LOCATIONS, ESTES GULCH SITE

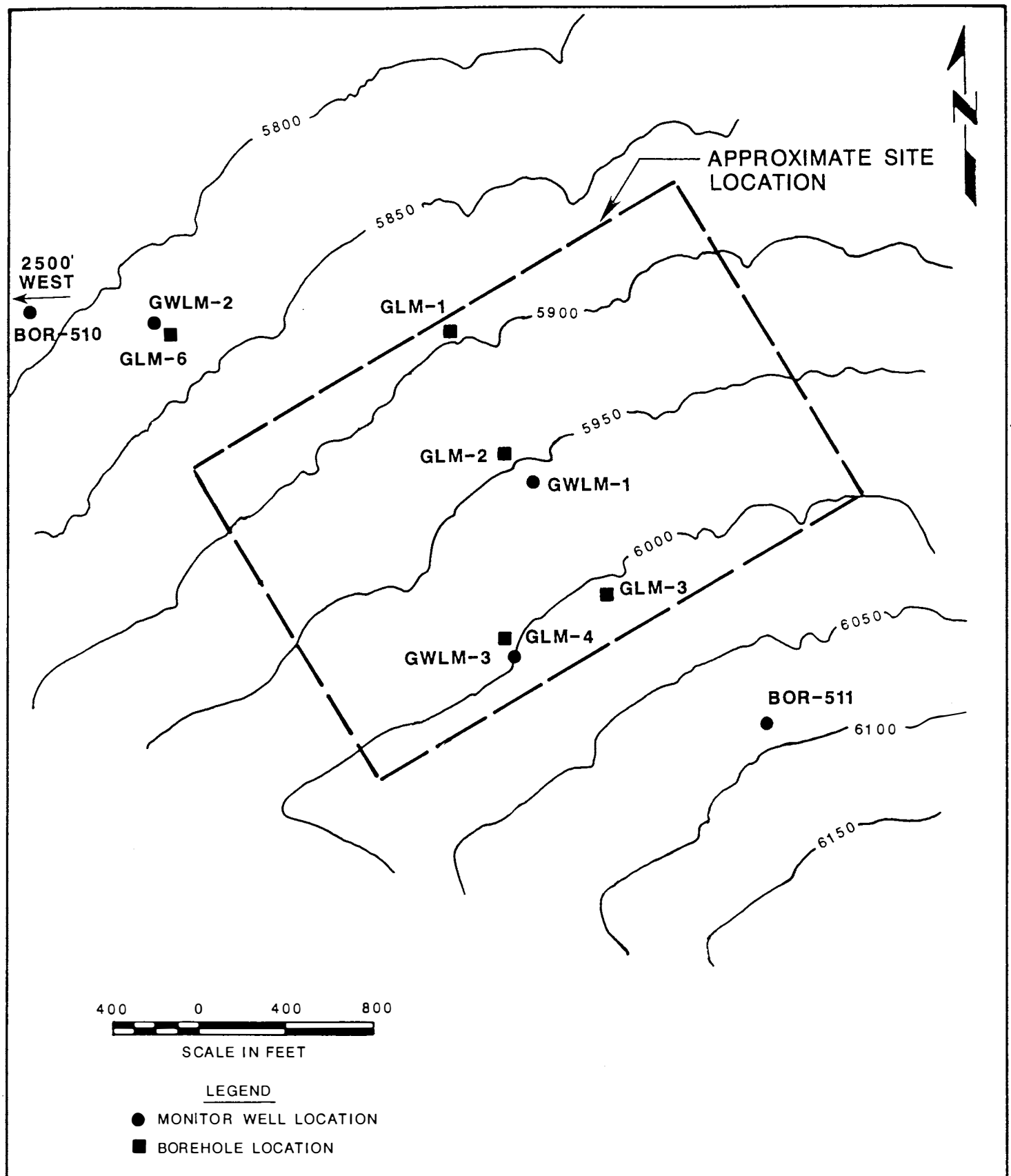


FIGURE E.2.7

MONITOR WELL AND BOREHOLE LOCATIONS, LUCAS MESA SITE

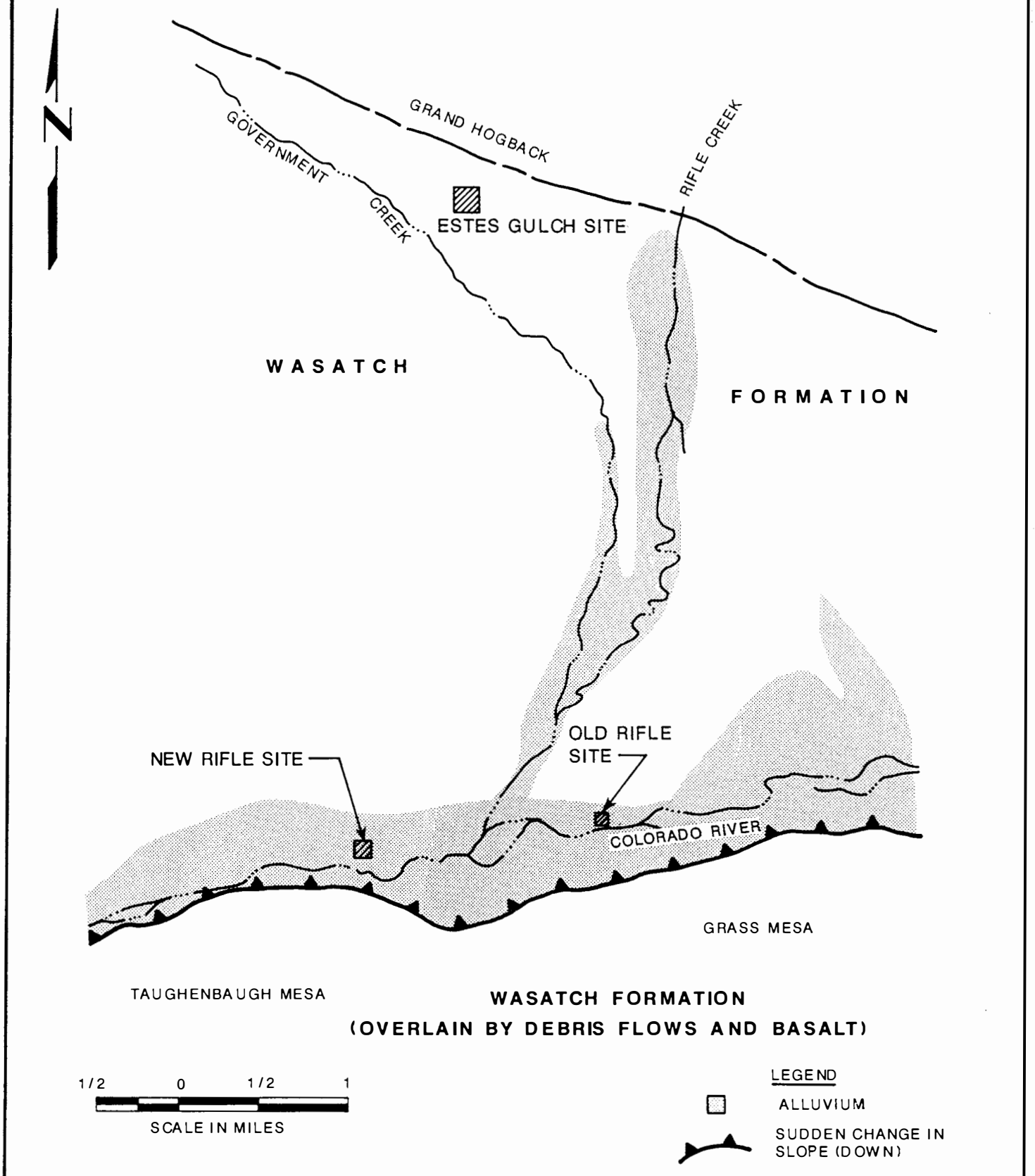


FIGURE E.2.8
SCHEMATIC REPRESENTATION OF PRINCIPAL GEOLOGIC UNITS IN THE RIFLE AREA

Member of the Wasatch Formation. The site is well within the Piceance Basin, on a slight syncline associated with the DeBeque anticline (Cashion, 1973). The Wasatch Formation bedrock beneath the site dips northeastward at 2 degrees.

Detailed descriptions of the geology at the Rifle UMTRA Project sites are provided in Section D.2 of Appendix D, Soils, Geology and Seismicity.

Geohydrology

Regional groundwater flow in the Piceance Creek Basin occurs primarily in the Parachute Creek Member of the Green River Formation that overlies the Wasatch Formation (Weeks, 1974). However, in the vicinity of the Rifle UMTRA Project sites, the Green River Formation has been eroded away, leaving the Wasatch Formation exposed.

Although the groundwater flow system in the Wasatch Formation is not well documented, structural and stratigraphic descriptions in Donnell (1968), Murray (1974), and Tweto et al. (1978) suggest that flow in the formation is structurally controlled, with groundwater flowing downdip toward the axis of the basin away from the Grand Hogback. Most of this flow occurs as lateral, confined flow in the more transmissive sandstone beds of the middle Molina Member of the Wasatch Formation. The upper, less transmissive units of the Shire Member act as a confining layer and limit vertical flow between the members.

The floodplain alluvium and the Wasatch Formation are two water-bearing units beneath the Old and New Rifle tailings sites. The tailings at both sites rest on the Colorado River alluvium, which is one mile wide, 20 to 40 feet deep, and bounded on the north and south by the Wasatch Formation (Figure E.2.8). The alluvium is recharged by precipitation, return irrigation flow, and the Colorado River. Beneath the alluvium, groundwater flow in the interlayered sandstone, siltstone, and claystone beds of the Wasatch Formation is semiconfined. The Wasatch Formation has lower hydraulic conductivities than the alluvium.

In general, groundwater flow in the alluvium and Wasatch Formation at the Rifle tailings sites is toward the west parallelling the Colorado River. Seasonal fluctuations in the Colorado River control flow in the alluvium. During the summer when the Colorado River is high, the river recharges the alluvium. During the fall and winter when the river is low, groundwater in the alluvium discharges to the river.

Similarly, the alluvium may also recharge the Wasatch Formation during periods of high flow, and the Wasatch Formation may recharge the alluvium during periods of low flow.

The Estes Gulch site is underlain by the Shire Member of the Wasatch Formation. Beneath the site, groundwater probably flows along the strike of the steeply dipping beds towards the southeast.

Groundwater flow in the Wasatch Formation beneath the Lucas Mesa site is most likely structurally controlled, flowing down dip to the northeast.

E.2.3.4 Old Rifle site

Groundwater flow and hydraulic parameters

The alluvium at the Old Rifle site is approximately 20 feet thick, with depths to groundwater ranging from two to 12 feet below the land surface. Groundwater levels in the alluvium fluctuate more than seven feet during the year (Table E.2.2) depending on the stage height of the Colorado River. Figures E.2.9 and E.2.10 depict the potentiometric surfaces in the alluvium at the Old Rifle site during summer and winter, respectively.

The sources of recharge to the alluvium include bank infiltration from the Colorado River, precipitation, surface and subsurface irrigation return flow, and discharge from the Wasatch Formation in areas with upward, vertical potentiometric gradients (Figure E.2.11). There is also recharge from a closed basin north of U.S. Highway 6; groundwater seeps from the hillside and is diverted through an underground culvert that discharges onto the Old Rifle site northeast of the tailings pile (Figures E.2.9 and E.2.10). This discharge percolates through the alluvium, creating a groundwater mound that extends into the tailings. Some mounded groundwater initially flows south and east but is eventually turned westward by the dominant hydraulic gradient within the alluvium. This gradient is 0.003.

Approximately 500 feet downgradient of the tailings pile, flow in the alluvium is deflected into the Colorado River by an outcrop of weathered Wasatch Formation claystone. Some groundwater continues to flow west in a 50-foot-wide strip of alluvium between the outcrop and the river. It is not known to what extent groundwater flows through the weathered claystone west of the site. Groundwater at the tailings site probably does not flow across the Colorado River in the alluvium because the river is a groundwater flow line.

Table E.2.2 Groundwater levels in alluvial monitor wells, Old Rifle site

Monitor well number[a]	Completion interval (depth in feet)	Groundwater level (feet above mean sea level)														Maximum water level fluctuation (feet)
		01/23/82	01/30/83	02/17/83	02/23/83	06/06/83	06/18/83	06/21/83	09/19/83	09/30/83	10/01/83	01/10/84	01/23/84	06/24/85	12/08/85	
581[b]	28.6 to 31.0	--	5300.55	5300.55	5300.55	5303.85	--	5304.95	5301.65	--	5301.45	5301.55	5301.45	5301.15	5301.82	4.60
582[b]	19.3 to 21.3	--	5303.91	5304.21	5304.21	5304.81	--	5305.21	5304.71	--	5304.71	5304.71	5304.71	5309.38	5305.40	5.47
583[b]	23.4 to 25.7	5300.48	5300.58	5300.48	5300.58	5303.78	--	5304.88	5301.58	--	5301.48	5301.48	5301.38	--	--	4.40
584[b]	13.0 to 17.0	--	5300.31	5300.31	5300.21	5305.81	5306.21	5307.11	5301.81	5301.71	5301.71	5301.71	5301.71	5305.78	5302.98	6.90
585[b]	11.5 to 19.5	--	5300.81	5300.91	5300.91	5304.51	5305.61	5306.21	5302.01	--	5301.81	5301.71	5301.61	--	--	5.40
586[b]	18.7 to 21.3	--	--	5297.55	5297.55	5301.65	5303.45	5303.95	5298.45	5298.45	5298.45	5298.45	5298.35	5301.20	5297.07	6.88
587[b]	13.3 to 15.6	--	--	5297.73	5297.47	5301.53	5303.33	5303.83	5298.33	5298.23	5298.23	5298.23	5298.13	--	--	6.36
588[b]	9.3 to 11.5	--	--	5297.51	5297.51	5301.61	5303.61	5304.11	5298.41	5298.41	5298.41	5298.41	5298.31	5301.80	5297.74	6.60
589[b]	6.0 to 17.5	--	5299.26	5299.26	5299.63	5301.36	5301.86	5306.86	5299.76	5299.66	5299.66	5299.56	5299.56	5301.05	5300.18	7.60
590[b]	11.2 to 19.0	--	--	5287.88	5287.78	5289.48	5290.08	5295.28	5288.48	5288.28	5288.18	5288.08	5288.08	5291.24	--	7.50
593[c]	22.3 to 27.3	--	--	--	5301.70	5303.90	--	5305.60	5302.90	--	5302.70	5302.70	5302.60	--	--	3.90
594[c]	22.3 to 27.3	--	--	--	5301.90	5304.60	--	5305.90	5302.80	--	5302.70	5302.80	5302.70	--	--	4.00
595[c]	17.5 to 22.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
596[c]	22.4 to 27.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
597[c]	7.5 to 12.5	--	--	--	--	--	--	--	--	--	--	--	--	5312.03	5311.06	0.97
598[c]	15.3 to 20.3	--	--	--	--	--	--	--	--	--	--	--	--	5312.15	5310.98	1.17
599[c]	7.2 to 12.2	--	--	--	--	--	--	--	--	--	--	--	--	5294.33	--	--
600[c]	15.8 to 20.8	--	--	--	--	--	--	--	--	--	--	--	--	5294.37	5291.74	2.63
601[c]	6.3 to 11.3	--	--	--	--	--	--	--	--	--	--	--	--	5292.71	5285.21	7.50
602[c]	14.65 to 19.65	--	--	--	--	--	--	--	--	--	--	--	--	5291.24	5289.65	1.59
603[c]	6.0 to 11.0	--	--	--	--	--	--	--	--	--	--	--	--	5285.93	5282.84	3.09
604[c]	16.5 to 21.5	--	--	--	--	--	--	--	--	--	--	--	--	5285.96	5283.09	2.87

[a]Monitor well locations are shown in Figure E.2.2.
[b]Well casing diameter is four inches.
[c]Well casing diameter is two inches.

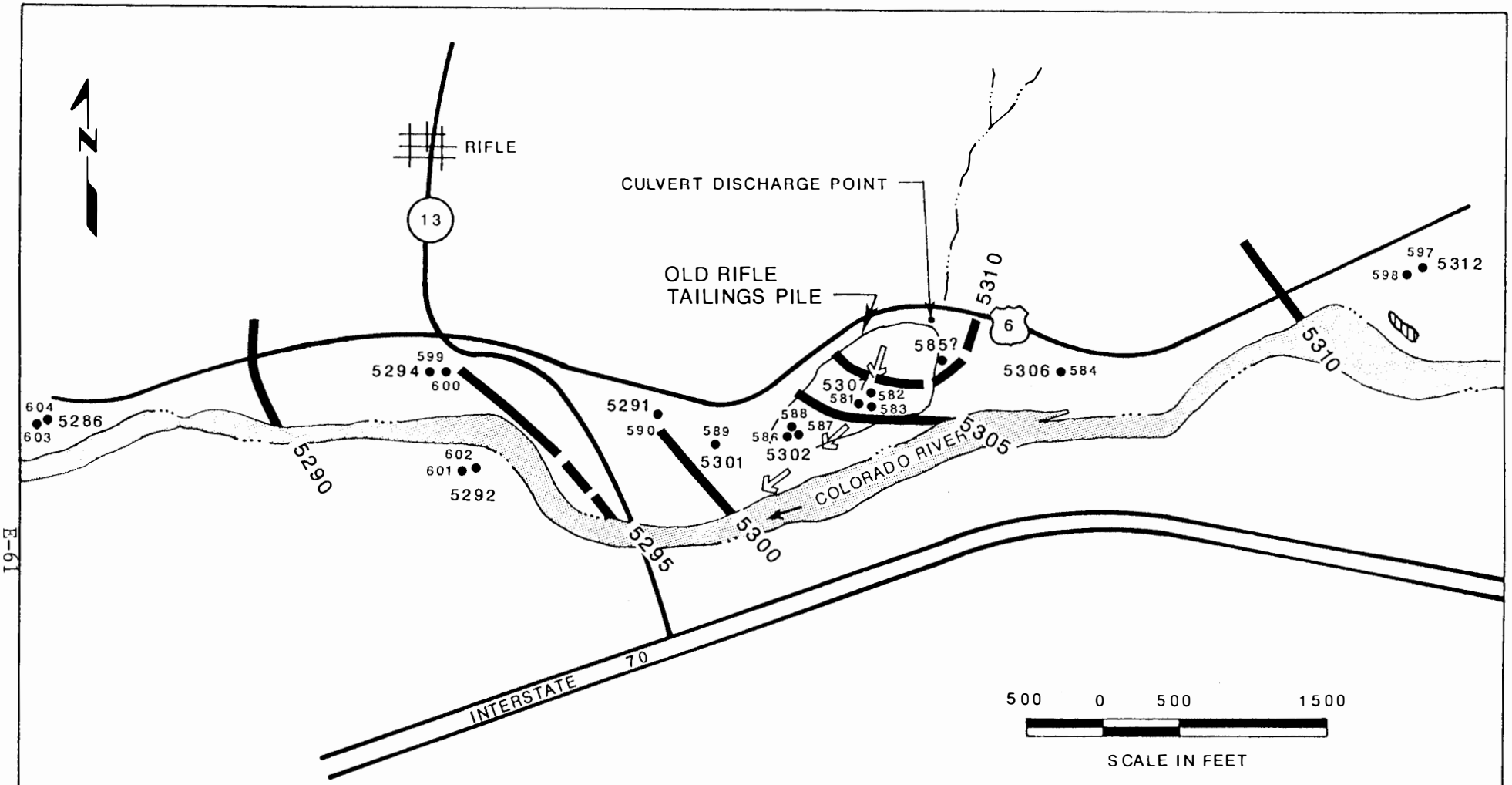


FIGURE E.2.9
ALLUVIAL POTENTIOMETRIC SURFACE, OLD RIFLE SITE, JUNE, 1985

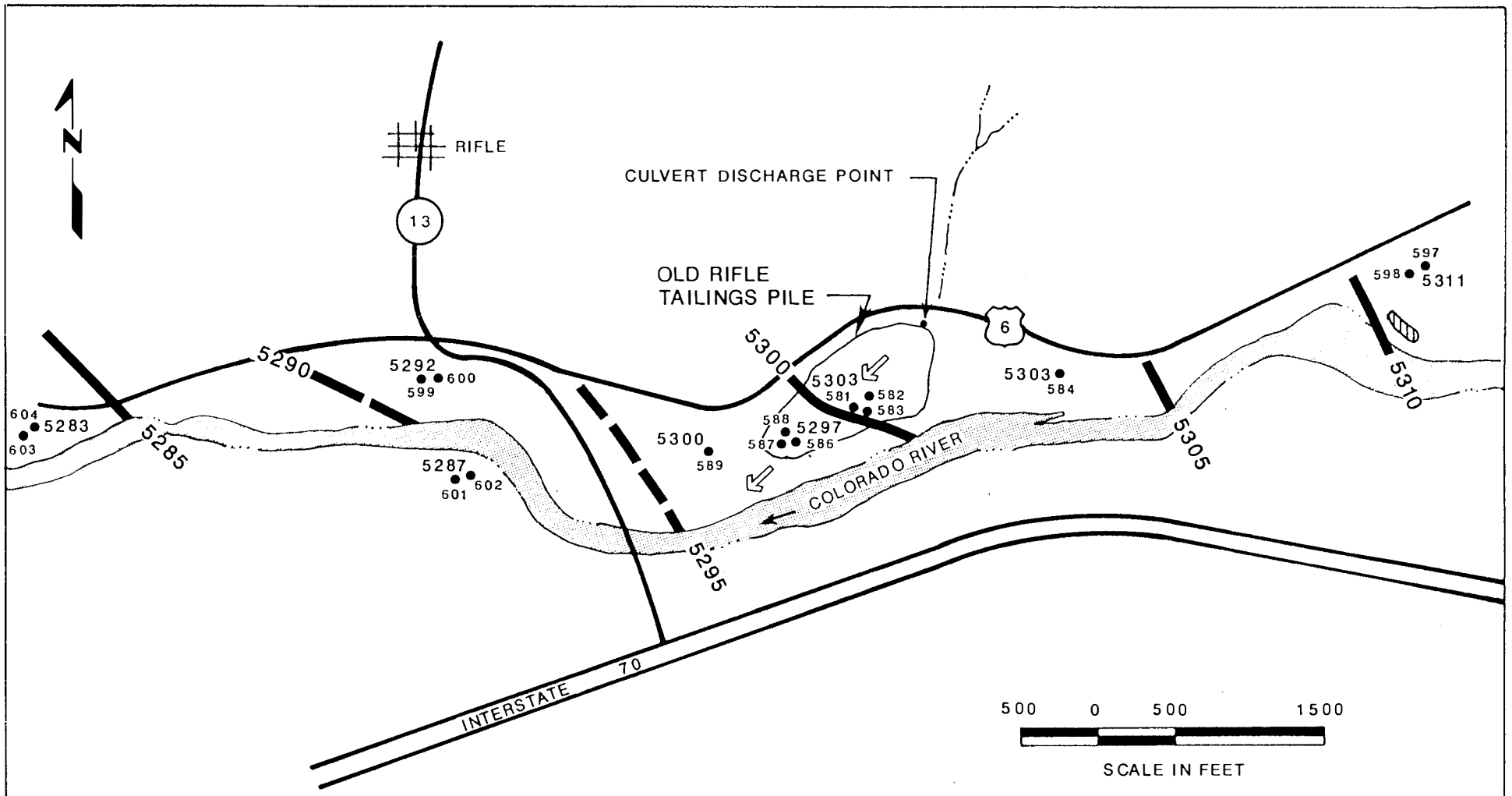


FIGURE E.2.10
ALLUVIAL POTENTIOMETRIC SURFACE, OLD RIFLE SITE, DECEMBER, 1985

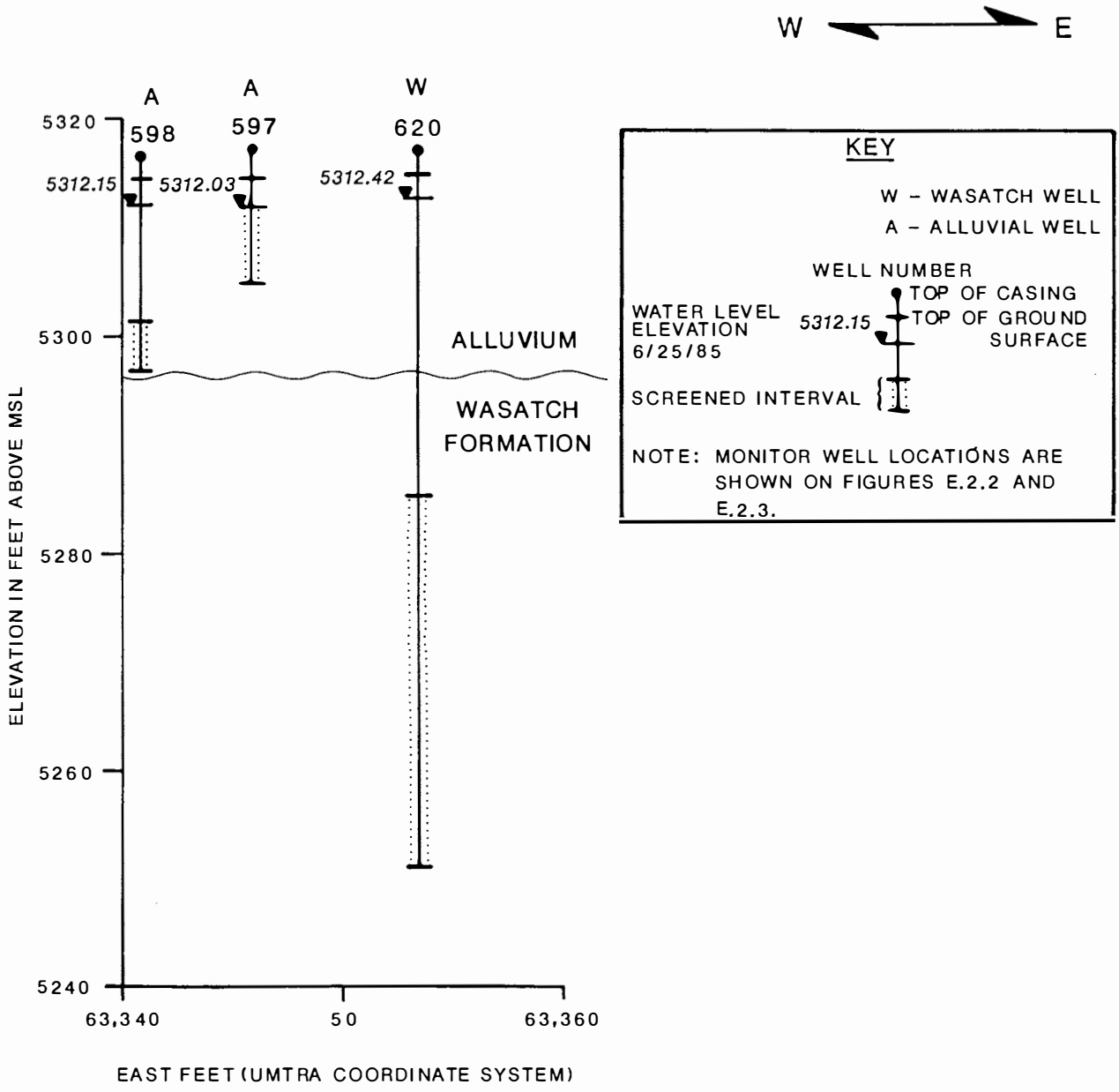


FIGURE E.2.11
WATER LEVEL DIFFERENCES
BETWEEN ALLUVIUM AND WASATCH FORMATION, OLD RIFLE SITE

Pumping tests conducted on five monitor wells in the alluvium at the Old Rifle site yielded an average hydraulic conductivity of 200 ft/day (Table E.2.3). The average linear groundwater velocity in the alluvium at the Old Rifle site was calculated to be 840 ft/yr using Darcy's Law equation (Freeze and Cherry, 1979), a hydraulic conductivity of 200 ft/day, an effective porosity of 0.27, and a hydraulic gradient of 0.003.

The Wasatch Formation beneath the Old Rifle site consists of interbedded layers of sandy siltstones and shales. Although these layers are regionally discontinuous, the Wasatch Formation is semiconfined. The potentiometric surface within the formation (Figure E.2.12) ranges from two to eight feet below the ground surface with groundwater flow toward the west. Table E.2.4 contains water level data for the Wasatch Formation. Anomalously low water levels in monitor wells 623, 624, 629, and 630 indicate that extremely low hydraulic conductivities have prevented equilibration of water levels.

Recharge to and discharge from the Wasatch Formation is dependent on vertical potentiometric gradients between the Wasatch Formation and the alluvium. Based on water level differences for nested monitor wells, vertical gradients at the Old Rifle site are generally upward (Figure E.2.11), with the Wasatch Formation discharging into the alluvium. However, groundwater mounding due to the culvert discharging northeast of the tailings has caused downward potentiometric gradients near Wasatch Formation monitor wells 623 and 624, and the alluvium is recharging the Wasatch Formation. Thus, there is a potential for contaminants within the alluvium to flow into the Wasatch Formation.

Slug injection tests performed on three monitor wells in the Wasatch Formation at the Old Rifle site yielded an average hydraulic conductivity of 0.027 ft/day (Table E.2.5). The average horizontal linear groundwater velocity was calculated to be 0.3 ft/yr using Darcy's Law, an average westward hydraulic conductivity of 0.03 ft/day, an effective porosity of 0.10, and a hydraulic gradient of 0.003.

Background water quality

Background water quality is defined as the quality of water that would be present had uranium processing activities not occurred. This was determined by averaging constituent concentrations in upgradient and cross-gradient monitor wells not affected by uranium milling activities, and then selecting the maximum (averaged) concentration of each constituent as background. Because the natural variation in background water quality is large and industrial activities may have affected groundwater quality between the Old and the New Rifle sites, background water quality was defined separately for each site.

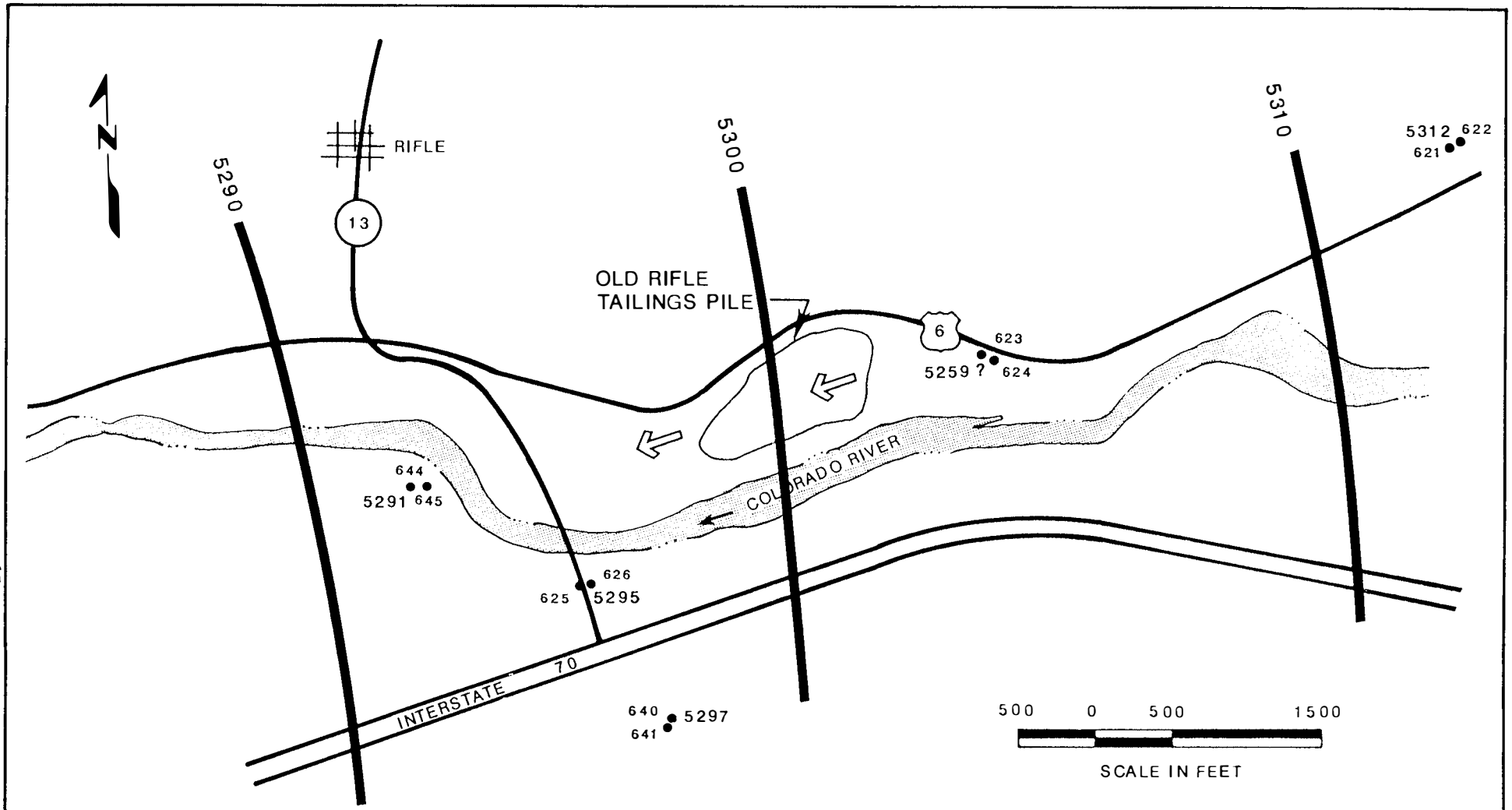


FIGURE E.2.12
POTENTIOMETRIC SURFACE IN WASATCH FORMATION, OLD RIFLE SITE, JANUARY, 1986

Table E.2.3 Hydraulic conductivity for the alluvial aquifer, Old Rifle site

Monitor well number[a]	Analytical method[b]	Hydraulic conductivity (ft/day)[b]
581	Transient	340
584	Steady state	59.5
586	Transient	765
589	Steady state	820
590	Steady state	28.3
		Geometric mean = 200 ft/day

[a]Monitor well locations are shown on Figure E.2.2.
[b]Ref. DOE, 1983. Hydraulic conductivities are based on aquifer tests conducted by the DOE in 1983.

Table E.2.4 Groundwater levels in Wasatch Formation monitor wells, Old Rifle site

Monitor well number[a]	Completion interval (depth in feet)	Groundwater level (feet above mean sea level) 06/24/85[d]	01/14/86
620[b]	31.75 to 66.75	5312.42	--
621[c]	79.5 to 99.5	--	5312.13
622[b]	48.5 to 58.5	--	5312.76
623[c]	89.5 to 99.5	--	5237.02
624[b]	64.5 to 74.5	--	5259.05
625[c]	76.5 to 96.5	--	5295.74
626[b]	49.5 to 59.5	--	5293.81
629[c]	161.5 to 181.5	--	5203.83
630[b]	131.5 to 141.5	--	5342.39
640[c]	88.0 to 98.0	--	5297.39
641[b]	59.0 to 69.0	--	5296.03
644[c]	126.5 to 146.5	--	5291.89
645[b]	91.5 to 111.5	--	5289.37

[a]Monitor well locations are shown on Figure E.2.3.
[b]Well casing diameter is two inches.
[c]Well casing diameter is four inches.
[d]No water level for this date.

Table E.2.5 Hydraulic conductivity for the Wasatch Formation, Old Rifle site

Monitor well number[a]	Hydraulic conductivity[b] (ft/day)
621	0.020
622	0.036
640	0.027
	Geometric mean = 0.027

[a]Monitor well locations are shown on Figure E.2.3.
[b]Hydraulic conductivities were determined using the Skibitzke method (Skibitzke, 1963).

The background quality of groundwater in the alluvium at the Old Rifle site was determined from chemical analyses of samples from upgradient monitor wells 597 and 598 and from cross-gradient monitor wells 601 and 602 (Figure E.2.2). Monitor wells 597 and 598 are located approximately 0.5 mile upgradient of the site, and monitor wells 601 and 602 are located across the Colorado River from the site. Because of their locations relative to the processing site, none of these wells has been affected by uranium milling activities. However, monitor wells 597 and 598 are located downgradient of a gravel pit, which may have affected water quality in the vicinity. Nevertheless, these wells were used as background wells because they are upgradient of the Old Rifle site. Monitor well 584 (Figure E.2.2) is located onsite in the contaminated ore-loading area, and was excluded as a background monitor well.

Table E.2.6 contains water quality analyses for all monitor wells at the Old Rifle site, and Table E.2.7 contains a summary of background and downgradient groundwater quality in the alluvium at the Old Rifle site. Although background was defined as the maximum average concentration of a chemical constituent in the upgradient and cross-gradient monitor wells, statistical maximums for each constituent are also presented in Table E.2.7. The statistical maximum is the average background concentration plus two standard deviations. The statistical maximums were not used to define background water quality because of the limited number of background monitor wells.

Background water quality in the alluvium exceeds the proposed EPA groundwater protection standards for molybdenum, selenium, uranium, and gross alpha activity. Groundwater from background monitor wells in the alluvium is a calcium sulfate type of water (Figure E.2.13).

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		581-01 12/08/85		581-01 10/22/87		581-01 12/09/88		582-01 02/17/83		582-01 06/21/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	390.		374.		376.		321.00		370.00	
ALUMINUM	MG/L	0.9		0.21		0.1		-		-	
AMMONIA	MG/L	-		-		-		-		2.42	
AMMONIUM	MG/L	0.5		< 0.1		-		-		-	
ANTIMONY	MG/L	-		-		0.005		-		-	
ARSENIC	MG/L	< 0.01		0.022		0.04		1.50		1.00	
BARIUM	MG/L	-		0.03		< 0.01		0.14		0.069	
BERYLLIUM	MG/L	-		-		< 0.01		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		0.1		-		-		-	
CADMIUM	MG/L	-		< 0.005		0.005		-		-	
CALCIUM	MG/L	205.		145.		165.		193.00		170.00	
CHLORIDE	MG/L	74.		40.6		46.		51.00		37.00	
CHROMIUM	MG/L	-		< 0.01		0.08	<	0.001		0.001	
COBALT	MG/L	-		-		< 0.05	<	0.001		0.009	
COND,IN-SITU	UMHO/CM	-		-		-		870.00		1380.00	
CONDUCTANCE	UMHO/CM	1400.		800.		490.		-		-	
COPPER	MG/L	-		-		< 0.02	<	0.0005	<	0.0005	
CYANIDE	MG/L	-		-		< 0.01		-		-	
FLUORIDE	MG/L	-		0.77		-		-		-	
GROSS ALPHA	PCI/L	500.	30.	-		-		-		-	
GROSS BETA	PCI/L	210.	10.	-		-		-		-	
IRON	MG/L	0.28		0.10		0.05		0.44		0.51	
LEAD	MG/L	-		0.02		< 0.01		-		-	
MAGNESIUM	MG/L	91.2		81.0		96.6		96.00		120.00	
MANGANESE	MG/L	0.97		0.62		0.68		0.038		0.05	
MERCURY	MG/L	-		-		< 0.0002		-		-	
MOLYBDENUM	MG/L	0.1		0.15		0.09	<	0.03		0.083	
NICKEL	MG/L	-		-		< 0.04		-		-	
NITRATE	MG/L	4.		< 0.1		-		0.31		-	
NITRITE	MG/L	-		< 0.1		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		1.20		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		68.20		65.80	
PB-210	PCI/L	5.3	1.2	-		-		-		-	
PH	SU	7.04		7.25		7.36		7.20		7.30	
PHOSPHATE	MG/L	-		< 0.1		-		-		-	
PO-210	PCI/L	0.1	1.3	-		-		-		-	
POTASSIUM	MG/L	6.84		4.87		5.53		7.87		4.40	
RA-226	PCI/L	0.	0.1	0.1	0.1	-		-		-	
RA-228	PCI/L	0.	1.1	0.8	0.7	-		-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.017		0.021		0.12		0.006	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		21.8		-		-		-	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		581-01 12/08/85	581-01 10/22/87	581-01 12/09/88	582-01 02/17/83	582-01 06/21/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	0.01	-	-
SODIUM	MG/L	194.	135.	129.	97.10	94.40
STRONTIUM	MG/L	-	-	2.4	-	-
SULFATE	MG/L	799.	502.	612.	655.00	500.00
SULFIDE	MG/L	-	< 0.1	-	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	11.00	15.50
TEMPERATURE	C - DEGREE	12.	12.0	10.5	-	-
TH-230	PCI/L	0.5 0.4	-	-	-	-
THALLIUM	MG/L	-	-	< 0.01	-	-
TIN	MG/L	-	-	0.012	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1750.	1390.	-	1400.00	1310.00
TOTAL U	PPM	-	-	-	1.921	1.946
URANIUM	MG/L	1.01	0.949	0.944	-	-
VANADIUM	MG/L	0.69	0.29	0.38	7.80	10.30
ZINC	MG/L	-	0.005	0.020	0.03	0.03

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE: 582-01 06/26/85 PARAMETER VALUE+/-UNCERTAINTY	582-01 12/09/85 PARAMETER VALUE+/-UNCERTAINTY	582-01 10/22/87 PARAMETER VALUE+/-UNCERTAINTY	583-01 02/17/83 PARAMETER VALUE+/-UNCERTAINTY	583-01 06/21/83 PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	372.00	380.	327.	297.00	360.00
ALUMINUM	MG/L	< 0.10	0.7	0.38	-	-
AMMONIA	MG/L	-	-	-	-	0.859
AMMONIUM	MG/L	2.7	2.9	1.3	-	-
ANTIMONY	MG/L	< 0.003	-	-	-	-
ARSENIC	MG/L	1.22	0.23	1.14	0.042	0.041
BARIUM	MG/L	< 0.10	-	0.02	0.15	0.046
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	< 0.1	-	-
CADMIUM	MG/L	< 0.001	-	0.008	-	-
CALCIUM	MG/L	156.	219.	128.	314.00	330.00
CHLORIDE	MG/L	41.00	55.	30.5	69.00	46.00
CHROMIUM	MG/L	< 0.01	-	< 0.01	< 0.001	0.001
COBALT	MG/L	< 0.05	-	-	< 0.001	0.012
COND,IN-SITU	UMHO/CM	-	-	-	1770.00	1610.00
CONDUCTANCE	UMHO/CM	1100.00	1300.	1093.	-	-
COPPER	MG/L	< 0.02	-	-	< 0.0005	< 0.0005
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	0.74	-	0.84	-	-
GROSS ALPHA	PCI/L	562.00 52.00	980. 40.	-	-	-
GROSS BETA	PCI/L	714.00 34.00	550. 10.	-	-	-
IRON	MG/L	0.32	0.41	0.28	0.18	0.88
LEAD	MG/L	< 0.01	-	< 0.01	-	-
MAGNESIUM	MG/L	111.	84.9	68.6	98.00	120.00
MANGANESE	MG/L	0.05	0.08	0.03	0.93	1.34
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.09	0.12	0.17	0.27	0.191
NICKEL	MG/L	< 0.04	-	-	-	-
NITRATE	MG/L	26.10	1.	< 0.1	< 0.01	-
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	1.00	-
NO2 & NO3	MG/L	5.90	-	-	-	-
ORG. CARBON	MG/L	2.9	-	-	62.50	71.10
PB-210	PCI/L	21.20 3.30	47. 2.	-	-	-
PH	SU	6.84	7.11	7.25	7.30	7.10
PHOSPHATE	MG/L	< 0.10	-	2.3	-	-
PO-210	PCI/L	< 1.00	5.3 1.2	-	-	-
POTASSIUM	MG/L	5.	4.93	4.00	9.48	6.79
RA-226	PCI/L	< 0.60	9.7 1.2	4.3 0.8	-	-
RA-228	PCI/L	< 1.00	2. 1.2	0.7 0.8	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	0.016	0.006	0.02	< 0.004
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	55.20	-	51.8	-	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		582-01 06/26/85		582-01 12/09/85		582-01 10/22/87		583-01 02/17/83		583-01 06/21/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY
SILVER	MG/L	< 0.01		-		-		-		-	
SODIUM	MG/L	100.00		145.		88.0		130.00		123.00	
STRONTIUM	MG/L	3.10		-		-		-		-	
SULFATE	MG/L	740.00		752.		396.		1280.00		830.00	
SULFIDE	MG/L	2.60		-		< 0.1		-		-	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		13.50	
TEMPERATURE	C - DEGREE	14.00		11.		14.4		-		-	
TH-230	PCI/L	8.80	0.30	2.1	0.9	-		-		-	
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	< 0.005		-		-		-		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	1642.00		1620.		1110.		2200.00		1950.00	
TOTAL U	PPM	-		-		-		1.964		1.796	
URANIUM	MG/L	0.162		2.08		1.11		-		-	
VANADIUM	MG/L	5.31		6.21		6.81		0.34		0.69	
ZINC	MG/L	< 0.005		-		< 0.005		0.05		0.03	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE: 584-01 02/16/83 PARAMETER VALUE+/-UNCERTAINTY	584-01 06/18/83 PARAMETER VALUE+/-UNCERTAINTY	584-01 06/26/85 PARAMETER VALUE+/-UNCERTAINTY	584-01 12/08/85 PARAMETER VALUE+/-UNCERTAINTY	584-01 10/22/87 PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	326.00	340.00	517.00	293.	425.
ALUMINUM	MG/L	-	-	< 0.10	0.4	0.25
AMMONIA	MG/L	-	< 0.10	-	-	-
AMMONIUM	MG/L	-	-	< 0.10	0.1	< 0.1
ANTIMONY	MG/L	-	-	< 0.003	-	-
ARSENIC	MG/L	0.04	< 0.001	< 0.01	< 0.01	0.005
BARIUM	MG/L	0.11	0.019	< 0.10	-	0.02
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	-	-	0.3
CADMIUM	MG/L	-	-	< 0.001	-	< 0.005
CALCIUM	MG/L	389.00	170.00	275.	192.	296.
CHLORIDE	MG/L	1600.00	18.00	455.00	40.	124.
CHROMIUM	MG/L	0.007	0.003	< 0.01	-	< 0.01
COBALT	MG/L	< 0.001	0.025	< 0.05	-	-
COND,IN-SITU	UMHO/CM	5600.00	1980.00	-	-	-
CONDUCTANCE	UMHO/CM	-	-	4000.00	1150.	2500.
COPPER	MG/L	0.0072	< 0.0005	< 0.02	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	0.44	-	0.45
GROSS ALPHA	PCI/L	-	-	81.00 47.00	410. 30.	-
GROSS BETA	PCI/L	-	-	39.00 13.00	210. 10.	-
IRON	MG/L	0.02	0.0041	< 0.03	< 0.03	0.06
LEAD	MG/L	-	-	< 0.01	-	< 0.01
MAGNESIUM	MG/L	207.00	58.00	174.	78.8	127.
MANGANESE	MG/L	0.015	0.02	0.80	0.04	0.46
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.06	0.046	< 0.01	0.12	0.15
NICKEL	MG/L	-	-	< 0.04	-	-
NITRATE	MG/L	11.00	-	19.50	4.	1.7
NITRITE	MG/L	-	-	-	-	< 0.1
NITROGEN,KJL	MG/L	0.65	-	-	-	-
NO2 & NO3	MG/L	-	-	4.40	-	-
ORG. CARBON	MG/L	74.30	63.30	6.3	-	-
PB-210	PCI/L	-	-	-	5.1 1.1	-
PH	SU	7.30	7.80	6.80	7.37	6.8
PHOSPHATE	MG/L	-	-	< 0.10	-	< 0.1
PO-210	PCI/L	-	-	-	0. 0.6	-
POTASSIUM	MG/L	28.30	11.75	12.00	3.66	6.23
RA-226	PCI/L	-	-	-	0. 0.1	0.0 0.2
RA-228	PCI/L	-	-	-	0.5 1.	0.3 0.8
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.40	0.011	0.18	0.009	0.071
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	15.80	-	17.0

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		584-01 02/16/83	584-01 06/18/83	584-01 06/26/85	584-01 12/08/85	584-01 10/22/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	< 0.01	-	-
SODIUM	MG/L	1310.00	430.00	990.00	127.	401.
STRONTIUM	MG/L	-	-	6.10	-	-
SULFATE	MG/L	1890.00	800.00	2640.00	718.	1360.
SULFIDE	MG/L	-	-	< 0.10	-	< 0.1
TEMP,IN-SITU	C-DEGREE	12.00	16.50	-	-	-
TEMPERATURE	C - DEGREE	-	-	11.00	7.	15.5
TH-230	PCI/L	-	-	-	0.4 0.4	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	0.007	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	5700.00	2050.00	5242.00	1430.	2970.
TOTAL U	PPM	0.229	0.118	-	-	-
URANIUM	MG/L	-	-	0.13	0.887	0.131
VANADIUM	MG/L	0.122	0.028	< 0.01	0.5	0.06
ZINC	MG/L	0.02	0.13	0.4	-	0.005

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		585-01 02/16/83	585-01 07/18/83	585-01 10/22/87	586-01 02/09/83	586-01 06/20/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	364.00	360.00	267.	327.00	320.00
ALUMINUM	MG/L	-	-	0.21	-	-
AMMONIA	MG/L	-	2.42	-	-	0.242
AMMONIUM	MG/L	-	-	< 0.1	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.001	< 0.001	0.001	0.002	< 0.001
BARIUM	MG/L	0.02	0.024	0.03	< 0.02	0.017
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	< 0.1	-	-
CADMIUM	MG/L	-	-	< 0.005	-	-
CALCIUM	MG/L	275.00	290.00	141.	157.00	160.00
CHLORIDE	MG/L	71.00	66.00	30.5	41.00	6.60
CHROMIUM	MG/L	< 0.001	0.001	< 0.01	< 0.001	< 0.001
COBALT	MG/L	< 0.001	0.01	-	< 0.001	0.007
COND,IN-SITU	UMHO/CM	1500.00	1700.00	-	1100.00	1280.00
CONDUCTANCE	UMHO/CM	-	-	895.	-	-
COPPER	MG/L	0.0042	< 0.0005	-	0.0024	< 0.0005
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	0.60	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.0212	0.0047	0.05	0.0097	0.019
LEAD	MG/L	-	-	< 0.01	-	-
MAGNESIUM	MG/L	104.00	130.00	72.9	88.00	100.00
MANGANESE	MG/L	0.42	0.50	0.31	0.14	0.20
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.05	0.054	0.11	< 0.03	0.023
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	0.76	-	< 0.1	0.86	-
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	0.28	-	-	0.34	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	87.30	73.70	-	67.00	71.30
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.40	7.20	7.25	7.50	7.30
PHOSPHATE	MG/L	-	-	< 0.1	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	6.42	7.62	3.69	4.37	4.48
RA-226	PCI/L	-	-	0.0 0.1	-	-
RA-228	PCI/L	-	-	0.4 1.0	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.15	0.025	0.006	0.009	< 0.002
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	19.2	-	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		585-01 02/16/83	585-01 07/18/83	585-01 10/22/87	586-01 02/09/83	586-01 06/20/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	119.00	148.00	72.5	99.00	102.00
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	1040.00	910.00	459.	585.00	500.00
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	10.00	15.00	-	12.00	17.00
TEMPERATURE	C - DEGREE	-	-	13.2	-	-
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1800.00	2070.00	1130.	1050.00	1332.00
TOTAL U	PPM	0.528	0.449	-	0.118	0.127
URANIUM	MG/L	-	-	0.364	-	-
VANADIUM	MG/L	0.13	0.25	0.37	0.013	0.077
ZINC	MG/L	0.12	0.04	0.035	0.02	0.02

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		586-01 06/26/85		586-01 12/08/85		586-01 10/25/87		587-01 02/07/83		587-01 06/20/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	319.00		358.		307.		327.00		310.00	
ALUMINUM	MG/L	< 0.10		1.		0.18		-		-	
AMMONIA	MG/L	-		-		-		-		< 0.10	
AMMONIUM	MG/L	< 0.10		0.1		< 0.1		-		-	
ANTIMONY	MG/L	< 0.003		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		0.002		0.001		0.002	
BARIUM	MG/L	< 0.10		-		0.02		0.06		0.023	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		< 0.1		-		-	
CADMIUM	MG/L	< 0.001		-		< 0.005		-		-	
CALCIUM	MG/L	119.		147.		132.		159.00		180.00	
CHLORIDE	MG/L	42.00		40.		34.3		42.00		20.00	
CHROMIUM	MG/L	< 0.01		-		< 0.01		0.002		< 0.001	
COBALT	MG/L	< 0.05		-		-		< 0.001		0.007	
COND,IN-SITU	UMHO/CM	-		-		-		1150.00		1350.00	
CONDUCTANCE	UMHO/CM	950.00		1200.		948.		-		-	
COPPER	MG/L	< 0.02		-		-		0.0067		< 0.0005	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.53		-		0.55		-		-	
GROSS ALPHA	PCI/L	42.00	16.00	70.	10.	-		-		-	
GROSS BETA	PCI/L	58.00	13.00	35.	5.	-		-		-	
IRON	MG/L	< 0.03		< 0.03		0.05		0.034		0.016	
LEAD	MG/L	< 0.01		-		< 0.01		-		-	
MAGNESIUM	MG/L	103.		83.2		79.9		88.00		110.00	
MANGANESE	MG/L	0.20		0.22		0.17		0.15		0.22	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.01		0.11		0.12		< 0.03		0.018	
NICKEL	MG/L	< 0.04		-		-		-		-	
NITRATE	MG/L	14.60		5.		2.2		0.48		-	
NITRITE	MG/L	-		-		< 0.1		-		-	
NITROGEN,KJL	MG/L	-		-		-		0.56		-	
NO2 & NO3	MG/L	3.30		-		-		-		-	
ORG. CARBON	MG/L	3.1		-		-		67.90		61.70	
PB-210	PCI/L	2.70	2.50	2.3	1.2	-		-		-	
PH	SU	6.96		7.13		6.9		6.20		7.20	
PHOSPHATE	MG/L	< 0.10		-		< 0.1		-		-	
PO-210	PCI/L	< 1.00		0.	0.5	-		-		-	
POTASSIUM	MG/L	5.		4.12		4.29		4.41		4.74	
RA-226	PCI/L	< 0.60		0.	0.1	0.0	0.1	-		-	
RA-228	PCI/L	104.00	72.00	0.	0.9	0.3	1.1	-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.01		< 0.005		0.014		0.006		0.016	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	21.40		-		21.0		-		-	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		586-01 06/26/85		586-01 12/08/85		586-01 10/25/87		587-01 02/07/83		587-01 06/20/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY
SILVER	MG/L	< 0.01		-		-		-		-	
SODIUM	MG/L	110.00		127.		98.7		100.00		106.00	
STRONTIUM	MG/L	3.00		-		-		-		-	
SULFATE	MG/L	600.00		578.		453.		590.00		540.00	
SULFIDE	MG/L	0.20		-		< 0.1		-		-	
TEMP,IN-SITU	C-DEGREE	-		-		-		12.00		16.00	
TEMPERATURE	C - DEGREE	13.00		12.		12.4		-		-	
TH-230	PCI/L	3.10	1.90	0.5	0.7	-		-		-	
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	< 0.005		-		-		-		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	1390.00		1290.		1150.		1230.00		1467.00	
TOTAL U	PPM	-		-		-		0.181		0.09	
URANIUM	MG/L	0.114		0.164		0.108		-		-	
VANADIUM	MG/L	0.03		0.29		0.07		0.015		0.06	
ZINC	MG/L	< 0.016		-		< 0.005		0.07		0.01	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		588-01 02/09/83	588-01 06/20/83	588-01 06/26/85	588-01 12/10/85	588-01 10/25/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	346.00	310.00	345.00	383.	357.
ALUMINUM	MG/L	-	-	< 0.10	0.5	0.20
AMMONIA	MG/L	-	0.69	-	-	-
AMMONIUM	MG/L	-	-	1.90	7.9	0.8
ANTIMONY	MG/L	-	-	< 0.003	-	-
ARSENIC	MG/L	0.004	0.001	< 0.01	< 0.01	< 0.001
BARIUM	MG/L	0.10	0.032	< 0.10	-	0.03
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	-	-	< 0.1
CADMIUM	MG/L	-	-	< 0.001	< 0.001	< 0.005
CALCIUM	MG/L	241.00	220.00	194.	248.	198.
CHLORIDE	MG/L	53.00	24.00	71.00	65.	55.7
CHROMIUM	MG/L	0.001	0.002	< 0.01	-	< 0.01
COBALT	MG/L	0.001	0.007	< 0.05	-	-
COND,IN-SITU	UMHO/CM	1190.00	1250.00	-	-	-
CONDUCTANCE	UMHO/CM	-	-	1300.00	1400.	1375.
COPPER	MG/L	0.006	< 0.0005	< 0.02	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	1.38	-	1.05
GROSS ALPHA	PCI/L	-	-	82.00 23.00	-	-
GROSS BETA	PCI/L	-	-	159.00 18.00	-	-
IRON	MG/L	0.15	0.028	< 0.03	0.09	0.09
LEAD	MG/L	-	-	< 0.01	-	< 0.01
MAGNESIUM	MG/L	85.00	73.00	94.	82.1	82.1
MANGANESE	MG/L	0.75	0.44	1.00	1.09	0.72
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.06	0.036	0.01	0.06	0.12
NICKEL	MG/L	-	-	< 0.04	-	-
NITRATE	MG/L	0.40	-	0.90	2.	< 0.1
NITRITE	MG/L	-	-	-	-	< 0.1
NITROGEN,KJL	MG/L	3.10	-	-	-	-
NO2 & NO3	MG/L	-	-	0.20	-	-
ORG. CARBON	MG/L	51.40	63.30	4.4	-	-
PB-210	PCI/L	-	-	< 1.50	-	-
PH	SU	7.10	7.00	6.70	7.03	6.75
PHOSPHATE	MG/L	-	-	< 0.10	-	< 0.1
PO-210	PCI/L	-	-	< 1.00	-	-
POTASSIUM	MG/L	5.93	7.32	6.	6.83	5.44
RA-226	PCI/L	-	-	< 0.6	-	0.6 0.3
RA-228	PCI/L	-	-	< 1.00	-	1.0 1.2
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.008	0.029	0.013	< 0.005	0.010
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	17.50	-	19.4

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		588-01 02/09/83		588-01 06/20/83		588-01 06/26/85		588-01 12/10/85		588-01 10/25/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
SILVER	MG/L	-		-		< 0.01		-		-	
SODIUM	MG/L	119.00		132.00		140.00		140.		117.	
STRONTIUM	MG/L	-		-		1.70		-		-	
SULFATE	MG/L	750.00		540.00		800.00		814.		601.	
SULFIDE	MG/L	-		-		< 0.10		-		< 0.1	
TEMP,IN-SITU	C-DEGREE	8.00		13.50		-		-		-	
TEMPERATURE	C - DEGREE	-		-		12.00		11.		13.5	
TH-230	PCI/L	-		-		16.30	2.00	-		-	
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	-		-		< 0.005		-		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	1460.00		1400.00		1740.00		1740.		1490.	
TOTAL U	PPM	0.337		0.704		-		-		-	
URANIUM	MG/L	-		-		0.12		0.221		0.128	
VANADIUM	MG/L	0.13		0.21		0.05		0.2		0.05	
ZINC	MG/L	0.03		0.08		0.2		-		0.008	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		589-01 02/16/83	589-01 06/18/83	589-01 06/26/85	589-01 12/18/85	590-01 02/15/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	342.00	200.00	144.00	238.	442.00
ALUMINUM	MG/L	-	-	< 0.10	0.4	-
AMMONIA	MG/L	-	1.573	-	-	-
AMMONIUM	MG/L	-	-	0.30	1.3	-
ANTIMONY	MG/L	-	-	< 0.003	-	-
ARSENIC	MG/L	< 0.001	0.001	< 0.01	< 0.01	< 0.001
BARIUM	MG/L	0.06	0.012	< 0.10	-	0.02
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	< 0.001	< 0.001	-
CALCIUM	MG/L	196.00	76.70	37.2	120.	256.00
CHLORIDE	MG/L	83.00	53.00	29.00	120.	200.00
CHROMIUM	MG/L	< 0.001	< 0.001	< 0.01	-	< 0.001
COBALT	MG/L	< 0.001	0.003	< 0.05	-	< 0.001
COND,IN-SITU	UMHO/CM	1210.00	610.00	-	-	2050.00
CONDUCTANCE	UMHO/CM	-	-	310.00	750.	-
COPPER	MG/L	0.0083	< 0.0005	< 0.02	-	0.0029
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	0.43	-	-
GROSS ALPHA	PCI/L	-	-	45.00 14.00	-	-
GROSS BETA	PCI/L	-	-	34.00 12.00	-	-
IRON	MG/L	0.208	0.008	< 0.03	0.1	0.0101
LEAD	MG/L	-	-	< 0.01	-	-
MAGNESIUM	MG/L	97.00	42.00	17.	50.3	129.00
MANGANESE	MG/L	0.79	0.32	0.98	2.49	0.095
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	< 0.03	0.015	0.03	0.18	0.05
NICKEL	MG/L	-	-	< 0.04	-	-
NITRATE	MG/L	< 0.01	-	5.80	4.	1.60
NITRITE	MG/L	-	-	-	-	-
NITROGEN,KJL	MG/L	3.20	-	-	-	0.62
NO2 & NO3	MG/L	-	-	1.30	-	-
ORG. CARBON	MG/L	66.40	48.70	3.2	-	100.00
PB-210	PCI/L	-	-	2.90 2.60	-	-
PH	SU	7.30	7.20	7.02	7.01	7.50
PHOSPHATE	MG/L	-	-	< 0.10	-	-
PO-210	PCI/L	-	-	< 1.00	-	-
POTASSIUM	MG/L	4.31	2.737	1.	3.36	9.84
RA-226	PCI/L	-	-	< 0.60	-	-
RA-228	PCI/L	-	-	< 1.00	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.057	< 0.002	< 0.005	< 0.005	0.144
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	12.20	-	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		589-01 02/16/83	589-01 06/18/83	589-01 06/26/85	589-01 12/18/85	590-01 02/15/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	< 0.01	-	-
SODIUM	MG/L	129.00	76.70	23.00	59.3	458.00
STRONTIUM	MG/L	-	-	0.50	-	-
SULFATE	MG/L	720.00	160.00	27.00	231.	1330.00
SULFIDE	MG/L	-	-	< 0.10	-	-
TEMP,IN-SITU	C-DEGREE	9.00	11.00	-	-	13.00
TEMPERATURE	C - DEGREE	-	-	14.00	8.	-
TH-230	PCI/L	-	-	< 1.00	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	< 0.005	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1500.00	647.00	310.00	767.	2710.00
TOTAL U	PPM	0.132	0.085	-	-	0.138
URANIUM	MG/L	-	-	0.303	0.0822	-
VANADIUM	MG/L	0.016	0.015	< 0.01	0.21	< 0.002
ZINC	MG/L	0.02	0.02	0.041	-	0.08

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		590-01 06/18/83		590-01 06/26/85		590-01 10/25/87		597-01 06/24/85		597-02 06/24/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	480.00		501.00		508.		549.00		549.00	
ALUMINUM	MG/L	-		< 0.10		0.18		< 0.10		< 0.10	
AMMONIA	MG/L	< 0.20		-		-		-		-	
AMMONIUM	MG/L	-		0.10		< 0.1		0.3		0.4	
ANTIMONY	MG/L	-		< 0.003		-		< 0.003		< 0.003	
ARSENIC	MG/L	< 0.001		< 0.01		0.005		< 0.01		< 0.01	
BARIUM	MG/L	0.067		< 0.10		0.02		< 0.10		< 0.10	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		0.1		-		-	
CADMIUM	MG/L	-		< 0.001		< 0.005		< 0.001		< 0.001	
CALCIUM	MG/L	270.00		199.		148.		171.		172.	
CHLORIDE	MG/L	4.60		233.00		170.		288.00		288.00	
CHROMIUM	MG/L	0.002		< 0.01		< 0.01		< 0.01		< 0.01	
COBALT	MG/L	0.03		< 0.05		-		< 0.05		< 0.05	
COND,IN-SITU	UMHO/CM	2680.00		-		-		-		-	
CONDUCTANCE	UMHO/CM	-		2200.00		1580.		2600.00		2600.00	
COPPER	MG/L	< 0.0005		< 0.02		-		< 0.02		< 0.02	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		0.50		0.79		0.42		0.34	
GROSS ALPHA	PCI/L	-		68.00	26.00	-		26.00	14.00	< 2.00	
GROSS BETA	PCI/L	-		20.00	11.00	-		11.00	3.00	< 3.00	
IRON	MG/L	0.0038		< 0.03		0.05		1.07		1.09	
LEAD	MG/L	-		< 0.01		< 0.01		0.01		0.01	
MAGNESIUM	MG/L	14.00		146.		92.0		156.00		158.00	
MANGANESE	MG/L	0.03		0.05		0.10		4.32		4.45	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.028		0.01		0.15		0.02		0.02	
NICKEL	MG/L	-		< 0.04		-		< 0.04		< 0.04	
NITRATE	MG/L	-		37.20		6.6		< 0.4		< 0.4	
NITRITE	MG/L	-		-		< 0.1		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		9.40		-		< 0.10		< 0.10	
ORG. CARBON	MG/L	97.30		4.6		-		21.		10.	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.60		6.76		7.1		7.15		7.15	
PHOSPHATE	MG/L	-		< 0.10		4.0		< 0.10		< 0.10	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	2.82		10.		7.14		10.00		10.00	
RA-226	PCI/L	-		-		0.0	0.1	-		-	
RA-228	PCI/L	-		-		0.5	1.3	-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.094		0.057		0.117		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		19.50		< 18.0		14.30		15.20	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		590-01 06/18/83	590-01 06/26/85	590-01 10/25/87	597-01 06/24/85	597-02 06/24/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	< 0.01	-	< 0.01	< 0.01
SODIUM	MG/L	450.00	420.00	500.	570.00	580.00
STRONTIUM	MG/L	-	4.50	-	1.90	2.20
SULFATE	MG/L	1000.00	1300.00	1070.	1450.	1420.
SULFIDE	MG/L	-	0.30	< 0.1	< 0.10	< 0.10
TEMP,IN-SITU	C-DEGREE	17.00	-	-	-	-
TEMPERATURE	C - DEGREE	-	13.00	16.2	10.00	10.00
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	< 0.005	-	0.022	0.015
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	2840.00	2814.00	2290.	2050.00	2980.00
TOTAL U	PPM	0.108	-	-	-	-
URANIUM	MG/L	-	0.284	0.0995	0.033	0.03
VANADIUM	MG/L	0.048	< 0.01	0.04	< 0.01	< 0.01
ZINC	MG/L	0.03	0.1	< 0.005	0.2	0.2

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		597-03 06/24/85		597-04 06/24/85		597-05 06/24/85		597-01 12/09/85		597-01 10/22/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	549.00		549.00		549.00		424.		489.	
ALUMINUM	MG/L	< 0.10		< 0.10		< 0.10		0.1		0.25	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	0.3		0.3		0.3		0.6		0.4	
ANTIMONY	MG/L	< 0.003		< 0.003		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		0.004	
BARIUM	MG/L	< 0.10		< 0.10		< 0.10		-		0.06	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		-		< 0.1	
CADMIUM	MG/L	0.001		< 0.001		< 0.001		-		< 0.005	
CALCIUM	MG/L	179.		167.		197.		180.		264.	
CHLORIDE	MG/L	288.00		291.00		288.00		240.		83.4	
CHROMIUM	MG/L	< 0.01		< 0.01		< 0.01		-		< 0.01	
COBALT	MG/L	< 0.05		< 0.05		< 0.05		-		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2600.00		2600.00		2600.00		2400.		2430.	
COPPER	MG/L	< 0.02		< 0.02		< 0.02		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.45		0.02		0.45		-		0.42	
GROSS ALPHA	PCI/L	15.00	13.00	< 2.00		20.00	14.00	4.	17.	-	
GROSS BETA	PCI/L	< 3.00		9.00	3.00	5.00	3.00	15.	9.	-	
IRON	MG/L	1.08		1.12		1.07		1.04		1.41	
LEAD	MG/L	0.01		0.01		0.01		-		< 0.01	
MAGNESIUM	MG/L	158.00		156.00		156.00		108.		190.	
MANGANESE	MG/L	4.55		4.39		4.42		4.2		4.51	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.02		0.02		0.02		0.14		0.19	
NICKEL	MG/L	< 0.04		< 0.04		< 0.04		-		-	
NITRATE	MG/L	< 0.4		< 0.4		< 0.4		1.		< 0.1	
NITRITE	MG/L	-		-		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	< 0.10		< 0.10		< 0.10		-		-	
ORG. CARBON	MG/L	14.		11.		8.9		-		-	
PB-210	PCI/L	-		-		-		0.	1.	-	
PH	SU	7.15		7.15		7.15		7.27		7.2	
PHOSPHATE	MG/L	< 0.10		< 0.10		< 0.10		-		< 0.1	
PO-210	PCI/L	-		-		-		0.	0.6	-	
POTASSIUM	MG/L	10.00		10.00		10.00		8.26		8.11	
RA-226	PCI/L	-		-		-		0.1	0.1	0.2	0.2
RA-228	PCI/L	-		-		-		0.6	0.8	0.5	1.0
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		< 0.005		< 0.005		< 0.005		0.036	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	14.80		14.50		15.20		-		17.4	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		597-03 06/24/85	597-04 06/24/85	597-05 06/24/85	597-01 12/09/85	597-01 10/22/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	< 0.01	< 0.01	< 0.01	-	-
SODIUM	MG/L	610.00	560.00	590.00	610.	345.
STRONTIUM	MG/L	2.10	2.00	1.10	-	-
SULFATE	MG/L	1410.	1440.	1470.	1440.	1420.
SULFIDE	MG/L	< 0.10	< 0.10	< 0.10	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.00	10.00	10.00	9.	14.0
TH-230	PCI/L	-	-	-	0.1 0.2	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	0.009	0.005	0.012	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	3000.00	3160.00	3050.00	2920.	3210.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.033	0.031	0.034	0.0167	0.0316
VANADIUM	MG/L	< 0.01	< 0.01	< 0.01	0.38	0.06
ZINC	MG/L	0.2	0.2	0.2	-	0.006

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE: 598-01 06/24/85 PARAMETER VALUE+/-UNCERTAINTY	598-01 12/09/85 PARAMETER VALUE+/-UNCERTAINTY	598-01 10/22/87 PARAMETER VALUE+/-UNCERTAINTY	599-01 06/26/85 PARAMETER VALUE+/-UNCERTAINTY	600-01 06/24/85 PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	2615.00	434.	485.	968.00	708.00
ALUMINUM	MG/L	< 0.10	0.8	0.24	< 0.10	< 0.10
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.1	0.6	0.4	-	0.6
ANTIMONY	MG/L	< 0.003	-	-	-	< 0.003
ARSENIC	MG/L	< 0.01	< 0.01	0.003	0.01	< 0.01
BARIUM	MG/L	< 0.10	-	0.04	< 0.10	< 0.10
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	< 0.1	-	-
CADMIUM	MG/L	< 0.001	-	< 0.005	< 0.001	< 0.001
CALCIUM	MG/L	147.	180.	231.	197.	199.
CHLORIDE	MG/L	307.00	240.	73.3	167.00	134.00
CHROMIUM	MG/L	< 0.01	-	< 0.01	< 0.01	< 0.01
COBALT	MG/L	< 0.05	-	-	< 0.05	< 0.05
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1500.00	2500.	1900.	1800.00	1400.00
COPPER	MG/L	< 0.02	-	-	< 0.02	< 0.02
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	0.34	-	0.42	0.52	0.51
GROSS ALPHA	PCI/L	23.00 14.00	30. 20.	-	-	15.00 13.00
GROSS BETA	PCI/L	7.00 3.00	20. 10.	-	-	7.00 3.00
IRON	MG/L	1.12	1.	0.84	51.80	5.14
LEAD	MG/L	< 0.01	-	< 0.01	< 0.01	< 0.01
MAGNESIUM	MG/L	140.00	110.	166.	142.00	144.00
MANGANESE	MG/L	2.03	3.3	3.55	1.00	0.41
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.01	0.11	0.18	-	< 0.01
NICKEL	MG/L	< 0.04	-	-	< 0.04	< 0.04
NITRATE	MG/L	< 0.4	1.	< 0.1	-	2.2
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	< 0.10	-	-	-	0.70
ORG. CARBON	MG/L	7.3	-	-	-	9.1
PB-210	PCI/L	-	0.1 1.	-	-	-
PH	SU	7.11	7.24	7.3	6.77	7.02
PHOSPHATE	MG/L	< 0.10	-	< 0.1	< 0.10	< 0.10
PO-210	PCI/L	-	0. 0.6	-	-	-
POTASSIUM	MG/L	7.00	8.29	7.41	10.00	8.00
RA-226	PCI/L	-	0. 0.1	0.0 0.1	-	-
RA-228	PCI/L	-	0.8 0.9	1.0 1.2	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	< 0.005	0.034	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	14.50	-	16.9	-	21.00

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		598-01 06/24/85	598-01 12/09/85	598-01 10/22/87	599-01 06/26/85	600-01 06/24/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	< 0.01	-	-	< 0.01	< 0.01
SODIUM	MG/L	520.00	610.	319.	270.00	230.00
STRONTIUM	MG/L	1.80	-	-	3.10	3.00
SULFATE	MG/L	1270.	1440.	1220.	404.	740.
SULFIDE	MG/L	< 0.10	-	< 0.1	-	< 0.10
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	11.00	10.	14.0	14.00	14.00
TH-230	PCI/L	-	0. 0.1	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	0.018	-	-	-	< 0.005
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	2790.00	3050.	2810.	1780.00	1890.00
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.037	0.0196	0.291	0.031	0.004
VANADIUM	MG/L	< 0.01	0.21	0.05	< 0.01	< 0.01
ZINC	MG/L	0.2	-	0.005	0.032	< 0.005

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		600-01 12/10/85		600-01 10/25/87		601-01 06/24/85		601-01 12/07/85		601-01 10/25/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	786.		587.		214.00		173.		162.	
ALUMINUM	MG/L	0.4		0.19		< 0.10		0.3		0.15	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	0.8		0.4		0.1		0.4		< 0.1	
ANTIMONY	MG/L	-		-		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		0.011		< 0.01		< 0.01		0.002	
BARIUM	MG/L	-		0.14		0.10		-		0.15	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		1.0		-		-		< 0.1	
CADMIUM	MG/L	< 0.001		< 0.005		< 0.001		-		< 0.005	
CALCIUM	MG/L	242.		243.		61.		111.		85.8	
CHLORIDE	MG/L	140.		130.		30.00		120.		130.	
CHROMIUM	MG/L	-		< 0.01		< 0.01		-		< 0.01	
COBALT	MG/L	-		-		< 0.05		-		-	
COND,IN-SITU	UMHO/CM	-		-		360.00		-		-	
CONDUCTANCE	UMHO/CM	1500.		1887.		360.00		550.		692.	
COPPER	MG/L	-		-		< 0.02		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		0.68		0.43		-		0.41	
GROSS ALPHA	PCI/L	-		-		< 2.00		6.6	4.6	-	
GROSS BETA	PCI/L	-		-		< 3.00		9.3	2.6	-	
IRON	MG/L	5.7		7.99		0.29		0.44		0.13	
LEAD	MG/L	-		< 0.01		< 0.01		-		< 0.01	
MAGNESIUM	MG/L	106.		105.		12.00		17.6		13.5	
MANGANESE	MG/L	0.44		0.52		0.79		1.34		0.74	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.14		0.15		0.02		0.11		0.04	
NICKEL	MG/L	-		-		< 0.04		-		-	
NITRATE	MG/L	8.		< 0.1		4.9		5.		< 0.1	
NITRITE	MG/L	-		< 0.1		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		1.00		-		-	
ORG. CARBON	MG/L	-		-		3.6		-		-	
PB-210	PCI/L	-		-		-		0.9	1.1	-	
PH	SU	7.27		7.25		7.24		7.42		7.35	
PHOSPHATE	MG/L	-		5.1		< 0.10		-		1.1	
PO-210	PCI/L	-		-		-		0.	0.6	-	
POTASSIUM	MG/L	8.18		6.31		2.00		2.95		3.11	
RA-226	PCI/L	-		0.7	0.3	-		0.3	0.2	0.6	0.7
RA-228	PCI/L	-		1.0	1.3	-		0.1	0.8	1.2	1.5
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.016		< 0.005		< 0.005		0.007	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		23.1		12.40		-		13.7	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		600-01 12/10/85	600-01 10/25/87	601-01 06/24/85	601-01 12/07/85	601-01 10/25/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	< 0.01	-	-
SODIUM	MG/L	220.	262.	41.00	47.2	78.1
STRONTIUM	MG/L	-	-	0.50	-	-
SULFATE	MG/L	506.	781.	35.	124.	92.
SULFIDE	MG/L	-	< 0.1	< 0.10	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	14.00	-	-
TEMPERATURE	C - DEGREE	13.	14.0	13.00	10.	15.1
TH-230	PCI/L	-	-	-	0.1 0.2	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	< 0.005	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1830.	1940.	360.00	579.	516.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0073	0.0028	0.007	0.0037	0.0026
VANADIUM	MG/L	0.2	0.04	< 0.01	0.21	0.03
ZINC	MG/L	-	0.005	0.015	-	< 0.005

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		602-01 06/24/85		602-01 12/08/85		603-01 06/26/85		603-01 12/09/85		603-01 10/25/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	205.00		148.		534.00		625.		494.	
ALUMINUM	MG/L	< 0.10		< 0.1		< 0.10		0.6		0.18	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	0.3		0.6		0.1		0.2		< 0.1	
ANTIMONY	MG/L	< 0.003		-		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		0.004	
BARIUM	MG/L	< 0.10		-		< 0.10		-		0.02	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		-		< 0.1	
CADMIUM	MG/L	< 0.001		-		< 0.001		< 0.001		< 0.005	
CALCIUM	MG/L	58.		107.		171.		327.		139.	
CHLORIDE	MG/L	27.00		140.		78.00		130.		48.	
CHROMIUM	MG/L	< 0.01		-		< 0.01		-		< 0.01	
COBALT	MG/L	< 0.05		-		< 0.05		-		-	
COND,IN-SITU	UMHO/CM	430.00		-		2200.00		-		-	
CONDUCTANCE	UMHO/CM	340.00		600.		2000.00		2800.		1635.	
COPPER	MG/L	< 0.02		-		< 0.02		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.47		-		0.59		-		0.68	
GROSS ALPHA	PCI/L	8.00	4.00	0.	3.4	42.00	22.00	-		-	
GROSS BETA	PCI/L	5.00	3.00	8.7	2.	33.00	12.00	-		-	
IRON	MG/L	0.39		0.66		0.10		0.18		0.06	
LEAD	MG/L	0.01		-		0.01		-		< 0.01	
MAGNESIUM	MG/L	12.00		16.8		172.00		219.		101.	
MANGANESE	MG/L	0.85		1.59		1.30		1.54		0.63	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.02		0.14		0.01		0.16		0.15	
NICKEL	MG/L	< 0.04		-		< 0.04		-		-	
NITRATE	MG/L	11.1		1.		14.6		11.		< 0.1	
NITRITE	MG/L	-		-		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	3.70		-		4.10		-		-	
ORG. CARBON	MG/L	4.5		-		4.9		-		-	
PB-210	PCI/L	-		0.1	1.1	-		-		-	
PH	SU	7.23		7.37		7.01		7.04		7.1	
PHOSPHATE	MG/L	< 0.10		-		0.50		-		3.0	
PO-210	PCI/L	-		0.	0.6	-		-		-	
POTASSIUM	MG/L	2.00		2.99		11.00		12.3		6.66	
RA-226	PCI/L	-		0.2	0.2	-		-		1.6	0.6
RA-228	PCI/L	-		0.	0.7	-		-		0.1	1.0
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		< 0.005		0.01		0.01		0.021	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	12.00		-		14.30		-		15.9	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		602-01 06/24/85	602-01 12/08/85	603-01 06/26/85	603-01 12/09/85	603-01 10/25/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	< 0.01	-	< 0.01	-	-
SODIUM	MG/L	37.00	52.6	300.00	441.	230.
STRONTIUM	MG/L	0.50	-	3.60	-	-
SULFATE	MG/L	34.	113.	1100.	1890.	736.
SULFIDE	MG/L	< 0.10	-	0.8	-	< 0.1
TEMP,IN-SITU	C-DEGREE	14.00	-	14.00	-	-
TEMPERATURE	C - DEGREE	12.00	11.	13.00	11.	14.9
TH-230	PCI/L	-	0.1 0.2	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	-	0.005	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	310.00	581.	2450.00	3820.	1570.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.002	< 0.0003	0.039	0.0461	0.0252
VANADIUM	MG/L	< 0.01	0.3	< 0.01	0.36	0.04
ZINC	MG/L	< 0.005	-	0.011	-	< 0.005

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		604-01 06/26/85		604-01 12/09/85		604-01 10/25/87		620-01 06/26/85		620-01 05/14/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	514.00		493.		411.		358.00		383.	
ALUMINUM	MG/L	< 0.10		0.6		0.17		< 0.10		-	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	< 0.10		0.3		< 0.1		0.6		0.3	
ANTIMONY	MG/L	< 0.003		-		-		< 0.003		-	
ARSENIC	MG/L	< 0.01		< 0.01		0.002		< 0.01		< 0.01	
BARIUM	MG/L	< 0.10		-		0.02		< 0.10		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		< 0.1		-		-	
CADMIUM	MG/L	< 0.001		< 0.001		< 0.005		< 0.001		< 0.001	
CALCIUM	MG/L	167.		211.		132.		226.		263.	
CHLORIDE	MG/L	56.00		50.		30.		225.00		196.	
CHROMIUM	MG/L	< 0.01		-		< 0.01		< 0.01		-	
COBALT	MG/L	< 0.05		-		-		< 0.05		-	
COND.IN-SITU	UMHO/CM	1500.00		-		-		-		-	
CONDUCTANCE	UMHO/CM	1500.00		1500.		1200.		2600.00		2700.	
COPPER	MG/L	< 0.02		-		-		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.52		-		0.70		0.23		-	
GROSS ALPHA	PCI/L	13.00	10.00	-		-		21.00	19.00	-	
GROSS BETA	PCI/L	24.00	12.00	-		-		18.00	11.00	-	
IRON	MG/L	< 0.03		0.05		0.05		0.18		0.152	
LEAD	MG/L	< 0.01		-		< 0.01		0.01		-	
MAGNESIUM	MG/L	148.00		128.		79.0		154.00		137.	
MANGANESE	MG/L	1.04		1.11		0.64		1.53		1.45	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.01		0.15		0.13		0.01		< 0.01	
NICKEL	MG/L	< 0.04		-		-		< 0.04		-	
NITRATE	MG/L	20.4		5.		1.8		1.8		-	
NITRITE	MG/L	-		-		< 0.1		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	5.20		-		-		< 0.10		-	
ORG. CARBON	MG/L	5.6		-		-		10.		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.02		7.11		7.05		7.15		7.2	
PHOSPHATE	MG/L	< 0.10		-		3.5		< 0.10		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	11.00		9.25		6.56		11.00		6.2	
RA-226	PCI/L	-		-		0.1	0.1	-		-	
RA-228	PCI/L	-		-		0.3	1.1	-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.009		0.008		0.018		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	14.50		-		15.5		12.80		-	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		604-01 06/26/85	604-01 12/09/85	604-01 10/25/87	620-01 06/26/85	620-01 05/14/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	< 0.01	-	-	< 0.01	-
SODIUM	MG/L	200.00	193.	180.	530.00	520.
STRONTIUM	MG/L	3.20	-	-	3.10	-
SULFATE	MG/L	860.	979.	585.	1720.	1650.
SULFIDE	MG/L	0.4	-	< 0.1	< 0.5	-
TEMP,IN-SITU	C-DEGREE	15.00	-	-	-	-
TEMPERATURE	C - DEGREE	12.00	12.	13.7	10.00	10.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	-	-	< 0.005	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1730.00	2140.	1280.	3430.00	3240.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.049	0.0313	0.0197	0.037	0.047
VANADIUM	MG/L	< 0.01	0.25	0.03	< 0.01	-
ZINC	MG/L	0.014	-	< 0.005	< 0.005	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE					
		620-02 05/14/86	620-03 05/14/86	620-04 05/14/86	620-05 05/14/86	620-01 10/26/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-	-	-	-	-	
ALKALINITY	MG/L CACO3	383.	383.	383.	383.	307.	
ALUMINUM	MG/L	-	-	-	-	0.26	
AMMONIA	MG/L	-	-	-	-	-	
AMMONIUM	MG/L	0.3	0.3	< 0.2	0.5	< 0.1	
ANTIMONY	MG/L	-	-	-	-	-	
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	0.007	
BARIUM	MG/L	-	-	-	-	0.03	
BERYLLIUM	MG/L	-	-	-	-	-	
BORON	MG/L	-	-	-	-	-	
BROMIDE	MG/L	-	-	-	-	0.1	
CADMIUM	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.005	
CALCIUM	MG/L	263.	266.	265.	264.	324.	
CHLORIDE	MG/L	197.	195.	197.	197.	410.	
CHROMIUM	MG/L	-	-	-	-	< 0.01	
COBALT	MG/L	-	-	-	-	-	
COND,IN-SITU	UMHO/CM	-	-	-	-	-	
CONDUCTANCE	UMHO/CM	2700.	2700.	2700.	2700.	3250.	
COPPER	MG/L	-	-	-	-	-	
CYANIDE	MG/L	-	-	-	-	-	
FLUORIDE	MG/L	-	-	-	-	0.19	
GROSS ALPHA	PCI/L	-	-	-	-	-	
GROSS BETA	PCI/L	-	-	-	-	-	
IRON	MG/L	0.144	0.139	0.145	0.152	0.17	
LEAD	MG/L	-	-	-	-	< 0.01	
MAGNESIUM	MG/L	139.	137.	139.	139.	124.	
MANGANESE	MG/L	1.45	1.45	1.5	1.49	1.18	
MERCURY	MG/L	-	-	-	-	-	
MOLYBDENUM	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	0.15	
NICKEL	MG/L	-	-	-	-	-	
NITRATE	MG/L	-	-	-	-	< 0.1	
NITRITE	MG/L	-	-	-	-	< 0.1	
NITROGEN,KJL	MG/L	-	-	-	-	-	
NO2 & NO3	MG/L	-	-	-	-	-	
ORG. CARBON	MG/L	-	-	-	-	-	
PB-210	PCI/L	-	-	-	-	-	
PH	SU	7.2	7.2	7.2	7.2	7.0	
PHOSPHATE	MG/L	-	-	-	-	6.2	
PO-210	PCI/L	-	-	-	-	-	
POTASSIUM	MG/L	6.2	6.01	6.08	6.09	6.84	
RA-226	PCI/L	-	-	-	-	0.0	0.1
RA-228	PCI/L	-	-	-	-	1.2	1.0
REDOX POTENT	MVOLTS	-	-	-	-	-	
SELENIUM	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	0.028	
SILCON	MG/L	-	-	-	-	-	
SILICA	MG/L	-	-	-	-	11.0	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		620-02 05/14/86	620-03 05/14/86	620-04 05/14/86	620-05 05/14/86	620-01 10/26/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	514.	518.	518.	518.	710.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	1650.	1660.	1640.	1640.	1920.
SULFIDE	MG/L	-	-	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.	10.	10.	10.	10.5
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	3230.	3260.	3270.	3250.	3690.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.057	0.053	0.048	0.051	0.0301
VANADIUM	MG/L	-	-	-	-	0.05
ZINC	MG/L	-	-	-	-	0.021

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		621-01 01/15/86		621-01 05/14/86		622-01 01/15/86		622-01 05/14/86		622-01 10/25/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		67.8		-	
ALKALINITY	MG/L CACO3	365.		336.		418.		311.		425.	
ALUMINUM	MG/L	0.3		< 0.1		0.3		< 0.1		0.06	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	< 0.1		0.4		< 0.1		0.5		0.3	
ANTIMONY	MG/L	< 0.003		-		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		0.007	
BARIUM	MG/L	0.3		0.13		0.2		< 0.1		0.06	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	0.3		-		0.3		-		-	
BROMIDE	MG/L	-		-		-		-		0.1	
CADMIUM	MG/L	< 0.001		< 0.001		< 0.001		< 0.001		< 0.005	
CALCIUM	MG/L	31.6		10.9		3.17		4.16		3.68	
CHLORIDE	MG/L	1800.		1060.		450.		405.		380.	
CHROMIUM	MG/L	-		-		-		-		< 0.01	
COBALT	MG/L	< 0.05		< 0.05		< 0.05		< 0.05		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2650.		2700.		1600.		1620.		1513.	
COPPER	MG/L	< 0.02		< 0.02		0.03		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	2.1		2.6		3.4		3.9		3.97	
GROSS ALPHA	PCI/L	-		< 61.		-		33.		-	
GROSS BETA	PCI/L	-		< 20.		-		< 15.		-	
IRON	MG/L	0.15		< 0.03		0.11		< 0.03		< 0.01	
LEAD	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
MAGNESIUM	MG/L	4.3		3.23		1.41		1.14		0.99	
MANGANESE	MG/L	0.02		0.012		0.01		0.01		< 0.01	
MERCURY	MG/L	< 0.0002		-		< 0.0002		-		-	
MOLYBDENUM	MG/L	0.2		0.161		0.2		0.254		0.31	
NICKEL	MG/L	0.06		< 0.04		< 0.04		< 0.04		-	
NITRATE	MG/L	< 1.		< 1.		< 1.		< 1.		< 0.1	
NITRITE	MG/L	-		-		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	-		< 1.5		-		< 1.5		-	
PH	SU	8.99		8.8		8.51		8.55		8.3	
PHOSPHATE	MG/L	0.1		-		0.1		-		0.5	
PO-210	PCI/L	-		< 1.		-		< 1.		-	
POTASSIUM	MG/L	8.96		3.54		2.14		1.49		1.28	
RA-226	PCI/L	-		< 1.		-		< 1.		0.1	0.2
RA-228	PCI/L	-		< 1.		-		< 1.		0.3	0.7
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		< 0.005		< 0.005		< 0.005		0.001	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	5.		7.2		5.		7.4		6.50	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		621-01 01/15/86	621-01 05/14/86	622-01 01/15/86	622-01 05/14/86	622-01 10/25/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	< 0.01	-	< 0.01	-	-
SODIUM	MG/L	1190.	818.	520.	474.	490.
STRONTIUM	MG/L	0.6	0.449	0.2	0.146	-
SULFATE	MG/L	39.	34.3	84.	67.8	65.
SULFIDE	MG/L	-	-	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.5	10.	10.5	12.	11.0
TH-230	PCI/L	-	< 1.	-	< 1.	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	0.007	< 0.005	< 0.005	< 0.005	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	2190.	2220.	1270.	1420.	1190.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0006	< 0.003	0.0005	< 0.003	0.0016
VANADIUM	MG/L	0.31	< 0.01	0.26	< 0.01	0.01
ZINC	MG/L	0.035	0.01	0.026	< 0.005	0.005

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE: 622-02 10/25/87 PARAMETER VALUE+/-UNCERTAINTY	622-03 10/25/87 PARAMETER VALUE+/-UNCERTAINTY	622-04 10/25/87 PARAMETER VALUE+/-UNCERTAINTY	622-05 10/25/87 PARAMETER VALUE+/-UNCERTAINTY	623-01 01/13/86 PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	425.	425.	425.	425.	591.
ALUMINUM	MG/L	0.07	0.06	0.06	0.06	109.
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.4	0.3	0.3	0.3	3.3
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	0.005	0.006	0.008	0.004	< 0.01
BARIUM	MG/L	0.06	0.06	0.06	0.06	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	0.1	0.2	0.1	0.1	-
CADMIUM	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	-
CALCIUM	MG/L	3.74	3.75	3.77	3.76	1330.
CHLORIDE	MG/L	470.	400.	400.	400.	5700.
CHROMIUM	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	-
COBALT	MG/L	-	-	-	-	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1513.	1513.	1513.	1513.	12500.
COPPER	MG/L	-	-	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	3.97	4.01	4.00	4.05	-
GROSS ALPHA	PCI/L	-	-	-	-	0. 50.
GROSS BETA	PCI/L	-	-	-	-	60. 40.
IRON	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	312.
LEAD	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	-
MAGNESIUM	MG/L	1.01	1.01	1.01	1.02	290.
MANGANESE	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	15.4
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.31	0.33	0.33	0.34	0.16
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 1.
NITRITE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	22. 3.
PH	SU	8.3	8.3	8.3	8.3	7.85
PHOSPHATE	MG/L	0.6	0.5	0.6	0.4	-
PO-210	PCI/L	-	-	-	-	10. 3.
POTASSIUM	MG/L	1.57	1.57	1.34	1.39	66.
RA-226	PCI/L	0.1 0.2	0.1 0.2	0.0 0.1	0.1 0.2	3.7 1.4
RA-228	PCI/L	0.3 1.0	0.0 1.0	0.0 1.1	0.0 1.3	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.004	0.003	0.003	0.003	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	6.63	6.68	6.68	6.63	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		622-02 10/25/87		622-03 10/25/87		622-04 10/25/87		622-05 10/25/87		623-01 01/13/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	480.		483.		480.		480.		3490.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	63.		62.		65.		59.		4910.	
SULFIDE	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		-	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	11.0		11.0		11.0		11.0		13.	
TH-230	PCI/L	-		-		-		-		4.5	1.9
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	1210.		1200.		1220.		1220.		15000.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	0.0014		0.0016		0.0015		0.0015		0.0164	
VANADIUM	MG/L	0.01		0.01		0.01		0.01		0.78	
ZINC	MG/L	0.005		0.008		0.006		0.005		-	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		623-01 05/23/86		623-01 10/26/87		624-01 01/13/86		624-01 05/27/86		624-01 11/04/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	95.		93.		286.		175.		-	
ALUMINUM	MG/L	< 0.1		0.26		13.8		< 0.1		0.16	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	1.9		3.2		1.3		1.		< 0.1	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		0.003		< 0.01		< 0.01		0.002	
BARIUM	MG/L	1.64		3.01		-		< 0.1		0.08	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		1.0		-		-		2.4	
CADMIUM	MG/L	< 0.001		< 0.005		-		< 0.001		0.014	
CALCIUM	MG/L	313.		328.		124.		66.		103.	
CHLORIDE	MG/L	7110.		1170.		2170.		2200.		2700.	
CHROMIUM	MG/L	-		< 0.01		-		-		< 0.01	
COBALT	MG/L	< 0.05		-		-		< 0.05		-	
COND.IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	15500.		14200.		5500.		7000.		7000.	
COPPER	MG/L	0.024		-		-		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.9		0.57		-		1.3		0.60	
GROSS ALPHA	PCI/L	< 250.		-		9.	36.	< 120.		-	
GROSS BETA	PCI/L	< 150.		-		20.	20.	< 40.		-	
IRON	MG/L	< 0.03		0.09		34.4		< 0.03		0.02	
LEAD	MG/L	< 0.01		0.03		-		< 0.01		0.02	
MAGNESIUM	MG/L	58.3		58.4		30.5		12.4		18.4	
MANGANESE	MG/L	0.211		0.19		1.33		0.054		0.36	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.01		0.12		0.16		0.01		0.04	
NICKEL	MG/L	< 0.04		-		-		< 0.04		-	
NITRATE	MG/L	< 1.		< 0.1		< 1.		< 1.		42.1	
NITRITE	MG/L	-		< 0.1		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	< 1.5		-		8.5	3.6	< 1.5		-	
PH	SU	7.5		7.5		9.44		8.25		7.4	
PHOSPHATE	MG/L	-		3.7		-		-		1.5	
PO-210	PCI/L	< 1.		-		9.9	1.9	< 1.		-	
POTASSIUM	MG/L	27.2		24.3		33.7		8.71		8.56	
RA-226	PCI/L	1.8		0.6	0.3	1.1	0.8	< 1.		0.0	0.4
RA-228	PCI/L	< 1.0		3.5	1.0	-		< 1.0		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.138		< 0.005		< 0.005		0.076	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	6.9		6.31		-		8.1		7.08	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		623-01 05/23/86		623-01 10/26/87		624-01 01/13/86		624-01 05/27/86		624-01 11/04/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	4170.		4550.		1660.		1880.		2000.	
STRONTIUM	MG/L	13.2		-		-		2.51		-	
SULFATE	MG/L	72.5		22.		945.		850.		407.	
SULFIDE	MG/L	-	< 0.1			-		-	< 0.1		
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	12.		13.0		13.		14.		10.0	
TH-230	PCI/L	< 1.		-		5.4	1.9	< 1.		-	
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	< 0.005		-		-		< 0.005		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	12400.		13700.		5110.		5240.		6070.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	< 0.003		0.0012		0.0095		0.024		0.0096	
VANADIUM	MG/L	< 0.01		0.05		0.4		< 0.01		0.03	
ZINC	MG/L	< 0.005		0.028		-		0.006		0.170	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		625-01 01/12/86	625-01 05/15/86	625-01 10/26/87	626-01 01/12/86	626-01 05/15/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-	-	-
ALKALINITY	MG/L CACO3	362.	395.	350.	242.	236.
ALUMINUM	MG/L	0.7	-	0.08	0.5	-
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.4	0.3	0.4	0.3	0.2
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.01	< 0.01	0.005	< 0.01	< 0.01
BARIUM	MG/L	-	-	0.07	-	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	0.1	-	-
CADMIUM	MG/L	-	< 0.001	< 0.005	-	< 0.001
CALCIUM	MG/L	3.93	5.05	4.98	4.67	5.43
CHLORIDE	MG/L	630.	605.	610.	280.	258.
CHROMIUM	MG/L	-	-	< 0.01	-	-
COBALT	MG/L	-	-	-	-	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1800.	1950.	2050.	1000.	1010.
COPPER	MG/L	-	-	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	3.31	-	-
GROSS ALPHA	PCI/L	0. 20.	-	-	0. 6.7	-
GROSS BETA	PCI/L	2. 14.	-	-	4. 4.2	-
IRON	MG/L	0.08	< 0.03	0.02	0.08	< 0.03
LEAD	MG/L	-	-	< 0.01	-	-
MAGNESIUM	MG/L	1.07	0.93	0.93	1.64	0.93
MANGANESE	MG/L	0.04	0.016	0.02	0.03	0.017
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.4	0.25	0.19	0.47	0.23
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	< 1.	-	< 0.1	< 1.	-
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	3.7 1.3	-	-	2.7 1.4	-
PH	SU	8.14	8.45	8.2	8.64	9.
PHOSPHATE	MG/L	-	-	0.5	-	-
PO-210	PCI/L	0. 0.4	-	-	0. 0.5	-
POTASSIUM	MG/L	2.92	2.25	2.00	3.	1.95
RA-226	PCI/L	0.2 0.1	-	0.2 0.2	0.2 0.1	-
RA-228	PCI/L	0. 1.	-	0.0 0.8	0. 1.1	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	< 0.005	0.002	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	6.55	-	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		625-01 01/12/86	625-01 05/15/86	625-01 10/26/87	626-01 01/12/86	626-01 05/15/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	612.	586.	600.	308.	288.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	67.	69.5	80.	65.	71.5
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.	9.5	11.5	10.	11.5
TH-230	PCI/L	0. 0.1	-	-	0.2 0.3	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1490.	1640.	1550.	1670.	916.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0015	< 0.003	0.0007	0.0022	< 0.003
VANADIUM	MG/L	0.2	-	0.01	0.06	-
ZINC	MG/L	-	-	< 0.005	-	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		626-01 10/25/87		629-01 01/16/86		629-01 05/13/86		630-01 01/16/86		630-01 05/13/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	259.		1720.		1980.		111.		130.	
ALUMINUM	MG/L	0.17		5.4		< 0.1		0.4		< 0.1	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	0.3		< 0.1		11.8		< 0.1		1.4	
ANTIMONY	MG/L	-		< 0.003		-		< 0.003		-	
ARSENIC	MG/L	0.005		< 0.01		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	0.04		0.5		0.44		3.1		2.19	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		0.3		-		0.8		-	
BROMIDE	MG/L	< 0.1		-		-		-		-	
CADMIUM	MG/L	< 0.005		< 0.001		< 0.001		< 0.001		< 0.001	
CALCIUM	MG/L	4.59		27.2		25.		89.2		90.9	
CHLORIDE	MG/L	260.		360.		486.		3600.		3600.	
CHROMIUM	MG/L	< 0.01		-		-		-		-	
COBALT	MG/L	-		< 0.05		< 0.05		< 0.05		< 0.05	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	1000.		7500.		9100.		8000.		8500.	
COPPER	MG/L	-		0.05		0.02		0.04		< 0.02	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	2.82		1.1		1.9		1.		1.1	
GROSS ALPHA	PCI/L	-		-		< 100.		-		< 190.	
GROSS BETA	PCI/L	-		-		245.		-		< 77.	
IRON	MG/L	0.02		0.15		0.032		0.13		< 0.03	
LEAD	MG/L	< 0.01		0.04		< 0.01		< 0.01		< 0.01	
MAGNESIUM	MG/L	0.85		1.31		0.01		27.1		26.	
MANGANESE	MG/L	< 0.01		0.02		< 0.01		0.05		0.176	
MERCURY	MG/L	-		< 0.0002		-		< 0.0002		-	
MOLYBDENUM	MG/L	0.30		0.5		0.334		0.2		0.033	
NICKEL	MG/L	-		0.06		< 0.04		0.1		< 0.04	
NITRATE	MG/L	< 0.1		4.		< 1.		< 1.		< 1.	
NITRITE	MG/L	< 0.1		-		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	-		-		< 1.5		-		< 1.5	
PH	SU	9.1		12.69		12.4		8.47		7.7	
PHOSPHATE	MG/L	0.5		0.1		-		0.1		-	
PO-210	PCI/L	-		-		< 1.		-		< 1.	
POTASSIUM	MG/L	2.03		321.		227.		33.1		9.06	
RA-226	PCI/L	0.1	0.2	-		1.2		-		2.4	
RA-228	PCI/L	0.5	1.0	-		< 1.		-		< 1.	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.001		0.01		0.017		< 0.005		< 0.005	
SILICON	MG/L	-		-		-		-		-	
SILICA	MG/L	6.78		15.		11.3		4.		8.8	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		626-01 10/25/87	629-01 01/16/86	629-01 05/13/86	630-01 01/16/86	630-01 05/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	< 0.01	-	< 0.01	-
SODIUM	MG/L	340.	910.	1160.	2220.	2100.
STRONTIUM	MG/L	-	1.3	2.86	3.8	4.93
SULFATE	MG/L	81.	247.	69.2	18.	24.4
SULFIDE	MG/L	< 0.1	-	-	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	11.6	11.	13.	11.	13.5
TH-230	PCI/L	-	-	< 1.	-	< 1.
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	0.006	< 0.005	0.006	< 0.005
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	810.	2640.	4300.	6040.	6240.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0023	0.0007	< 0.003	< 0.0003	< 0.003
VANADIUM	MG/L	0.02	0.55	0.15	0.22	< 0.01
ZINC	MG/L	< 0.005	0.048	0.011	0.067	0.026

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		640-01 01/14/86		640-01 05/14/86		641-01 01/14/86		641-01 05/14/86		641-01 10/25/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	286.		259.		238.		208.		218.	
ALUMINUM	MG/L	0.5		-		0.3		-		0.09	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	< 0.1		0.4		< 0.1		0.5		0.4	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		0.003	
BARIUM	MG/L	-		-		-		-		0.08	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		-		0.2	
CADMIUM	MG/L	< 0.001		< 0.001		< 0.001		< 0.001		< 0.005	
CALCIUM	MG/L	5.69		5.53		23.2		17.7		16.9	
CHLORIDE	MG/L	250.		795.		690.		671.		610.	
CHROMIUM	MG/L	-		-		-		-		< 0.01	
COBALT	MG/L	-		-		-		-		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2350.		2400.		2100.		2110.		2000.	
COPPER	MG/L	-		-		-		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		-		-		-		1.01	
GROSS ALPHA	PCI/L	-		-		-		-		-	
GROSS BETA	PCI/L	-		-		-		-		-	
IRON	MG/L	0.06		< 0.03		0.03		< 0.03		0.02	
LEAD	MG/L	-		-		-		-		< 0.01	
MAGNESIUM	MG/L	3.75		2.7		7.31		6.33		5.52	
MANGANESE	MG/L	0.01		< 0.01		0.04		0.027		0.02	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.2		< 0.01		0.2		< 0.01		0.04	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	< 1.		-		< 1.		-		< 0.1	
NITRITE	MG/L	-		-		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	9.65		9.25		8.04		8.1		8.0	
PHOSPHATE	MG/L	-		-		-		-		0.9	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	44.7		18.5		4.		3.15		3.37	
RA-226	PCI/L	-		-		-		-		0.3	0.2
RA-228	PCI/L	-		-		-		-		0.0	1.2
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		< 0.005		< 0.005		< 0.005		0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		-		-		6.89	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		640-01 01/14/86	640-01 05/14/86	641-01 01/14/86	641-01 05/14/86	641-01 10/25/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	560.	720.	600.	604.	600.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	661.	236.	249.	228.	238.
SULFIDE	MG/L	-	-	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	9.5	9.	11.	11.	10.9
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1940.	2080.	1750.	1740.	1620.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0005	< 0.003	< 0.0003	< 0.003	< 0.0003
VANADIUM	MG/L	0.07	-	0.18	-	0.02
ZINC	MG/L	-	-	-	-	< 0.005

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		644-01 01/12/86		644-01 05/16/86		644-01 10/26/87		644-01 12/10/88		645-01 01/12/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
3/8IN.SIEVE	% PASSING	-		-		-		-		-	
ALKALINITY	MG/L CACO3	411.		48.		91.		102.		120.	
ALUMINUM	MG/L	0.8		< 0.1		0.24		0.1		0.6	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	2.4		1.7		3.5		-		2.	
ANTIMONY	MG/L	-		-		-		0.033		-	
ARSENIC	MG/L	< 0.01		< 0.01		0.004		< 0.01		< 0.01	
BARIUM	MG/L	-		7.92		8.44		8.63		-	
BERYLLIUM	MG/L	-		-		-		< 0.01		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		1.6		-		-	
CADMIUM	MG/L	-		< 0.001		0.005		0.070		-	
CALCIUM	MG/L	252.		277.		296.		268.		222.	
CHLORIDE	MG/L	6300.		7590.		7780.		7640.		5700.	
CHROMIUM	MG/L	-		-		< 0.01		0.09		-	
COBALT	MG/L	-		< 0.05		-		< 0.05		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	11000.		15000.		16000.		11000.		10000.	
COPPER	MG/L	-		< 0.02		-		0.02		-	
CYANIDE	MG/L	-		-		-		< 0.01		-	
FLUORIDE	MG/L	-		0.6		0.51		-		-	
GROSS ALPHA	PCI/L	0.	40.	< 280.		-		-		0.	70.
GROSS BETA	PCI/L	230.	30.	< 150.		-		-		60.	40.
IRON	MG/L	0.08		< 0.03		0.06		0.06		0.12	
LEAD	MG/L	-		< 0.01		0.03		0.05		-	
MAGNESIUM	MG/L	32.9		63.3		53.5		54.3		39.	
MANGANESE	MG/L	0.04		0.041		0.24		0.26		0.18	
MERCURY	MG/L	-		-		-		< 0.0002		-	
MOLYBDENUM	MG/L	0.25		< 0.01		0.07		0.03		0.21	
NICKEL	MG/L	-		< 0.04		-		< 0.04		-	
NITRATE	MG/L	< 1.		< 1.		-		-		< 1.	
NITRITE	MG/L	-		-		< 0.1		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	1.8	1.5	< 1.5		-		-		1.9	1.2
PH	SU	11.64		8.6		-		7.84		8.03	
PHOSPHATE	MG/L	-		-		3.2		-		-	
PO-210	PCI/L	0.	0.5	< 1.		-		-		0.	0.5
POTASSIUM	MG/L	175.		43.2		26.0		40.1		15.3	
RA-226	PCI/L	6.9	1.8	6.6		0.8	0.4	-		5.7	1.
RA-228	PCI/L	-		< 1.0		10.	1.	-		3.6	1.1
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		< 0.005		0.170		0.008		< 0.005	
SILICON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		8.7		6.65		-		-	

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		644-01 01/12/86	644-01 05/16/86	644-01 10/26/87	644-01 12/10/88	645-01 01/12/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	-	0.02	-
SODIUM	MG/L	3820.	1460.	4550.	4050.	3410.
STRONTIUM	MG/L	-	15.6	-	15.6	-
SULFATE	MG/L	65.	6.6	9.	2.	< 10.
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.	10.	9.5	10.5	12.
TH-230	PCI/L	0.7 0.5	< 1.	-	-	0.1 0.2
THALLIUM	MG/L	-	-	-	0.01	-
TIN	MG/L	-	< 0.005	-	0.198	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	10100.	13000.	13000.	-	9980.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	< 0.0003	< 0.003	0.0008	0.0009	0.0014
VANADIUM	MG/L	0.2	< 0.01	0.07	0.03	0.2
ZINC	MG/L	-	0.022	0.005	0.007	-

Table E.2.6 Groundwater quality data by location, Old Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		645-01 05/16/86	645-01 10/25/87	645-01 12/10/88		
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
3/8IN.SIEVE	% PASSING	-	-	-		
ALKALINITY	MG/L CACO3	142.	103.	113.		
ALUMINUM	MG/L	< 0.1	0.18	0.1		
AMMONIA	MG/L	-	-	-		
AMMONIUM	MG/L	1.4	2.6	-		
ANTIMONY	MG/L	-	-	0.015		
ARSENIC	MG/L	< 0.01	0.002	< 0.01		
BARIUM	MG/L	3.61	3.84	4.21		
BERYLLIUM	MG/L	-	-	< 0.01		
BORON	MG/L	-	-	-		
BROMIDE	MG/L	-	1.5	-		
CADMIUM	MG/L	< 0.001	< 0.005	0.063		
CALCIUM	MG/L	214.	231.	222.		
CHLORIDE	MG/L	6010.	6830.	6800.		
CHROMIUM	MG/L	-	< 0.01	0.08		
COBALT	MG/L	< 0.05	-	< 0.05		
COND.IN-SITU	UMHO/CM	-	-	-		
CONDUCTANCE	UMHO/CM	12500.	12290.	11500.		
COPPER	MG/L	< 0.02	-	< 0.02		
CYANIDE	MG/L	-	-	< 0.01		
FLUORIDE	MG/L	0.7	0.57	-		
GROSS ALPHA	PCI/L	< 210.	-	-		
GROSS BETA	PCI/L	< 77.	-	-		
IRON	MG/L	0.051	0.11	0.13		
LEAD	MG/L	< 0.01	0.04	0.05		
MAGNESIUM	MG/L	36.4	38.1	41.6		
MANGANESE	MG/L	0.251	0.24	0.27		
MERCURY	MG/L	-	-	< 0.0002		
MOLYBDENUM	MG/L	< 0.01	0.08	0.05		
NICKEL	MG/L	< 0.04	-	< 0.04		
NITRATE	MG/L	< 1.	< 0.1	-		
NITRITE	MG/L	-	< 0.1	-		
NITROGEN,KJL	MG/L	-	-	-		
NO2 & NO3	MG/L	-	-	-		
ORG. CARBON	MG/L	-	-	-		
PB-210	PCI/L	< 1.5	-	-		
PH	SU	7.6	7.65	7.77		
PHOSPHATE	MG/L	-	2.4	-		
PO-210	PCI/L	< 1.	-	-		
POTASSIUM	MG/L	11.2	13.4	19.6		
RA-226	PCI/L	4.6	1.2 0.4	-		
RA-228	PCI/L	< 1.0	6.2 1.2	-		
REDOX POTENT	MVOLTS	-	-	-		
SELENIUM	MG/L	< 0.005	0.041	< 0.005		
SILCON	MG/L	-	-	-		
SILICA	MG/L	7.6	6.40	-		

Table E.2.6 Groundwater quality data by location, Old Rifle site (Concluded)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE		
		645-01 05/16/86	645-01 10/25/87	645-01 12/10/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SILVER	MG/L	-	-	0.02
SODIUM	MG/L	3650.	4050.	3670.
STRONTIUM	MG/L	9.77	-	12.4
SULFATE	MG/L	6.3	5.	< 0.1
SULFIDE	MG/L	-	< 0.1	-
TEMP,IN-SITU	C-DEGREE	-	-	-
TEMPERATURE	C - DEGREE	12.	11.7	10.5
TH-230	PCI/L	1.	-	-
THALLIUM	MG/L	-	-	0.01
TIN	MG/L	< 0.005	-	0.260
TITANIUM	MG/L	-	-	-
TOTAL SOLIDS	MG/L	11600.	11800.	-
TOTAL U	PPM	-	-	-
URANIUM	MG/L	< 0.003	< 0.0003	0.0004
VANADIUM	MG/L	< 0.01	0.04	0.03
ZINC	MG/L	0.007	< 0.005	< 0.005

MAPPER DATA FILE NAME: RF001*UDPGWQ103043

Table E.2.7 Background water quality and contaminant concentrations in alluvial groundwater, Old Rifle site

Background wells: 597,598,601,602

On-site and downgradient wells: 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 599, 600, 603, 604

	BACKGROUND CONCENTRATIONS							DOWNGRADIENT CONCENTRATIONS					
Parameter	MCL (mg/l)	Background sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)	Downgradient sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)
Proposed EPA Groundwater Protection Standards (40 CFR 192):													
Arsenic	0.05	11	0.005	602	0.005	0.000	0.005	51	1.018	582	0.081	0.270	0.621
Barium	1.0	7	0.125	601	0.069	0.038	0.144	42	0.098	583	0.049	0.023	0.096
Cadmium	0.01	7	0.002	597	0.001	0.001	0.002	27	0.004	582	0.002	0.001	0.004
Chromium	0.05	7	0.005	ALL	0.005	N.A.	N.A.	42	0.018	581	0.004	0.004	0.013
Lead	0.05	7	0.010	602	0.007	0.002	0.012	22	0.010	581	0.006	0.002	0.009
Mercury	0.002	0	N.A.	N.A.	N.A.	N.A.	N.A.	1	0.000	581	0.000	N.A.	N.A.
Molybdenum	0.1	11	0.117	597	0.088	0.026	0.140	50	0.231	583	0.086	0.050	0.186
Nitrate	44.0	11	6.1	602	2.6	2.7	8.0	39	15.1	590	4.9	4.6	14.2
Selenium	0.01	11	0.014	597	0.008	0.006	0.020	50	0.134	584	0.031	0.040	0.111
Silver	0.05	4	0.005	ALL	0.005	N.A.	N.A.	12	0.008	581	0.005	0.001	0.007
Uranium	0.044	11	0.116	598	0.037	0.054	0.145	31	1.117	582	0.296	0.359	1.014
Ra-226/228 (pCi/L)	5.0	7	1.1	601	0.7	0.4	1.5	19	34.9	586	4.5	10.2	24.9
Gross Alpha (pCi/L)	15.0	8	3.2	602	1.0	1.5	4.0	14	16.5	603	2.8	6.1	14.9
Appendix I Inorganic Constituents (40 CFR 192):													
Antimony	None	4	0.002	ALL	0.002	N.A.	N.A.	11	0.005	581	0.002	0.001	0.004
Beryllium	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	1	0.005	581	0.005	N.A.	N.A.
Carbon Disulphide	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Cobalt	None	4	0.025	ALL	0.025	N.A.	N.A.	32	0.025	599,600,603,	0.015	0.008	0.0
Copper	None	4	0.010	ALL	0.010	N.A.	N.A.	32	0.010	599,600,603,	0.005	0.005	0.0
Cyanide	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	1	0.005	581	0.005	N.A.	N.A.
Fluorine	None	0	N.A.	N.A	N.A.	N.A.	N.A.	0	N.A.	N.A	N.A.	N.A.	N.A.
Nickel	None	4	0.020	ALL	0.020	N.A.	N.A.	12	0.020	ALL	0.020	N.A.	N.A.
Sulfide	None	7	0.050	ALL	0.050	N.A.	N.A.	18	1.330	582	0.234	0.380	0.994
Thallium	None	0	N.A.	N.A	N.A.	N.A.	N.A.	1	0.005	581	0.005	N.A.	N.A.
Tin	None	4	0.022	597	0.011	0.010	0.032	11	0.007	581	0.004	0.002	0.008
Vanadium	None	11	0.153	602	0.118	0.038	0.193	51	7.290	582	0.658	1.910	4.480
Zinc	None	7	0.103	597	0.062	0.095	0.251	42	0.139	584	0.045	0.070	0.185
Detection Constituents:													
Calcium	None	11	207.1	597	140.4	65.4	4271.2	51	322.0	583	203.5	52.2	308.0
Chloride	None	11	206.8	598	146.9	67.7	282.2	51	447.4	584	102.2	108.7	319.6
Iron	None	11	1.2	597	0.7	0.4	1.6	49	51.8	599	4.2	13.8	31.8
Magnesium	None	11	151.6	597	79.8	75.7	231.1	51	164.0	603	107.1	27.0	161.1
Manganese	None	11	4.4	597	2.4	1.6	5.6	51	1.2	602	0.6	0.4	1.5
Potassium	None	11	8.8	597	5.4	3.3	11.9	51	12.4	584	7.0	2.6	12.1
Sodium	None	11	512.3	597	273.9	258.7	791.3	51	651.6	584	216.6	164.6	545.8
Sulfate	None	11	1432.7	597	724.9	748.1	2221.0	51	1481.6	584	792.3	336.6	1465.6
TDS	None	11	2993.0	597	1701.6	1428.4	4558.5	50	3478.0	584	2641.0	2840.0	8321.0
Alkalinity	None	11	1178.0	598	506.2	470.7	1447.7	51	968.0	599	440.0	191.8	823.4
pH	None	11	7.3	601	7.3	N.A.	N.A.	51	7.3	585	7.0	N.A.	N.A.

LEGEND

- △ BACKGROUND WELL
- o ONSITE WELL
- □ LYSIMETER COMPLETED IN THE TAILINGS
- • DOWNGRADIENT OR CROSSGRADIENT WELL

(TRILINEAR SCALES ARE PERCENTAGES OF EQUIVALENTS PER LITER OF MAJOR IONS.)

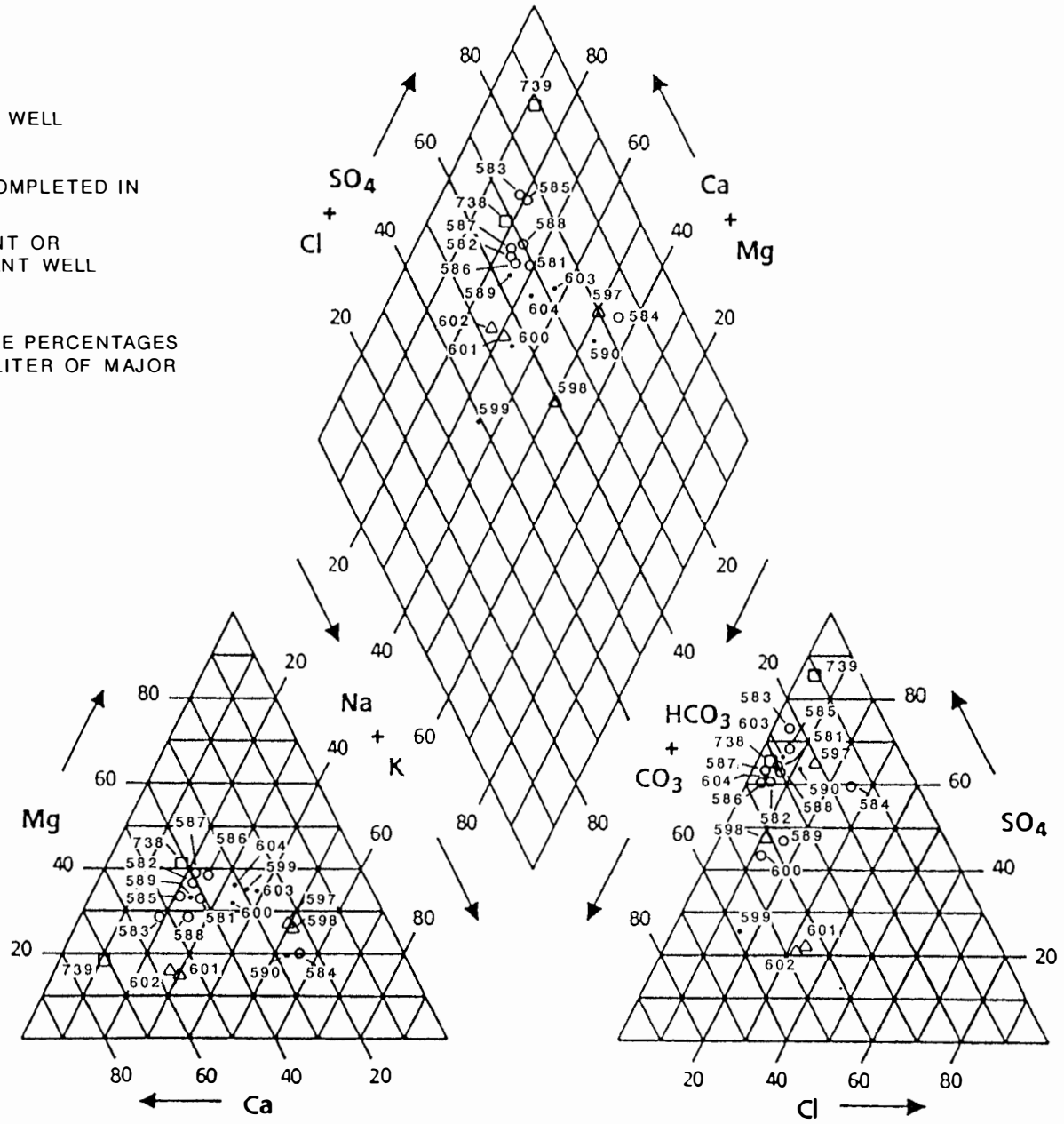


FIGURE E.2.13
TRILINEAR DIAGRAM OF ALLUVIAL GROUNDWATER
OLD RIFLE SITE

The background quality of groundwater in the Wasatch Formation at the Old Rifle site was determined from chemical analyses of samples from upgradient monitor wells 620, 621, and 622 and cross-gradient monitor wells 625, 626, and 641 (Figure E.2.3). Monitor well 620 is located approximately 0.5 mile upgradient of the processing site, and although groundwater from this well contains relatively high concentrations of sulfate, uranium and selenium, the well is not contaminated from activities at the Old Rifle processing site and reflects baseflow in the Wasatch Formation. Hence, monitor well 620 was used to define background water quality in spite of the relatively high concentrations of constituents within the sample. Monitor wells 629 and 640 are contaminated with the cement grout used to construct the wells, and were excluded from use in defining background water quality. Monitor well 630 was excluded as a background well because it is a considerable distance from the site. Monitor wells 623 and 624 are located onsite, and do not represent background water quality in the Wasatch Formation. Monitor wells 644 and 645 are located downgradient of the site, and were excluded as background wells.

Background and downgradient water quality for the Wasatch Formation at the Old Rifle site is summarized in Table E.2.8. Background water quality for the Wasatch Formation at the Old Rifle site exceeds the proposed EPA groundwater protection MCLs for molybdenum, selenium, and gross alpha activity. Groundwater from background monitor wells in the Wasatch Formation is a sodium sulfate type of water (Figure E.2.14).

Tailings and milling process characterization

The Old Rifle tailings pile is 13 acres in area and contains an estimated 333,000 cubic yards of tailings. The tailings consist of fine sands with a moderate amount of clay, and are up to 20 feet thick. Although the tailings are generally above the water table, the lower portions of the tailings become saturated during high stage periods of the Colorado River (DOE, 1983). The DOE has observed inundation of the lower 5.5 feet of tailings near monitor wells 581, 582, and 583 (Figure E.2.2) during high flow periods.

The Old Rifle mill was built in 1924 to recover vanadium from roscoelite ores. Extraction processes used included salt roasting, water leaching, and precipitation of sodium hexavanadate with sulfuric acid (Merritt, 1971). The processes were modified in 1946 to extract uranium by acid leaching and subsequent processing. Sulfuric and hydrochloric acids were used with ammonia to precipitate a "green-sludge" product. This was purified by redissolving it in sulfuric acid and sodium chlorite, and then adding sodium carbonate. Finally, yellow cake was obtained from the purified solution by acidifying and boiling, and then adding ammonia gas (Merritt, 1971).

Table E.2.8 Background water quality and contaminant concentrations in Wasatch Formation groundwater, Old Rifle site

Background wells: 620, 621, 622, 625, 626, 641 On site and downgradient wells: 623, 624, 644, 645

		BACKGROUND CONCENTRATIONS						DOWNGRADIENT CONCENTRATIONS					
Parameter	MCL (mg/l)	Background sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)	Sample size	Downgradient maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)
Proposed EPA Groundwater Protection Standards (40 CFR 192):													
Arsenic	0.05	17	0.006	620	0.005	0.001	0.007	14	0.004	623	0.004	0.002	0.007
Barium	1.0	10	0.215	621	0.101	0.086	0.274	10	8.330	644	4.140	3.230	10.610
Cadmium	0.0	15	0.002	625,626	0.001	0.001	0.003	10	0.025	644	0.016	0.027	0.070
Chromium	0.05	6	0.005	ALL	0.005	N.A.	N.A.	6	0.048	644	0.032	0.041	0.115
Lead	0.05	10	0.008	620	0.006	0.002	0.009	10	0.032	645	0.024	0.019	0.061
Mercury	0.002	2	0.000	ALL	0.000	N.A	N.A.	2	0.000	ALL	0.000	N.A.	N.A.
Molybdenum	0.1	17	0.333	626	0.199	0.133	0.467	14	0.095	623	0.085	0.082	0.249
Nitrate	44.0	13	0.9	620	0.4	0.5	1.4	11	14.4	624	4.2	12.6	29.3
Seleniu	0.01	17	0.011	620	0.004	0.006	0.016	14	0.048	623	0.033	0.056	0.144
Silver	0.05	3	0.005	ALL	0.005	N.A.	N.A.	2	0.020	ALL	0.020	N.A.	N.A.
Uranium	0.044	17	0.039	620	0.008	0.016	0.039	14	0.014	624	0.005	0.007	0.020
Ra 226/228 (pCi/L)	5.	9	1.2	620	0.5	0.6	1.7	8	10.0	644	6.0	6.0	18.0
Gross Alpha (pCi/L)	15.	5	31.9	621	12.4	17.0	46.	8	64.7	644	51.0	19.1	89.1
Appendix I Inorganic Constituents (40 CFR 192):													
Antimony	None	3	0.002	ALL	0.002	N.A.	N.A.	2	0.033	644	0.024	0.013	0.049
Beryllium	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	2	0.005	ALL	0.005	N.A.	N.A.
Carbon Disulphide	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Cobalt	None	5	0.025	ALL	0.025	N.A.	N.A.	6	0.025	ALL	0.025	N.A.	N.A.
Copper	None	5	0.020	622	0.014	0.009	0.032	6	0.024	623	0.014	0.006	0.027
Cyanide	None	0	N.A	N.A.	N.A.	N.A.	N.A.	2	0.005	ALL	0.005	N.A.	N.A.
Fluorine	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Nickel	None	5	0.040	621	0.028	0.018	0.064	6	0.020	ALL	0.020	N.A.	N.A.
Sulfide	None	6	0.150	620	0.083	0.082	0.247	4	0.050	ALL	0.050	N.A.	N.A.
Thallium	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	2	0.010	ALL	0.010	N.A.	N.A.
Tin	None	5	0.005	621	0.003	0.002	0.007	6	0.131	645	0.078	0.119	0.315
Vanadium	None	13	0.158	621	0.087	0.110	0.307	14	0.278	623	0.132	0.218	0.567
Zinc	None	10	0.023	621	0.011	0.012	0.035	10	0.088	624	0.025	0.052	0.129
Detection Constituents:													
Calcium	None	17	271.4	620	56.1	104.5	265.1	14	657.0	623	303.3	305.6	914.6
Chloride	None	17	1430.0	621	562.9	388.4	1340.0	14	7327.0	644	5407.0	2314.0	1004.0
Iron	None	17	0.2	620	0.1	0.1	0.2	14	104.0	623	24.8	83.2	191.1
Magnesium	None	17	138.7	620	26.6	53.8	134.2	14	135.6	623	59.1	68.2	195.4
Manganese	None	17	1.4	620	0.3	0.5	1.4	14	5.3	623	1.4	4.1	9.5
Potassium	None	17	8.0	620	3.9	2.8	9.4	14	71.1	644	36.6	42.9	122.4
Sodium	None	17	1004.0	621	573.5	210.7	995.0	14	4220.0	644	3529.3	984.	5498.0
Sulfate	None	17	1763.0	620	395.6	658.0	1711.0	14	1668.0	623	521.8	1303.0	3129.0
TDS	None	17	3457.0	620	1874.4	842.0	3558.0	12	13700.0	623	10583.0	3387.0	17360.0
Alkalinity	None	17	385.0	622	318.3	72.2	462.6	13	259.7	623	182.3	157.0	496.0
pH	None	17	8.9	626	7.8	N.A.	N.A.	13	8.3	644	7.8	N.A.	N.A.

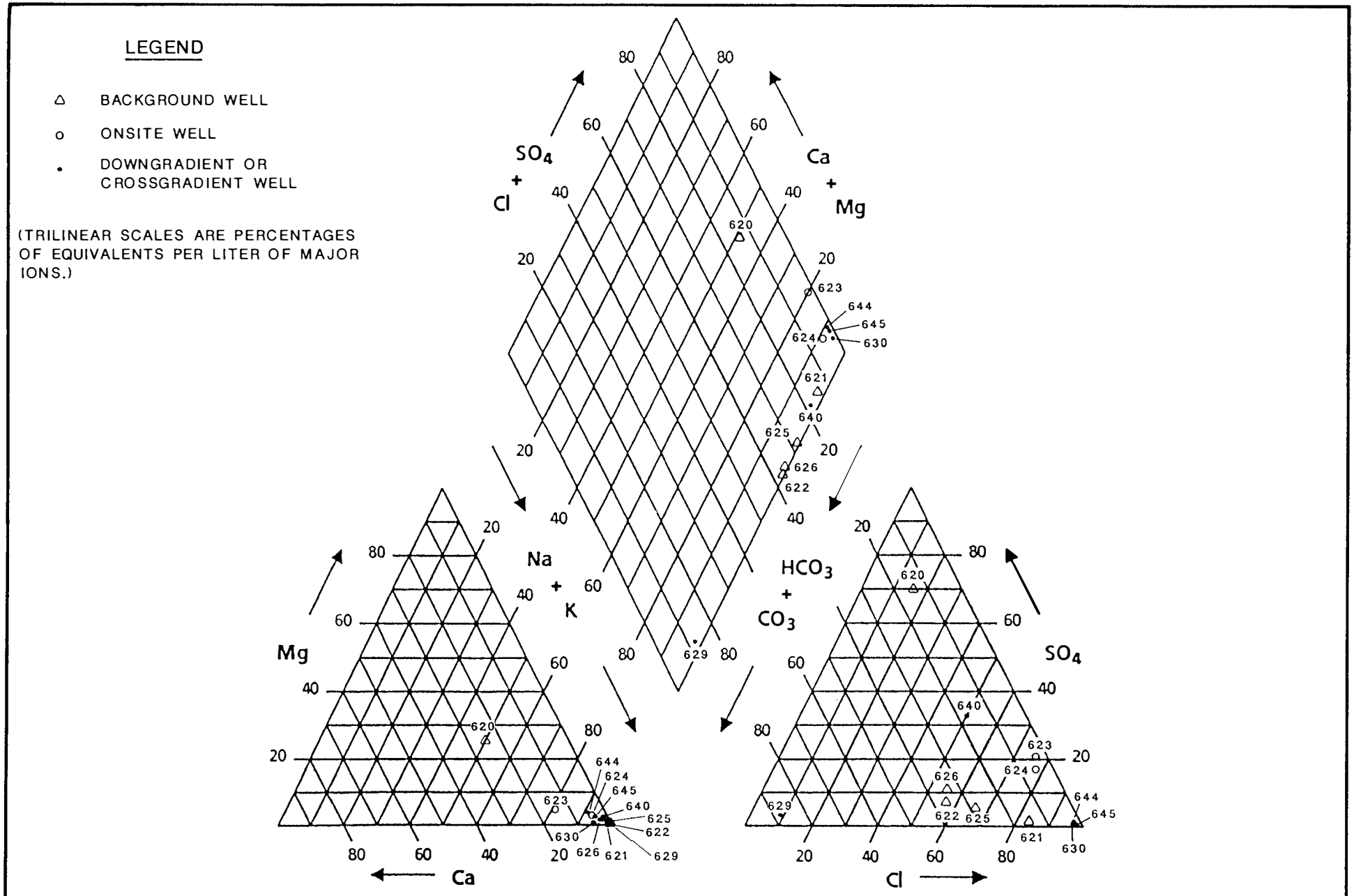


FIGURE E.2.14
TRILINEAR DIAGRAM OF WASATCH FORMATION GROUNDWATER
OLD RIFLE SITE

The contaminant source concentrations at the Old Rifle site were estimated by averaging the concentrations from lysimeters completed in the Old Rifle tailings. Although the five lysimeters were recently installed in the tailings pile, only two lysimeters produced enough sample for analysis. The lysimeters were sampled in December, 1988, and the analytical results, representing contaminant source concentrations at the Old Rifle site, are presented in Table E.2.9.

Three tailings samples were analyzed for Appendix IX (40 CFR 264) organic constituents. Benzo [a] anthracene was found at a concentration of 770 parts per billion, approximately 2.5 times the detection limit. In addition, trace concentrations (below detection limit) of anthracene, acetone, and benzene were found. The sources of these organic constituents are unknown. Benzo [a] anthracene and anthracene are commonly found in wood preservatives. Acetone is a common cleaning and drying solvent, and the trace concentrations in the tailings may be due to laboratory contamination. Benzene, a solvent, is used in the production of a large number of organic compounds and in solvent extraction processes. However, no solvent extraction was used at the Old Rifle site.

The seepage flux of tailings leachate into groundwater at the Old Rifle site was estimated using the Darcy's equation (Freeze and Cherry, 1979). Under saturated conditions in a perched groundwater system, the lowest saturated hydraulic conductivity in a horizontally-stratified geologic system controls vertical seepage flux. The saturated hydraulic conductivities for the Old Rifle tailings ranged from 0.02 cm/s to 1.7×10^{-6} cm/s (DOE, 1987), an average (geometric mean) 3.7×10^{-4} cm/s. These values are not low enough to create a distinct piezometric surface within the tailings, and precipitation infiltrates rapidly through the tailings into groundwater. Therefore, seepage through the tailings is equal to the net infiltration rate. Based on annual precipitation of 11 inches per year and assuming 20 percent net infiltration, the total annual seepage through the pile from precipitation averages 2130 gallons per day (1.5 gpm). A 20 percent net infiltration rate was selected to be conservative; actual infiltration may be considerably lower. This does not include seepage due to groundwater mounding at the culvert northeast of the tailings.

Extent of contamination

Alluvium

Seepage of tailings fluids has contaminated groundwater in the entire 20-foot thickness of the alluvium beneath the Old Rifle site. Most contaminated groundwater occurs directly

Table E.2.9 Contaminant source concentrations, Old Rifle site[a]

Parameter	MCL (mg/l)	Sample size	Lysimeter concentrations Maximum (mg/l)	Lysimeter concentrations Mean (mg/l)
Proposed EPA groundwater protection standards (40 CFR Part 192):				
Arsenic	0.05	2	1.56	0.79
Barium	1.0	2	<0.01	<0.01
Cadmium	0.01	2	0.013	0.01
Chromium	0.05	2	0.17	0.135
Lead	0.05	2	<0.01	<0.01
Mercury	0.002	2	<0.0002	<0.0002
Molybdenum	0.1	2	0.44	0.27
Nitrate	44.0	2	3.4	3.15
Selenium	0.01	2	2.45	1.37
Silver	0.05	2	0.04	0.03
Uranium	0.044	2	1.39	0.753
Ra 226/228 (pCi/l)	5.0	1	64	64
Gross alpha (pCi/l)	15.0	1	250	250
Appendix IX (40 CFR 264) inorganic constituents:				
Antimony	None	2	0.012	0.0105
Beryllium	None	2	0.27	0.175
Carbon disulfide	None	0	N.A.	N.A.
Cobalt	None	2	0.025	0.025
Copper	None	2	0.41	0.11
Cyanide	None	2	<0.05	<0.05
Fluoride	None	2	2	2.55
Nickel	None	2	<0.04	0.04
Sulfide	None	1	<0.1	<0.1
Thallium	None	2	0.005	0.005
Tin	None	2	0.026	0.0185
Vanadium	None	2	29.2	19.2
Detection constituents				
Calcium	None	2	511	333
Chloride	None	2	42	42
Iron	None	2	0.11	0.09
Magnesium	None	2	87.8	84.2
Manganese	None	2	0.14	0.09
Potassium	None	2	5.22	4.51
Sodium	None	2	93.8	87.5
Sulfate	None	2	1480	1057
TDS	None	2	2600	1885
Alkalinity	None	2	312	258
pH	None	2	7.53	7.48

[a]Source concentrations determined from one sample each from lysimeters RFO-738 and 739 in December 1988.

below and downgradient (west) of the tailings (Figure E.2.15). The contamination extends westward to a distance of approximately 200 feet, where weathered Wasatch Formation claystone pinches out much of the alluvium, diverting contaminated groundwater into the Colorado River and considerably reducing the contamination downgradient from that point. The lateral extent of contamination in the alluvium is limited by the Wasatch Formation claystone to the north and the Colorado River to the south.

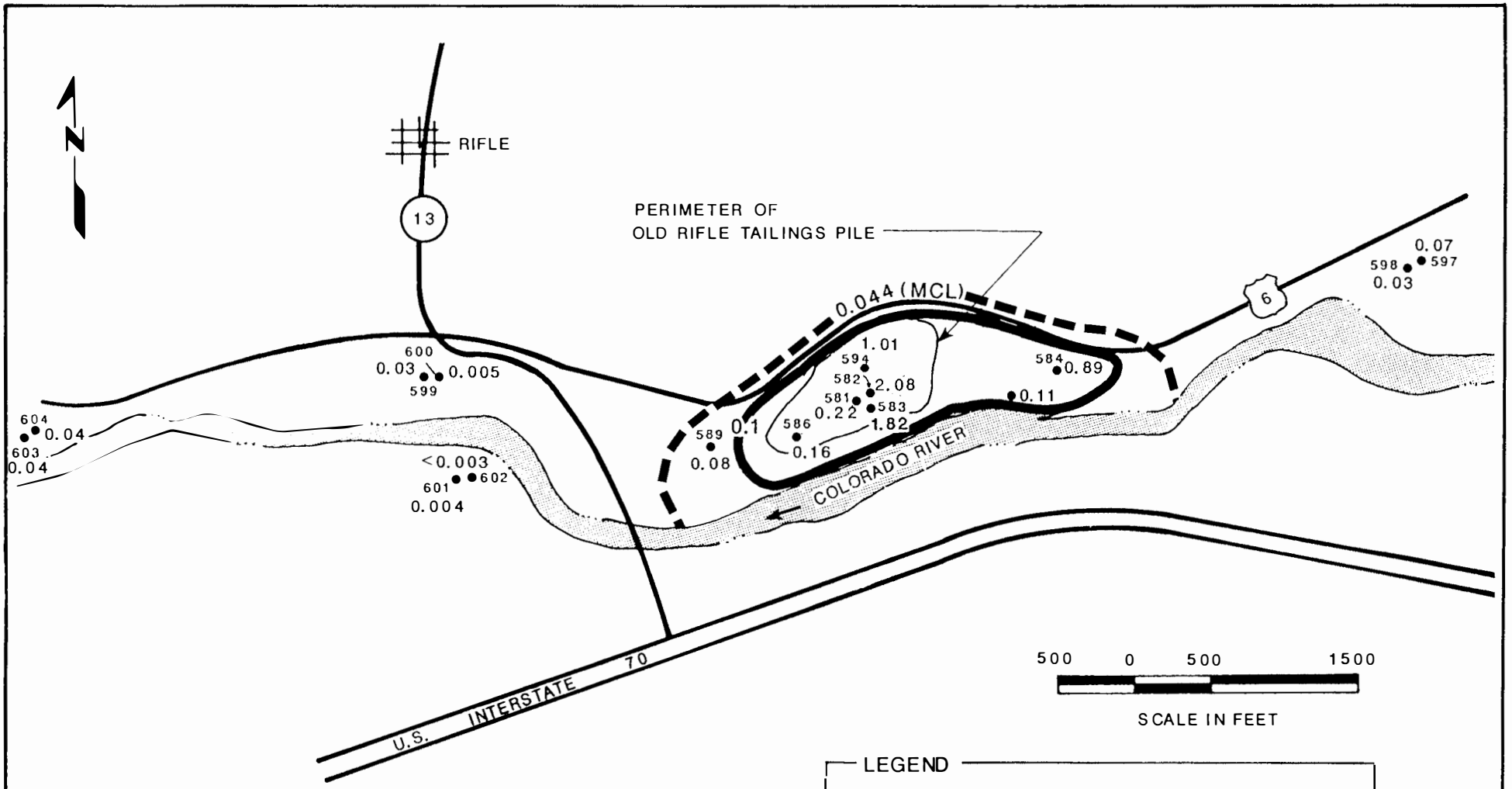
Uranium concentrations in groundwater within the alluvium exceed the proposed EPA MCLs by an order of magnitude, and provide a good indication of the extent and magnitude of contamination. Figure E.2.15 shows the distribution of the uranium concentrations and the uranium isopleths in the alluvial groundwater at the Old Rifle site. Other contaminant concentrations are highly variable and were not contoured.

Background and downgradient water quality for the alluvial monitor wells at the Old Rifle site is summarized in Table E.2.7. Tailings seepage has resulted in degradation of groundwater quality, and maximum concentrations of several constituents in the alluvium exceed background concentrations and the proposed EPA MCLs (Table E.2.7). Concentrations of arsenic, molybdenum, selenium, uranium and activities of gross alpha and radium-226 and -228 combined exceed the proposed EPA groundwater MCLs. Tailings seepage has also resulted in concentrations of the Appendix IX constituents, sulfide and vanadium, which are elevated above background in the alluvium at the Old Rifle site.

The degree of contamination in alluvial monitor wells at the Old Rifle site is shown on the bivariate plot of calcium and sulfate in alluvial groundwater samples (Figure E.2.16). In general, groundwater from the contaminated wells contained higher concentrations of calcium and sulfate than groundwater from the background monitor wells. A trilinear diagram of alluvial groundwater samples (Figure E.2.13) indicates that higher percentages of sulfate occur in contaminated alluvial groundwater and that higher percentages of carbonate and bicarbonate occur in uncontaminated alluvial groundwater.

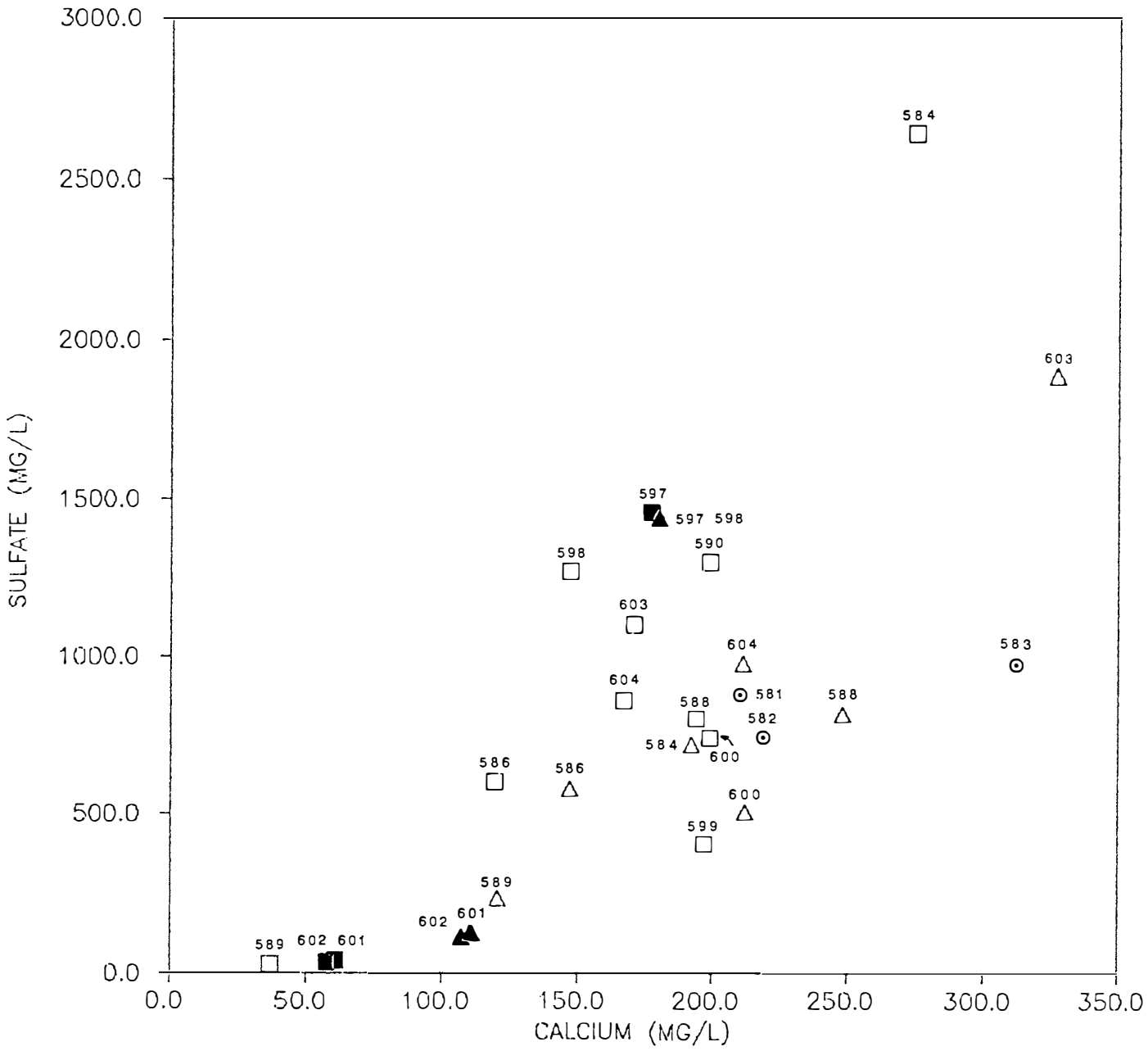
Wasatch Formation

Groundwater quality in the Wasatch Formation at the Old Rifle site has also been affected by the uranium milling activities. Contamination occurs to a depth of at least 100 feet. The lateral extent of contamination is believed to be less than in the alluvium due to the lower hydraulic conductivity of the formation and the upward potentiometric



F-120

FIGURE E.2.15
URANIUM CONCENTRATIONS IN ALLUVIAL GROUNDWATER, OLD RIFLE SITE



LEGEND

- □ ONSITE AND DOWNGRADIENT WELLS 6/85
- △ ON SITE AND DOWN GRADIENT WELLS 12/85
- ■ BACKGROUND WELLS 6/85
- ▲ BACKGROUND WELLS 12/85
- ⊙ WELLS COMPLETED THROUGH THE TAILINGS

FIGURE E.2.16
BIVARIATE PLOT OF CALCIUM AND SULFATE CONCENTRATIONS IN ALLUVIAL GROUNDWATER, OLD RIFLE SITE

gradients that occur in the vicinity of the site. However, seasonal drainage from a culvert north of the tailings pile has generated a localized groundwater mound, creating a vertical hydraulic potential for contaminants in the alluvium to migrate into the Wasatch Formation. This contamination is limited to areas where the overlying alluvium is contaminated and where downward potentiometric gradients occur.

Water quality analyses for all monitor wells at the Old Rifle site are presented in Table E.2.6, and water quality for the groundwater within the Wasatch Formation at the Old Rifle site is summarized in Table E.2.18. Maximum concentrations of several constituents in the Wasatch Formation downgradient of the tailings exceed background concentrations and the proposed EPA groundwater protection standards (Table E.2.18). Downgradient concentrations of barium, cadmium, and selenium and activities of gross alpha and radium-226 and -228 combined exceed the proposed EPA groundwater protection standards and downgradient concentrations of the Appendix IX constituents antimony, tin, vanadium and zinc are elevated above background concentrations in the Wasatch Formation.

Onsite monitor wells 623 and 624 are contaminated, as indicated by the bivariate plot of sulfate and uranium for groundwater samples from the Wasatch Formation (Figure E.2.17). Background monitor well 620 also contains elevated concentrations of sulfate and uranium, and does not plot near the other background wells on Figure E.2.16. These elevated concentrations in monitor well 620 may reflect geochemical processes occurring due to activities at the upgradient gravel pit. Monitor well 644, located 2000 feet west of the Old Rifle tailings across the Colorado River, contains concentrations of barium, cadmium and activities of gross alpha and radium-226 and -228 combined exceeding the proposed EPA groundwater MCLs (Table E.2.8). However, this well is not contaminated, as groundwater samples from this monitor well plot on the bivariate plot of Figure E.2.16 within the range of background wells. The high concentrations of these constituents in this monitor well reflect the naturally poor quality of groundwater from the Wasatch Formation. Although monitor well 644 is not contaminated, it was not used as a background well because it is downgradient from the tailings.

Aquifer flushing

Alluvium

Preliminary calculations were conducted to estimate the natural flushing period for geochemically conservative contaminants (such as nitrate and sulfate) in the alluvium at the Old Rifle site. The length of time required to flush one pore

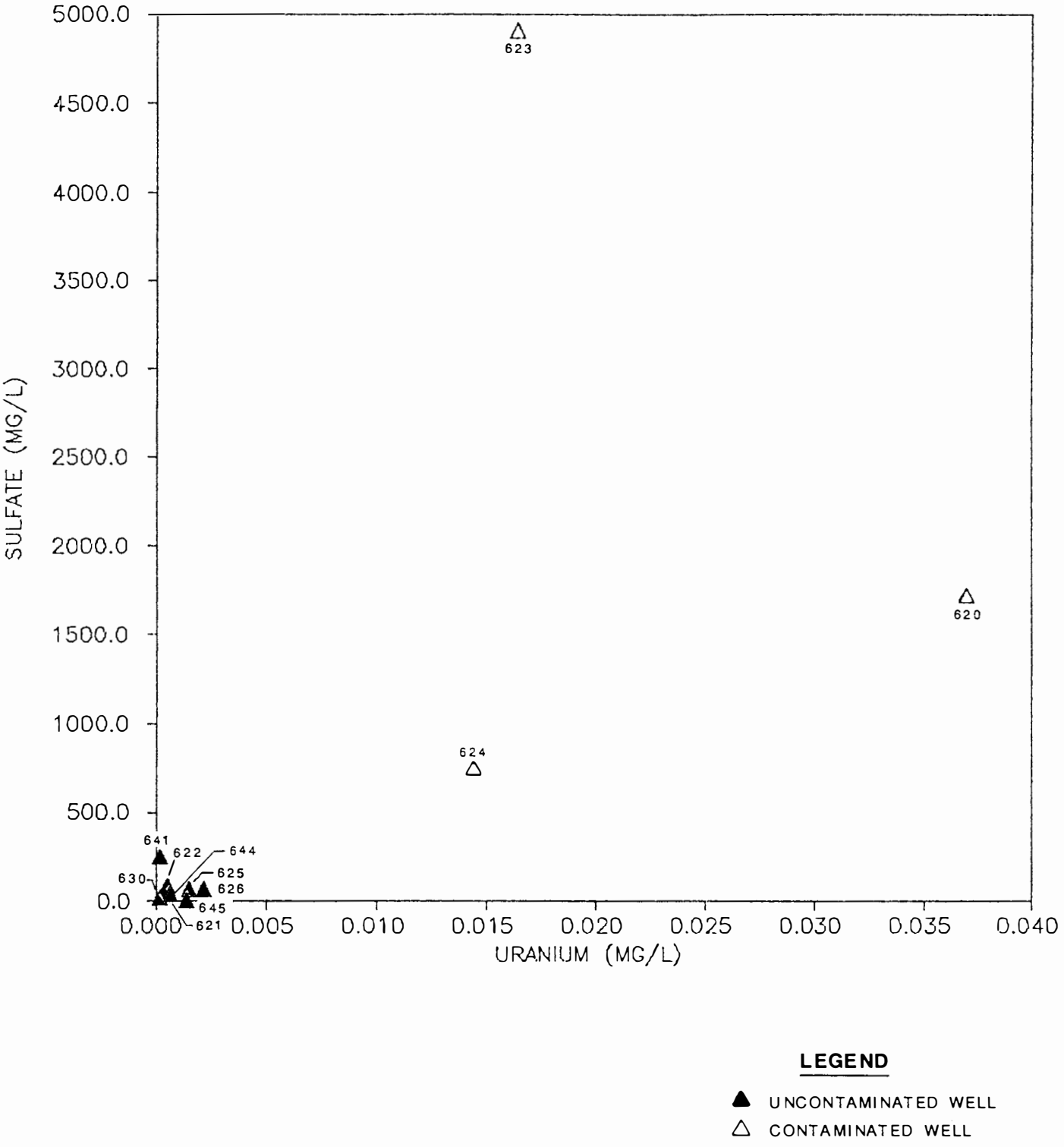


FIGURE E.2.17
BIVARIATE PLOT OF SULFATE AND URANIUM CONCENTRATIONS IN WASATCH FORMATION GROUNDWATER, OLD RIFLE SITE

volume from the upgradient edge of the tailings to the discharge zone along the Colorado River (the maximum flowpath distance) was calculated using the following simple relationship between average linear groundwater velocity in the alluvium and the flowpath distance:

$$Tf = L / V$$

where

Tf = flushing time for one pore volume (years)
L = the maximum flowpath distance from the upgradient edge of the tailings to the discharge zone along the Colorado River.
V = the average linear groundwater velocity (ft/year)

This simple relationship is based on the assumptions that the contaminants are geochemically conservative (such as sulfate and nitrate), that the source of contaminants is removed instantaneously; and that dispersion is negligible.

The natural flushing period for geochemically conservative species in groundwater within the alluvium at the Old Rifle site was estimated to be less than 10 years. Thus, it is reasonable to conclude that conservative contaminant species in the alluvium will flush to background concentrations within 10 years after the tailings have been removed, and certainly within 100 years after the tailings have been removed.

The length of time for natural flushing to remove geochemically non-conservative species (such as metals) cannot presently be determined. The information required to estimate the time for these species to disperse to background concentrations or to MCLs includes an additional and very detailed geochemical characterization. This more detailed data would be obtained during the separate characterization process that addresses Subpart B of 40 CFR 192. However, it is reasonable to assume that the required flushing times for geochemically less-conservative species in the alluvium at the Old Rifle site may be considerably greater than 10 years.

Wasatch Formation

Because the hydraulic conductivity of the Wasatch Formation is significantly lower than that of the alluvium, natural flushing of contaminants in the Wasatch Formation would be negligible compared to natural flushing in the alluvium. Therefore, little or no natural flushing is predicted to occur in the Wasatch Formation within 100 years at the Old Rifle site.

Appendix IX organic contaminants

Limited sampling for organic contaminants has been done at the Old Rifle site. Analyses for EPA priority pollutant organics were conducted on samples from on-site monitor wells 581 and 586 in 1986, and analyses for EPA Appendix IX organic constituents were conducted on samples from on-site monitor wells 581 and 583 and from background well 601 in 1988.

The solvent acetone was detected in monitor well 581 at a concentration of 41 parts per billion (ppb). The solvent toluene was detected in monitor well 586 at a concentration of nine ppb. The compound alpha-BHC was detected in monitor well 581 at 0.23 ppb. Although these chemicals were not used in the actual milling process at the Old Rifle site, they may have been used onsite while the mill was in operation.

E.2.3.5 New Rifle site

Groundwater flow and hydraulic parameters

The alluvium at the New Rifle site is 25 to 30 feet thick, and depths to groundwater range from five to 10 feet. Groundwater levels fluctuate approximately five feet during the year (Table E.2.10), depending on the stage of the Colorado River. The alluvial potentiometric surface (Figures E.2.18 and E.2.19) does not extend into the tailings pile during high stage, as it does at the Old Rifle site, but remains two to three feet below the pile.

Groundwater flow in the alluvium at the New Rifle site is toward the west and southwest under a hydraulic gradient ranging from 0.002 to 0.006. The alluvium is recharged by the Colorado River east of the site, and groundwater flow generally parallels the river channel to eventually discharge into the river downgradient of the site. Seasonal flow in Pioneer Ditch north of the site (Figure E.2.18) may also recharge the alluvium, adding the slight southwesterly component of flow. There are downward potentiometric gradients between the alluvium and the Wasatch Formation (Figure E.2.20), and groundwater in the alluvium discharges into the formation.

Pumping tests performed by the DOE on ten alluvial monitor wells at the New Rifle site during 1983 and 1985 indicate that the hydraulic conductivity in the alluvium averages 70 ft/day (Table E.2.11). The average linear groundwater velocity was calculated to be 280 ft/yr using Darcy's Law, an average hydraulic conductivity of 70 ft/day, an effective porosity of 0.27, and an average hydraulic gradient of 0.003.

Table E.2.10 Groundwater levels in alluvial monitor wells, New Rifle site

Monitor well number[a]	Completion interval (depth in feet)	Groundwater level (feet above mean sea level)													
		11/09/82	01/12/83	02/10/83	02/23/83	06/06/83	06/14/83	06/21/83	09/19/83	09/26/83	10/01/83	01/16/84	01/18/84	01/24/84	06/25/85
581[b]	17.9 to 22.9	5255.40	--[d]	5256.70	5256.70	5258.10	5258.70	5258.80	5257.80	5257.70	5257.70	5257.30	5257.30	5257.20	5259.36
582[b]	7.3 to 11.3	--	5256.62	5256.82	5256.72	5258.12	5258.72	5258.92	5257.92	5257.82	5257.82	5257.42	5257.42	5257.32	--
583[b]	12.5 to 16.5	--	5256.70	5256.50	5256.50	5257.90	5258.50	5258.70	5257.60	5257.50	5257.50	5257.20	5257.20	5257.10	5259.59
584[b]	69.9 to 73.1	--	--	5257.10	5257.31	5258.51	5258.91	5259.11	5258.71	5258.61	5258.51	5258.11	5258.01	5257.81	--
585[b]	8.0 to 25.0	--	5266.59	5266.19	5266.59	5269.49	5270.29	5270.69	5267.59	5267.59	5267.39	5267.19	5267.19	5267.19	--
586[b]	56.7 to 60.7	--	--	--	5257.51	5258.81	5259.41	5259.51	5258.81	5258.71	5258.71	5258.21	5258.11	5258.11	--
587[b]	63.0 to 66.0	--	--	5260.94	5257.44	5258.64	5259.24	5259.44	5258.74	5258.64	5258.64	5258.14	5258.04	5258.04	--
588[b]	5.5 to 25.5	--	5258.83	5258.63	5258.63	5261.13	5261.43	5261.63	5259.56	5259.43	5259.33	5259.03	--	5258.83	5260.98
589[b]	7.0 to 22.0	--	5248.17	5248.27	5248.37	5250.07	5250.27	5250.37	5248.87	5248.57	5248.37	5248.77	--	5248.67	5251.96
590[b]	9.0 to 23.0	--	5251.67	5251.67	--	5252.97	5253.47	5253.67	5252.87	5252.67	5252.67	5252.27	--	5252.27	--
591[c]	8.3 to 13.3	--	--	--	--	--	--	--	--	--	--	--	--	--	5269.69
592[c]	16.8 to 21.8	--	--	--	--	--	--	--	--	--	--	--	--	--	5269.63
593[c]	12.3 to 17.3	--	--	--	--	--	--	--	--	--	--	--	--	--	5265.58
594[c]	18.0 to 23.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5264.37
595[c]	8.07 to 23.07	--	--	--	--	--	--	--	--	--	--	--	--	--	5259.14
596[c]	8.0 to 13.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5250.09
598[c]	6.5 to 11.5	--	--	--	--	--	--	--	--	--	--	--	--	--	5253.49
599[c]	12.0 to 17.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5253.52
600[c]	12.0 to 17.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5255.42
601[c]	7.32 to 12.32	--	--	--	--	--	--	--	--	--	--	--	--	--	5255.50
602[c]	6.4 to 11.4	--	--	--	--	--	--	--	--	--	--	--	--	--	5245.99
603[c]	18.4 to 23.4	--	--	--	--	--	--	--	--	--	--	--	--	--	5245.82
604[c]	6.6 to 11.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--
605[c]	20.0 to 25.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5239.23
608[c]	9.7 to 29.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
609[c]	8.2 to 23.2	--	--	--	--	--	--	--	--	--	--	--	--	--	5252.67
610[c]	5.0 to 35.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5261.46
615[c]	9.0 to 29.0	--	--	--	--	--	--	--	--	--	--	--	--	--	5262.99
616[c]	10.2 to 20.2	--	--	--	--	--	--	--	--	--	--	--	--	--	5259.37
618[c]	18.5 to 23.5	--	--	--	--	--	--	--	--	--	--	--	--	--	5250.04
619[c]	8.57 to 13.57	--	--	--	--	--	--	--	--	--	--	--	--	--	5258.90

[a]Monitor well locations are shown on Figure E.2.2.
[b]Well casing diameter is four inches.
[c]Well casing diameter is two inches.
[d]Means no water level for this date.

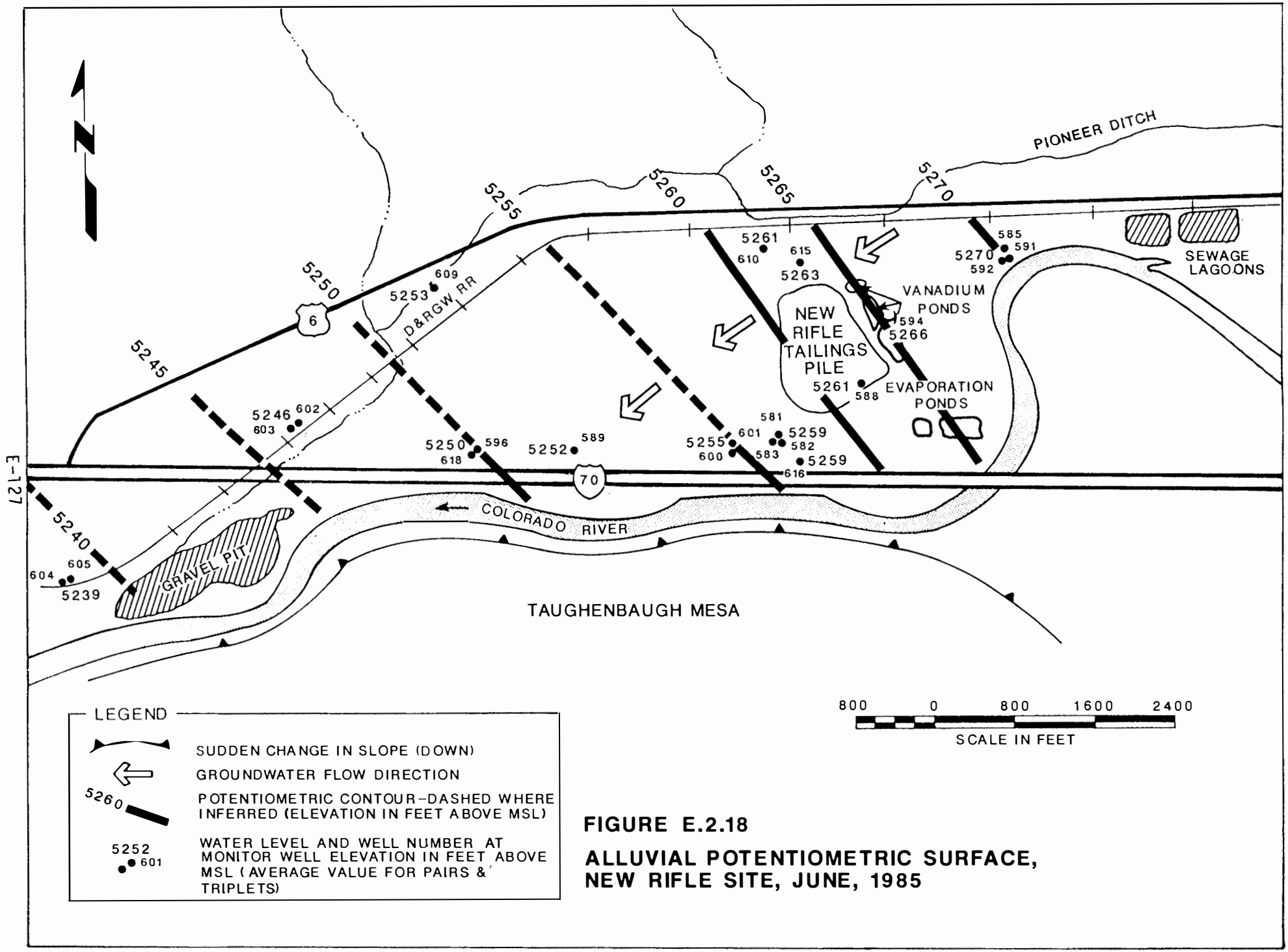


FIGURE E.2.18

ALLUVIAL POTENTIOMETRIC SURFACE, NEW RIFLE SITE, JUNE, 1985

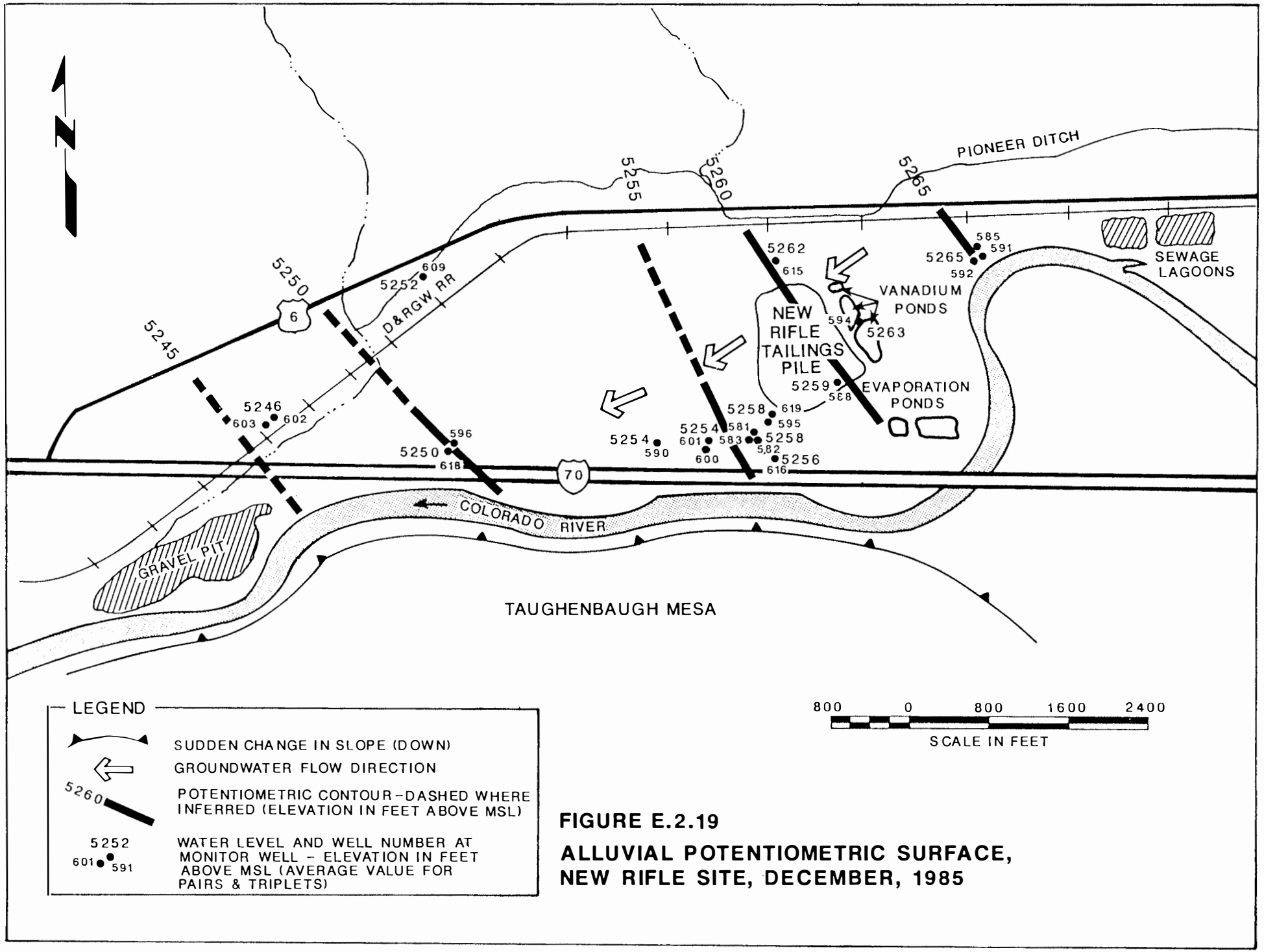


FIGURE E.2.19

ALLUVIAL POTENTIOMETRIC SURFACE, NEW RIFLE SITE, DECEMBER, 1985

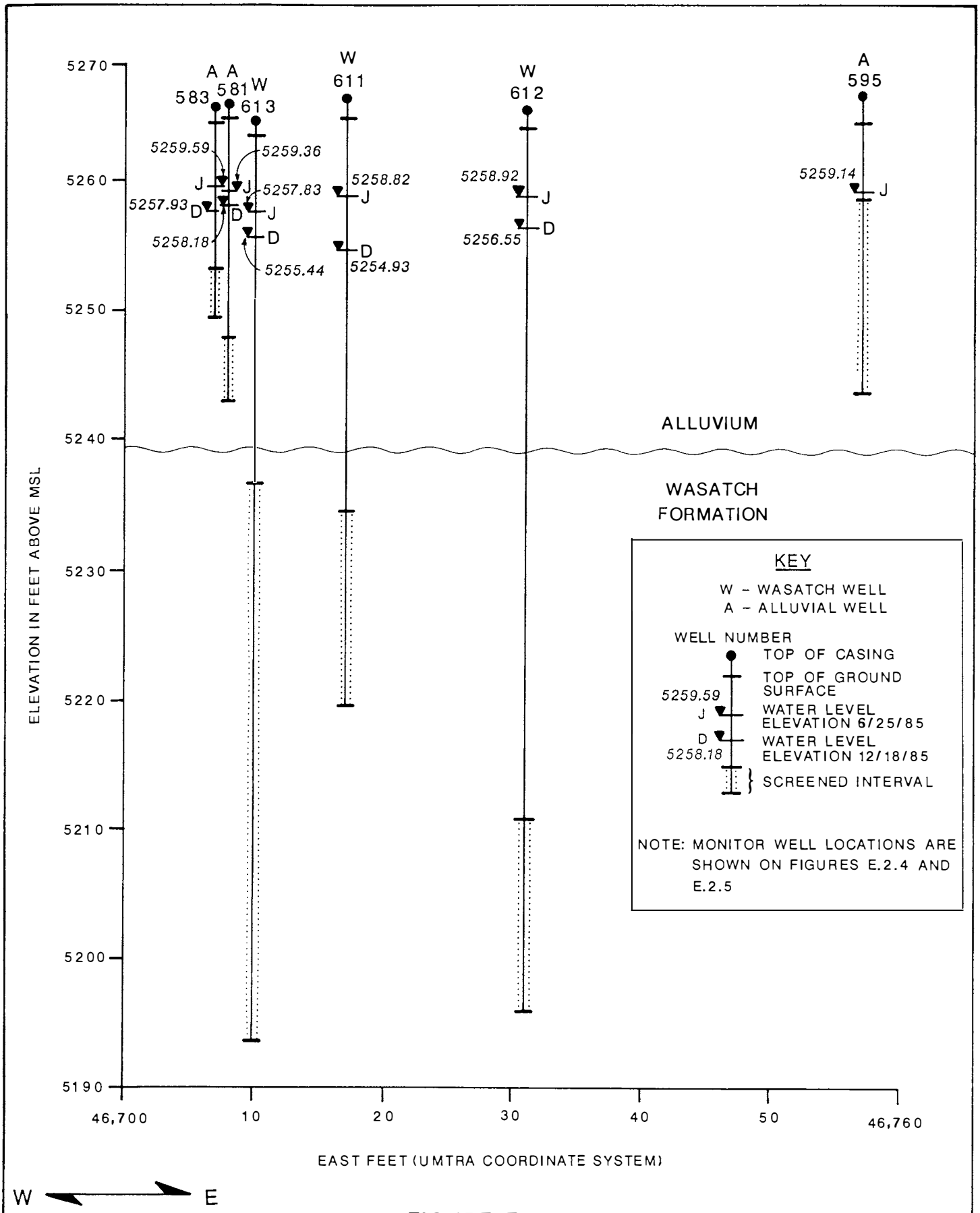


FIGURE E.2.20
WATER LEVEL DIFFERENCES
BETWEEN ALLUVIUM AND WASATCH FORMATION, NEW RIFLE SITE

Table E.2.11 Hydraulic conductivity for the alluvial aquifer, New Rifle site

Monitor well number[a]	Analytical method	Hydraulic conductivity (ft/day)
581	Transient[b]	102[b]
582	Theis[c]	85[c]
583	Transient[b]	70.9[b]
583	Theis[c]	139[c]
584	Transient[b]	82.2[b]
585	Transient[b]	14.5[b]
587	Transient[b]	19.8[b]
588	Transient[b]	70.9[b]
589	Transient[b]	150[b]
590	Transient[b]	145[b]
	Geometric mean = 70 ft/day	

[a]Monitor well locations are shown on Figure E.2.4.
[b]Ref. DOE, 1983. Hydraulic conductivities are based on aquifer tests conducted by the DOE in 1983.
[c]Ref. Davis and DeWeist, 1966. Hydraulic conductivities are based on aquifer tests conducted by the DOE in 1985.

Groundwater flow in the Wasatch Formation at the New Rifle site is to the southwest (Figure E.2.21), paralleling flow in the alluvium. Table E.2.12 presents groundwater levels in monitor wells completed in the Wasatch Formation. The Wasatch Formation is hydraulically connected to the alluvium although potentiometric levels are lower than in the alluvium (Figure E.2.20); consequently, groundwater from the alluvium recharges the Wasatch Formation.

The Wasatch Formation at the New Rifle site contains more sandstone interbeds than at the Old River site and is therefore more transmissive to groundwater flow. Slug injection tests on 12 monitor wells in the Wasatch Formation at the New Rifle site yielded an average hydraulic conductivity of 0.46 ft/day (Table E.2.13). This is an order of magnitude greater than the average hydraulic conductivity measured at the Old River site and reflects the greater transmissivity of the underlying sandstone beds in the Wasatch Formation at the New Rifle site. The average linear groundwater velocity was calculated for the formation using Darcy's equation (Freeze and Cherry, 1979). Based on a mean hydraulic conductivity of 0.46 ft/day, an effective porosity of 0.15, and a hydraulic gradient of 0.003, the average linear velocity was calculated to be 3 ft/yr to the west.

Background water quality

Background water quality in the alluvium at the New Rifle site was defined using samples from New Rifle monitor wells 591 and 592 and RFO 603 and 604 (Figures E.2.2 and E.2.4). Water quality in the alluvium at the New Rifle site is summarized in Table E.2.15 and complete water quality analyses for all monitor wells at the New Rifle site are presented in Table E.2.14. Background concentrations of molybdenum, selenium, uranium, and gross alpha activity exceed the proposed EPA groundwater protection standards. Background water quality in the alluvium at the New Rifle site is a calcium sulfate type of water (Figure E.2.22).

Background water quality in the Wasatch Formation at the New Rifle site was determined using water quality analyses from monitor wells 640, 641, 644, 645, 646, and 647. Monitor wells 640 and 641 are north of U.S. Highway 6, crossgradient to the site. Monitor wells 644 and 645 are across the Colorado River southeast of (crossgradient to) the site, and monitor wells 646 and 647 are located 0.5 mile east (upgradient) of the site.

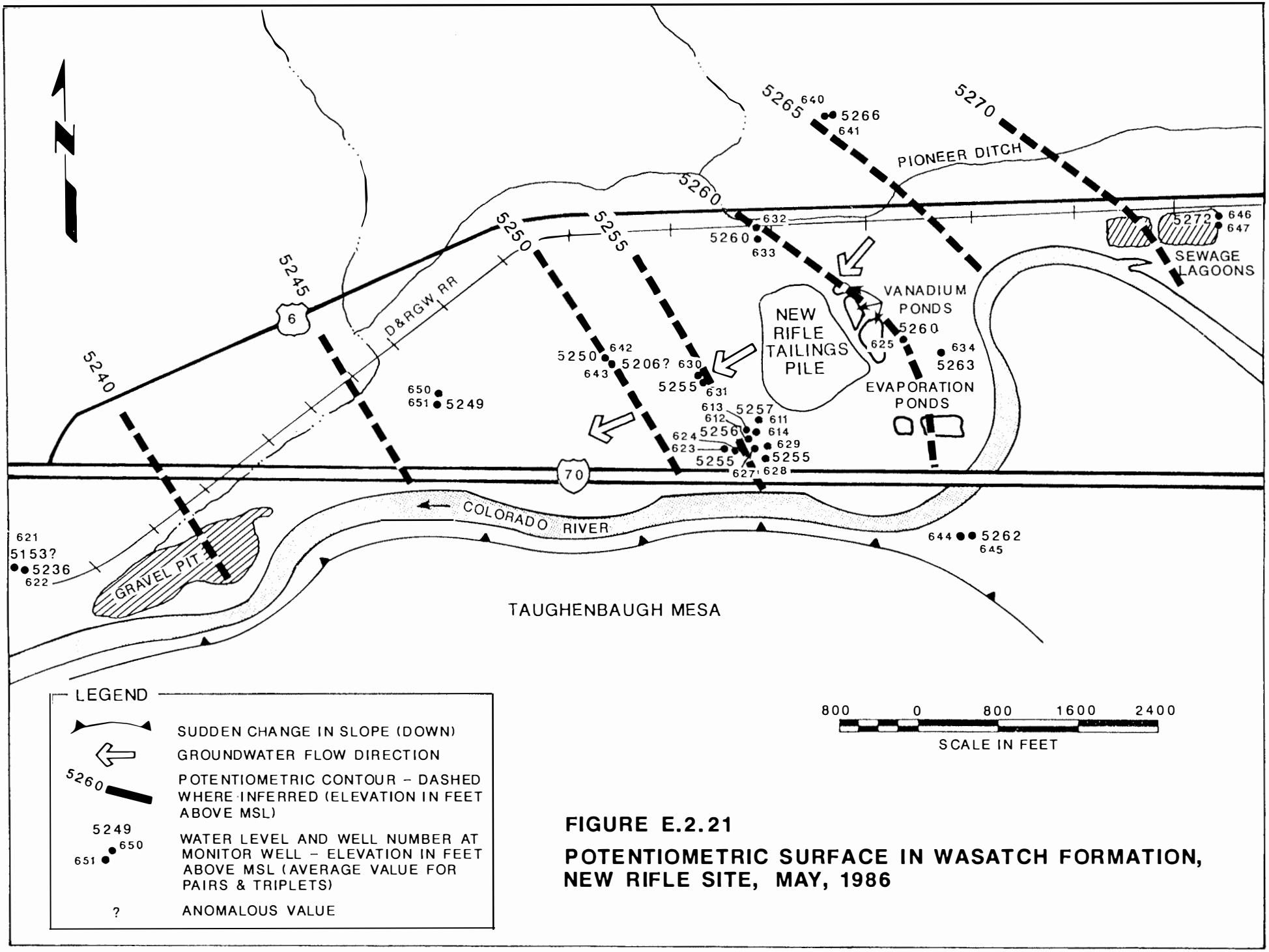


FIGURE E.2.21

POTENTIOMETRIC SURFACE IN WASATCH FORMATION, NEW RIFLE SITE, MAY, 1986

Table E.2.12 Groundwater levels in Wasatch Formation monitor wells, New Rifle site

Monitor well number[a]	Completion interval (depth in ft)	Groundwater level (feet above mean sea level)[f] 06/24/85	11/21/85	12/17/85	01/14/86	Maximum water level fluctuation (feet)[f]
611[b]	31.8 to 46.8	5258.82	--	5254.93	--	3.89
612[b]	54.48 to 69.48	5258.92	--	5256.55	--	2.37
613[b]	28.0 to 71.0	5257.83	--	5255.94	--	1.89
614[b]	3.75 to 33.75	5255.03	--	--	--	--
621[c,e]	99.5 to 119.0	--	--	--	--	--
622[b]	54.5 to 59.5	--	--	--	5234.76	--
623[d]	46.5 to 66.5	--	5251.30	--	--	--
624[b]	29.0 to 39.0	--	5254.36	--	--	--
625[d]	91.5 to 101.5	--	5216.19	--	--	--
626[b,e]	67.5 to 77.5	--	--	--	--	--
627[d]	67.1 to 86.5	--	5252.95	--	--	--
628[d]	93.5 to 113.5	--	--	5253.27	--	--
629[b]	45.0 to 55.0	--	--	5254.92	--	--
630[d]	69.5 to 89.5	--	--	--	5254.72	--
631[b]	47.5 to 57.5	--	--	--	5256.43	--
632[d]	86.5 to 96.5	--	--	--	5259.71	--
633[b]	63.5 to 73.5	--	--	--	5260.53	--
634[b]	41.5 to 51.5	--	--	--	5261.76	--
640[d]	132.7 to 152.7	--	--	--	5242.62	--
641[b]	72.0 to 82.0	--	--	--	5238.09	--
642[d]	73.5 to 93.5	--	--	--	5198.78	--
643[b]	60.5 to 70.5	--	--	--	5261.97	--
644[d]	86.5 to 96.5	--	--	--	5261.81	--
645[b]	61.5 to 71.5	--	--	--	5270.65	--
646[d]	121.5 to 141.5	--	--	--	5272.84	--
647[d]	59.5 to 74.5	--	--	--	5242.91	--
650[d]	84.0 to 94.0	--	--	--	5243.42	--
651[b,e]	55.0 to 65.0	--	--	--	--	--

[a]Monitor well locations are shown on Figure E.2.5.
[b]Well casing diameter is two inches.
[c]Well casing diameter is six inches.
[d]Well casing diameter is four inches.
[e]Well is dry.
[f] -- = No water level for this date.

Table E.2.13 Hydraulic conductivity for the Wasatch Formation, New Rifle site

Monitor well number[a]	Hydraulic conductivity[b] (ft/day)
611	0.83[c]
611	2.10[d]
612	0.42
624	0.62
627	0.13
629	1.20
632	0.06
634	10.0
644	0.02
645	0.69
646	0.17
647	0.83
Geometric mean = 0.46 ft/day	

[a]Monitor well locations are shown on Figure E.2.5.
[b]Hydraulic conductivities were determined using the Skibitzke method (Skibitzke, 1963).
[c]Hydraulic conductivity is based on a slug injection test conducted by the DOE June 29, 1985.
[d]Hydraulic conductivity is based on a slug injection test conducted by the DOE January 12, 1986.

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		581-01 06/26/85		581-01 12/17/85		581-01 10/27/87		581-01 12/10/88		582-01 02/15/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	1598.00		1461.		1010.		861.		402.00	
ALUMINUM	MG/L	0.10		0.7		0.23		0.2		-	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	4300.		1800.		2750.		-		-	
ANTIMONY	MG/L	< 0.003		-		-		0.174		-	
ARSENIC	MG/L	< 0.01		< 0.01		0.018		< 0.01		1.50	
BARIUM	MG/L	< 0.1		-		0.02		< 0.01		0.04	
BERYLLIUM	MG/L	-		-		-		< 0.01		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		0.5		-		-	
CADMIUM	MG/L	< 0.001		-		< 0.005		0.068		-	
CALCIUM	MG/L	451.		403.		393.		327.		442.00	
CHLORIDE	MG/L	1060.00		860.		710.		600.		340.00	
CHROMIUM	MG/L	< 0.01		-		< 0.01		0.12	<	0.001	
COBALT	MG/L	0.12		-		-		0.05	<	0.001	
COND,IN-SITU	UMHO/CM	-		-		-		-		5400.00	
CONDUCTANCE	UMHO/CM	29000.00		22500.		26000.		12500.		-	
COPPER	MG/L	< 0.02		-		-		< 0.02		0.0174	
CYANIDE	MG/L	-		-		-		< 0.01		-	
FLUORIDE	MG/L	6.10		-		7.80		-		-	
GROSS ALPHA	PCI/L	< 2.00		200.	150.	-		-		-	
GROSS BETA	PCI/L	102.00	15.00	270.	70.	-		-		-	
IRON	MG/L	67.00		39.8		36.3		27.3		19.70	
LEAD	MG/L	< 0.01		-		0.03		0.02		-	
MAGNESIUM	MG/L	231.		169.		112.		92.3		103.00	
MANGANESE	MG/L	53.90		19.6		13.1		10.0		9.38	
MERCURY	MG/L	-		-		-		< 0.0002		-	
MOLYBDENUM	MG/L	0.10		3.		2.78		3.01		2.88	
NICKEL	MG/L	0.20		-		-		0.10		-	
NITRATE	MG/L	0.4		20.		0.2		-		0.30	
NITRITE	MG/L	-		-		< 0.1		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		273.00	
NO2 & NO3	MG/L	0.1		-		-		-		-	
ORG. CARBON	MG/L	76.		-		-		-		115.00	
PB-210	PCI/L	< 1.50		2.	1.2	-		-		-	
PH	SU	7.00		7.16		7.0		7.20		7.50	
PHOSPHATE	MG/L	1.30		-		8.06		-		-	
PO-210	PCI/L	< 1.00		0.2	0.5	-		-		-	
POTASSIUM	MG/L	211.		165.		95.2		98.0		91.30	
RA-226	PCI/L	< 0.6		0.1	0.1	0.3	0.2	-		-	
RA-228	PCI/L	< 1.00		2.8	1.4	1.3	0.9	-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.16		< 0.005		0.469		0.018		0.124	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	12.40		-		13.2		-		-	
SILVER	MG/L	< 0.01		-		-		0.02		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		581-01 06/26/85		581-01 12/17/85		581-01 10/27/87		581-01 12/10/88		582-01 02/15/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY
SODIUM	MG/L	9500.00		5790.		6050.		3770.		1420.00	
STRONTIUM	MG/L	5.30		-		-		2.4		-	
SULFATE	MG/L	29100.00		17700.		19500.		14500.		4600.00	
SULFIDE	MG/L	< 0.10		-		< 0.1		-		-	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		10.00	
TEMPERATURE	C - DEGREE	9.00		12.		12.0		11.0		-	
TH-230	PCT/L	3.40	1.40	0.	0.1	-		-		-	
THALLIUM	MG/L	-		-		-		0.02		-	
TIN	MG/L	0.119		-		-		0.047		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	42050.00		27100.		30100.		-		6640.00	
TOTAL U	PPM	-		-		-		-		0.969	
URANIUM	MG/L	0.608		-		0.123		0.0602		-	
VANADIUM	MG/L	0.61		0.76		0.35		0.34		0.14	
ZINC	MG/L	2.5		-		0.411		0.265		0.04	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		582-01 06/14/83	583-01 02/10/83	583-01 06/14/83	583-01 06/26/85	583-01 12/18/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	420.00	667.00	880.00	1098.00	643.
ALUMINUM	MG/L	-	-	-	0.20	0.5
AMMONIA	MG/L	350.90	-	1240.00	-	-
AMMONIUM	MG/L	-	-	-	1950.	730.
ANTIMONY	MG/L	-	-	-	< 0.003	-
ARSENIC	MG/L	0.98	0.006	< 0.001	< 0.01	< 0.01
BARIUM	MG/L	0.078	< 0.004	0.057	< 0.10	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	< 0.001	-
CALCIUM	MG/L	580.00	420.00	570.00	433.	388.
CHLORIDE	MG/L	320.00	451.00	4.00	960.00	850.
CHROMIUM	MG/L	0.016	< 0.001	0.09	< 0.01	-
COBALT	MG/L	0.052	0.006	0.16	0.07	-
COND,IN-SITU	UMHO/CM	5600.00	12900.00	21600.00	-	-
CONDUCTANCE	UMHO/CM	-	-	-	19000.00	11000.
COPPER	MG/L	0.034	0.0505	0.19	0.14	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	-	1.90	-
GROSS ALPHA	PCI/L	-	-	-	< 2.00	300. 80.
GROSS BETA	PCI/L	-	-	-	109.00 16.00	240. 40.
IRON	MG/L	17.80	0.33	0.20	17.40	7.36
LEAD	MG/L	-	-	-	< 0.01	-
MAGNESIUM	MG/L	120.00	129.00	140.00	187.	156.
MANGANESE	MG/L	9.20	12.00	20.70	49.90	17.8
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	2.38	3.81	2.32	0.09	3.17
NICKEL	MG/L	-	-	-	0.08	-
NITRATE	MG/L	-	< 0.10	-	< 0.4	3.
NITRITE	MG/L	-	-	-	-	-
NITROGEN,KJL	MG/L	-	768.00	-	-	-
NO2 & NO3	MG/L	-	-	-	< 0.10	-
ORG. CARBON	MG/L	103.00	134.00	188.00	42.	-
PB-210	PCI/L	-	-	-	< 1.50	4.4 1.
PH	SU	6.90	7.70	7.40	6.90	7.21
PHOSPHATE	MG/L	-	-	-	0.90	-
PO-210	PCI/L	-	-	-	< 1.00	0.3 0.5
POTASSIUM	MG/L	98.00	131.00	180.00	150.	120.
RA-226	PCI/L	-	-	-	2.3 1.5	0.2 0.2
RA-228	PCI/L	-	-	-	< 1.00	0.6 0.9
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.002	0.016	< 0.002	0.071	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	9.80	-
SILVER	MG/L	-	-	-	< 0.01	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		582-01 06/14/83	583-01 02/10/83	583-01 06/14/83	583-01 06/26/85	583-01 12/18/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	1400.00	3670.00	6600.00	6000.00	2870.
STRONTIUM	MG/L	-	-	-	4.00	-
SULFATE	MG/L	4000.00	11600.00	16000.00	18900.00	8500.
SULFIDE	MG/L	-	-	-	< 0.10	-
TEMP,IN-SITU	C-DEGREE	11.00	10.00	17.00	-	-
TEMPERATURE	C - DEGREE	-	-	-	10.00	13.
TH-230	PCI/L	-	-	-	< 1.00	0.1 0.2
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	0.059	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	6410.00	15650.00	25400.00	28200.00	12800.
TOTAL U	PPM	0.434	0.184	0.389	-	-
URANIUM	MG/L	-	-	-	0.371	0.527
VANADIUM	MG/L	0.30	0.54	0.54	0.28	0.5
ZINC	MG/L	0.09	0.48	0.73	2.1	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		584-01 02/14/83	584-01 06/16/83	584-01 12/10/88	585-01 02/15/83	585-01 06/17/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	1880.00	110.00	1137.	469.00	430.00
ALUMINUM	MG/L	-	-	0.2	-	-
AMMONIA	MG/L	-	2057.00	-	-	3.509
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	0.140	-	-
ARSENIC	MG/L	0.02	< 0.005	< 0.01	0.001	< 0.001
BARIUM	MG/L	0.04	0.23	< 0.01	0.06	0.017
BERYLLIUM	MG/L	-	-	< 0.01	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	0.090	-	-
CALCIUM	MG/L	790.00	700.00	328.	160.00	170.00
CHLORIDE	MG/L	1270.00	1300.00	640.	60.00	< 2.00
CHROMIUM	MG/L	0.18	0.075	0.11	0.001	0.002
COBALT	MG/L	< 0.001	0.26	0.07	< 0.001	0.012
COND,IN-SITU	UMHO/CM	35900.00	42000.00	-	1490.00	1450.00
CONDUCTANCE	UMHO/CM	-	-	15000.	-	-
COPPER	MG/L	0.11	0.41	< 0.02	0.0009	0.004
CYANIDE	MG/L	-	-	< 0.01	-	-
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	97.00	45.10	13.1	0.032	0.031
LEAD	MG/L	-	-	0.02	-	-
MAGNESIUM	MG/L	190.00	220.00	75.6	122.00	120.00
MANGANESE	MG/L	27.00	24.70	11.6	0.19	0.39
MERCURY	MG/L	-	-	< 0.0002	-	-
MOLYBDENUM	MG/L	2.26	1.76	8.38	< 0.03	0.026
NICKEL	MG/L	-	-	0.21	-	-
NITRATE	MG/L	0.27	-	-	1.60	-
NITRITE	MG/L	-	-	-	-	-
NITROGEN,KJL	MG/L	3540.00	-	-	1.40	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	372.00	355.00	-	104.00	90.80
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.20	7.00	7.06	7.80	7.80
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	143.00	150.00	78.3	7.60	5.99
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.21	< 0.01	0.015	0.14	< 0.002
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	0.02	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		584-01 02/14/83	584-01 06/16/83	584-01 12/10/88	585-01 02/15/83	585-01 06/17/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	16400.00	15000.00	4790.	262.00	248.00
STRONTIUM	MG/L	-	-	2.3	-	-
SULFATE	MG/L	4800.00	39000.00	19100.	850.00	750.00
SULFIDE	MG/L	-	-	-	-	-
TEMP,IN-SITU	C-DEGREE	11.50	17.00	-	10.00	12.00
TEMPERATURE	C - DEGREE	-	-	10.0	-	-
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	0.02	-	-
TIN	MG/L	-	-	0.035	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	63800.00	58100.00	-	1770.00	2020.00
TOTAL U	PPM	0.386	0.314	-	0.049	0.063
URANIUM	MG/L	-	-	0.0629	-	-
VANADIUM	MG/L	0.35	0.71	0.69	< 0.002	0.035
ZINC	MG/L	0.17	0.07	0.028	0.04	0.04

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		585-01 10/26/87	586-01 02/22/83	586-01 06/16/83	587-01 02/14/83	587-01 06/16/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	523.	225.00	420.00	1100.00	1000.00
ALUMINUM	MG/L	0.10	-	-	-	-
AMMONIA	MG/L	-	-	423.50	-	2420.00
AMMONIUM	MG/L	< 0.1	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	0.004	0.26	0.025	0.03	< 0.005
BARIUM	MG/L	0.02	0.05	0.021	0.02	0.065
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	< 0.1	-	-	-	-
CADMIUM	MG/L	< 0.005	-	-	-	-
CALCIUM	MG/L	126.	467.00	600.00	697.00	660.00
CHLORIDE	MG/L	50.	350.00	430.00	780.00	120.00
CHROMIUM	MG/L	< 0.01	0.002	0.015	0.12	0.099
COBALT	MG/L	-	< 0.001	0.067	0.004	0.18
COND,IN-SITU	UMHO/CM	-	8000.00	7500.00	25000.00	28200.00
CONDUCTANCE	UMHO/CM	1750.	-	-	-	-
COPPER	MG/L	-	0.101	0.024	0.107	0.28
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	0.72	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.04	0.022	3.20	37.00	21.10
LEAD	MG/L	< 0.01	-	-	-	-
MAGNESIUM	MG/L	113.	117.00	110.00	137.00	160.00
MANGANESE	MG/L	0.65	1.74	14.10	22.00	21.80
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.14	3.68	1.57	2.31	1.73
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	9.4	< 0.10	-	0.16	-
NITRITE	MG/L	< 0.1	-	-	-	-
NITROGEN,KJL	MG/L	-	390.00	-	2190.00	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	72.80	103.00	226.00	250.00
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.0	8.40	7.50	7.40	7.30
PHOSPHATE	MG/L	5.61	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.99	98.40	5.93	148.00	6.75
RA-226	PCI/L	0.0 0.1	-	-	-	-
RA-228	PCI/L	0.3 1.0	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.022	0.04	< 0.002	< 0.02	< 0.01
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	20.9	-	-	-	-
SILVER	MG/L	-	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		585-01 10/26/87	586-01 02/22/83	586-01 06/16/83	587-01 02/14/83	587-01 06/16/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	265.	1960.00	150..00	9550.00	9200.00
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	728.	6800.00	4600.00	29400.00	22000.00
SULFIDE	MG/L	< 0.1	-	-	-	-
TEMP,IN-SITU	C-DEGREE	-	12.00	15.50	10.00	16.50
TEMPERATURE	C - DEGREE	13.5	-	-	-	-
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1650.	8600.00	6960.00	36220.00	33900.00
TOTAL U	PPM	-	0.09	0.108	0.216	0.24
URANIUM	MG/L	0.0343	-	-	-	-
VANADIUM	MG/L	0.03	0.12	3.40	0.42	0.56
ZINC	MG/L	< 0.005	0.02	0.08	0.14	0.08

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		587-01 12/10/88	588-01 02/15/83	588-01 06/17/83	588-01 06/26/85	588-01 12/16/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	804.	455.00	420.00	656.00	717.
ALUMINUM	MG/L	0.2	-	-	0.90	0.5
AMMONIA	MG/L	-	-	47.19	-	-
AMMONIUM	MG/L	-	-	-	2880.	3500.
ANTIMONY	MG/L	0.096	-	-	0.005	-
ARSENIC	MG/L	0.04	0.43	0.025	0.02	< 0.01
BARIUM	MG/L	< 0.01	0.05	0.027	0.20	-
BERYLLIUM	MG/L	< 0.01	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	-	-	-
CADMIUM	MG/L	0.046	-	-	0.002	< 0.001
CALCIUM	MG/L	332.	674.00	700.00	723.00	460.
CHLORIDE	MG/L	520.	450.00	29.00	550.00	640.
CHROMIUM	MG/L	0.11	< 0.001	0.019	0.02	-
COBALT	MG/L	< 0.05	0.016	0.05	0.09	-
COND.IN-SITU	UMHO/CM	-	7300.00	7200.00	-	-
CONDUCTANCE	UMHO/CM	12000.	-	-	20000.00	25000.
COPPER	MG/L	< 0.02	0.0166	0.044	< 0.02	-
CYANIDE	MG/L	< 0.01	-	-	-	-
FLUORIDE	MG/L	-	-	-	5.20	-
GROSS ALPHA	PCI/L	-	-	-	< 2.00	-
GROSS BETA	PCI/L	-	-	-	77.00 14.00	-
IRON	MG/L	17.2	5.35	3.07	15.60	7.85
LEAD	MG/L	0.02	-	-	< 0.01	-
MAGNESIUM	MG/L	68.7	39.40	41.00	154.00	83.
MANGANESE	MG/L	9.29	6.37	6.00	25.60	8.59
MERCURY	MG/L	< 0.0002	-	-	-	-
MOLYBDENUM	MG/L	3.84	1.00	1.40	0.71	13.4
NICKEL	MG/L	0.06	-	-	0.21	-
NITRATE	MG/L	-	0.50	-	< 0.4	< 1.
NITRITE	MG/L	-	-	-	-	-
NITROGEN,KJL	MG/L	-	44.00	-	-	-
NO2 & NO3	MG/L	-	-	-	< 0.10	-
ORG. CARBON	MG/L	-	74.20	115.00	54.00	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.11	7.40	7.10	6.90	7.36
PHOSPHATE	MG/L	-	-	-	0.20	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	64.5	51.70	4.54	190.00	171.
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.018	0.064	< 0.002	0.01	0.032
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	19.50	-
SILVER	MG/L	0.02	-	-	< 0.01	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		587-01 12/10/80	588-01 02/15/83	588-01 06/17/83	588-01 06/26/85	588-01 12/16/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	2820.	2230.00	190.00	6000.00	6300.
STRONTIUM	MG/L	2.9	-	-	5.60	-
SULFATE	MG/L	11000.	5760.00	4800.00	19600.00	22600.
SULFIDE	MG/L	-	-	-	< 0.10	-
TEMP,IN-SITU	C-DEGREE	-	11.00	15.00	-	-
TEMPERATURE	C - DEGREE	10.5	-	-	12.00	12.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	0.01	-	-	-	-
TIN	MG/L	0.034	-	-	0.075	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	8860.00	7910.00	27800.00	34900.
TOTAL U	PPM	-	0.046	0.043	-	-
URANIUM	MG/L	0.0004	-	-	0.018	0.0135
VANADIUM	MG/L	0.60	2.10	1.50	1.77	2.8
ZINC	MG/L	0.039	0.56	0.55	3.19	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		588-01 10/27/87		589-01 02/10/83		589-01 06/17/83		589-01 10/27/87		590-01 02/10/83	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	487.		1151.00		1000.00		1185.		1219.00	
ALUMINUM	MG/L	0.23		-		-		0.20		-	
AMMONIA	MG/L	-		-		2299.00		-		-	
AMMONIUM	MG/L	813.		-		-		2350.		-	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	0.132		0.01		< 0.005		0.007		0.008	
BARIUM	MG/L	0.02		0.05		0.025		0.03		0.04	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	< 0.1		-		-		< 0.1		-	
CADMIUM	MG/L	< 0.005		-		-		< 0.005		-	
CALCIUM	MG/L	409.		675.00		640.00		415.		702.00	
CHLORIDE	MG/L	220.		842.00		21.00		1150.		687.00	
CHROMIUM	MG/L	< 0.01		0.14		0.066		< 0.01		0.015	
COBALT	MG/L	-		< 0.001		0.17		-		0.006	
COND,IN-SITU	UMHO/CM	-		29400.00		31300.00		-		31800.00	
CONDUCTANCE	UMHO/CM	6870.		-		-		26300.		-	
COPPER	MG/L	-		0.10		0.26		-		0.26	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	6.33		-		-		0.97		-	
GROSS ALPHA	PCI/L	-		-		-		-		-	
GROSS BETA	PCI/L	-		-		-		-		-	
IRON	MG/L	2.18		0.27		0.15		0.10		0.30	
LEAD	MG/L	< 0.01		-		-		< 0.01		-	
MAGNESIUM	MG/L	29.8		324.00		400.00		229.		191.00	
MANGANESE	MG/L	2.79		12.00		11.80		8.30		20.00	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	3.35		1.02		0.56		2.58		4.40	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	< 0.1		200.00		-		1020.		6.60	
NITRITE	MG/L	< 0.1		-		-		< 0.1		-	
NITROGEN,KJL	MG/L	-		1840.00		-		-		1160.00	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		219.00		246.00		-		271.00	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.0		7.20		7.60		6.95		7.20	
PHOSPHATE	MG/L	2.73		-		-		8.89		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	28.0		549.00		500.00		188.		370.00	
RA-226	PCI/L	0.2	0.2	-		-		0.2	0.2	-	
RA-228	PCI/L	0.2	1.7	-		-		2.2	1.2	-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.108		0.41		< 0.01		0.625		0.15	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	17.4		-		-		12.2		-	
SILVER	MG/L	-		-		-		-		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		588-01 10/27/87	589-01 02/10/83	589-01 06/17/83	589-01 10/27/87	590-01 02/10/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	1185.	12000.00	12000.00	8130.	12200.00
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	5000.	34000.00	27000.00	21900.	35600.00
SULFIDE	MG/L	< 0.1	-	-	< 0.1	-
TEMP,IN-SITU	C-DEGREE	-	12.00	14.00	-	12.00
TEMPERATURE	C - DEGREE	14.3	-	-	12.8	-
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	7460.	44130.00	41500.00	32900.	48800.00
TOTAL U	PPM	-	1.037	0.823	-	0.69
URANIUM	MG/L	0.0441	-	-	0.241	-
VANADIUM	MG/L	0.70	0.026	0.076	0.05	1.40
ZINC	MG/L	0.065	0.09	0.15	< 0.005	1.70

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		590-01 06/17/83	590-01 12/18/85	590-01 10/27/87	591-01 06/26/85	591-01 12/12/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	1100.00	1350.	1500.	658.00	665.
ALUMINUM	MG/L	-	0.3	0.20	0.20	0.5
AMMONIA	MG/L	2299.00	-	-	-	-
AMMONIUM	MG/L	-	2300.	3650.	0.40	0.2
ANTIMONY	MG/L	-	-	-	< 0.003	-
ARSENIC	MG/L	< 0.005	< 0.01	0.008	< 0.01	< 0.01
BARIUM	MG/L	0.014	-	0.02	< 0.10	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	0.2	-	-
CADMIUM	MG/L	-	0.011	0.016	< 0.001	< 0.001
CALCIUM	MG/L	620.00	457.	417.	234.00	162.
CHLORIDE	MG/L	19.00	1300.	1180.	71.00	62.
CHROMIUM	MG/L	0.088	-	< 0.01	< 0.01	-
COBALT	MG/L	0.25	-	-	< 0.05	-
COND,IN-SITU	UMHO/CM	31900.00	-	-	1700.00	-
CONDUCTANCE	UMHO/CM	-	32000.	37000.	1750.00	1900.
COPPER	MG/L	0.23	-	-	< 0.02	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	4.61	3.50	-
GROSS ALPHA	PCI/L	-	-	-	50.00 22.00	-
GROSS BETA	PCI/L	-	-	-	36.00 12.00	-
IRON	MG/L	0.23	0.13	0.09	1.28	0.64
LEAD	MG/L	-	-	< 0.01	< 0.01	-
MAGNESIUM	MG/L	270.00	211.	192.	152.00	125.
MANGANESE	MG/L	17.00	18.8	10.4	5.12	1.64
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	4.53	3.	2.41	0.04	0.12
NICKEL	MG/L	-	-	-	< 0.04	-
NITRATE	MG/L	-	280.	45.0	21.30	< 1.
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	4.80	-
ORG. CARBON	MG/L	265.00	-	-	7.00	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.30	6.97	6.90	6.89	7.01
PHOSPHATE	MG/L	-	-	8.46	< 0.10	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	480.00	240.	141.	5.00	5.5
RA-226	PCI/L	-	-	0.4 0.2	-	-
RA-228	PCI/L	-	-	1.5 1.3	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.01	< 0.005	0.809	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	8.11	17.30	-
SILVER	MG/L	-	-	-	< 0.01	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		590-01 06/17/83	590-01 12/18/85	590-01 10/27/87	591-01 06/26/85	591-01 12/12/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	12000.00	10400.	11300.	290.00	322.
STRONTIUM	MG/L	-	-	-	2.70	-
SULFATE	MG/L	31000.00	26300.	32400.	900.00	940.
SULFIDE	MG/L	-	-	< 0.1	< 0.10	-
TEMP,IN-SITU	C-DEGREE	17.00	-	-	11.50	-
TEMPERATURE	C - DEGREE	-	10.	13.5	12.00	14.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	< 0.005	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	42900.00	40500.	45600.	2028.00	2070.
TOTAL U	PPM	0.299	-	-	-	-
URANIUM	MG/L	-	0.128	0.258	0.15	0.0769
VANADIUM	MG/L	1.10	3.2	1.03	< 0.01	0.51
ZINC	MG/L	1.22	-	0.909	0.1	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		591-01 10/26/87		592-01 06/26/85		592-01 12/16/85		592-01 10/26/87		592-01 12/10/88	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	562.		497.00		561.		549.		877.	
ALUMINUM	MG/L	0.09		1.20		0.3		0.11		0.1	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	< 0.1		0.30		0.8		< 0.1		-	
ANTIMONY	MG/L	-		< 0.003		-		-		0.022	
ARSENIC	MG/L	0.004		< 0.01		< 0.01		0.005		< 0.01	
BARIUM	MG/L	0.06		< 0.10		-		0.06		< 0.01	
BERYLLIUM	MG/L	-		-		-		-		< 0.01	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	< 0.1		-		-		< 0.1		-	
CADMIUM	MG/L	< 0.005		< 0.001		-		< 0.005		0.009	
CALCIUM	MG/L	148.		141.00		175.		140.		138.	
CHLORIDE	MG/L	50.		53.00		58.		50.		44.	
CHROMIUM	MG/L	< 0.01		< 0.01		-		< 0.01		0.08	
COBALT	MG/L	-		< 0.05		-		-		< 0.05	
COND,IN-SITU	UMHO/CM	-		1300.00		-		-		-	
CONDUCTANCE	UMHO/CM	1820.		1350.00		1850.		2250.		1500.	
COPPER	MG/L	-		< 0.02		-		-		0.02	
CYANIDE	MG/L	-		-		-		-		< 0.01	
FLUORIDE	MG/L	0.79		0.64		-		0.72		-	
GROSS ALPHA	PCI/L	-		20.00	15.00	40.	20.	-		-	
GROSS BETA	PCI/L	-		22.00	12.00	39.	8.	-		-	
IRON	MG/L	0.23		1.81		1.55		0.70		0.68	
LEAD	MG/L	< 0.01		< 0.01		-		< 0.01		< 0.01	
MAGNESIUM	MG/L	116.		130.00		137.		114.		111.	
MANGANESE	MG/L	0.70		1.02		0.89		0.78		0.82	
MERCURY	MG/L	-		-		-		-		< 0.0002	
MOLYBDENUM	MG/L	0.15		0.02		0.19		0.13		0.10	
NICKEL	MG/L	-		< 0.04		-		-		0.04	
NITRATE	MG/L	< 0.1		23.90		3.		< 0.1		-	
NITRITE	MG/L	< 0.1		-		-		< 0.1		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		5.40		-		-		-	
ORG. CARBON	MG/L	-		4.80		-		-		-	
PB-210	PCI/L	-		-		2.6	1.5	-		-	
PH	SU	7.1		6.93		7.31		7.05		7.32	
PHOSPHATE	MG/L	5.52		< 0.10		-		5.43		-	
PO-210	PCI/L	-		-		0.	0.4	-		-	
POTASSIUM	MG/L	3.90		6.00		5.4		3.80		4.4	
RA-226	PCI/L	0.2	0.2	-		0.4	0.2	0.2	0.2	-	
RA-228	PCI/L	1.0	1.5	-		0.	0.8	0.1	1.3	-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.018		< 0.005		< 0.005		0.019		0.022	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	18.7		16.50		-		16.9		-	
SILVER	MG/L	-		< 0.01		-		-		0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		591-01 10/26/87	592-01 06/26/85	592-01 12/16/85	592-01 10/26/87	592-01 12/10/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	281.	230.00	272.	334.	252.
STRONTIUM	MG/L	-	2.10	-	-	2.1
SULFATE	MG/L	819.	680.00	1000.	882.	884.
SULFIDE	MG/L	< 0.1	< 0.10	-	< 0.1	-
TEMP,IN-SITU	C-DEGREE	-	13.00	-	-	-
TEMPERATURE	C - DEGREE	14.1	11.00	12.	12.0	10.
TH-230	PCI/L	-	-	0. 0.1	-	-
THALLIUM	MG/L	-	-	-	-	< 0.01
TIN	MG/L	-	< 0.005	-	-	0.009
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1870.	1642.00	2080.	1910.	-
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0546	0.03	-	0.0437	0.0690
VANADIUM	MG/L	0.03	0.01	0.3	0.03	0.05
ZINC	MG/L	< 0.005	0.2	-	< 0.005	0.012

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		593-01 06/26/85		593-01 12/14/85		594-01 06/26/85		594-01 12/14/85		594-01 10/26/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	2068.00		1971.		1190.00		1014.		661.	
ALUMINUM	MG/L	1.40		0.6		0.90		0.5		0.27	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	8390.		6100.		3200.		1700.		1050.	
ANTIMONY	MG/L	< 0.003		-		< 0.003		-		-	
ARSENIC	MG/L	0.01		< 0.01		< 0.01		< 0.01		2.39	
BARIUM	MG/L	< 0.10		-		< 0.10		-		0.02	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		-		0.1	
CADMIUM	MG/L	< 0.001		0.03		< 0.001		< 0.001		0.011	
CALCIUM	MG/L	813.00		581.		632.00		594.		391.	
CHLORIDE	MG/L	1430.00		1400.		760.00		710.		270.	
CHROMIUM	MG/L	< 0.01		-		< 0.01		-		< 0.01	
COBALT	MG/L	0.67		-		0.22		-		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	35000.00		45000.		18000.00		22000.		11500.	
COPPER	MG/L	0.04		-		< 0.02		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	4.10		-		9.00		-		5.39	
GROSS ALPHA	PCI/L	62.00	41.00	-		< 2.00		-		-	
GROSS BETA	PCI/L	114.00	16.00	-		52.00	12.00	-		-	
IRON	MG/L	68.20		44.1		28.40		33.4		13.2	
LEAD	MG/L	0.06		-		0.04		-		< 0.01	
MAGNESIUM	MG/L	362.00		171.		132.00		147.		38.7	
MANGANESE	MG/L	51.10		18.9		19.60		11.9		3.76	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	9.80		12.7		4.30		6.56		4.14	
NICKEL	MG/L	1.43		-		0.40		-		-	
NITRATE	MG/L	0.90		< 1.		8.00		310.		< 0.1	
NITRITE	MG/L	-		-		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	0.50		-		1.80		-		-	
ORG. CARBON	MG/L	310.00		-		71.00		-		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	6.95		7.18		6.82		6.94		6.8	
PHOSPHATE	MG/L	3.70		-		0.40		-		3.93	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	190.00		205.		110.00		120.		38.2	
RA-226	PCI/L	-		-		-		-		0.0	0.2
RA-228	PCI/L	-		-		-		-		0.5	1.2
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.19		< 0.005		0.041		< 0.005		0.185	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	11.10		-		19.50		-		24.0	
SILVER	MG/L	< 0.01		-		< 0.01		-		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		593-01 06/26/85	593-01 12/14/85	594-01 06/26/85	594-01 12/14/85	594-01 10/26/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	14000.00	9120.	5300.00	6460.	2030.
STRONTIUM	MG/L	4.70	-	2.50	-	-
SULFATE	MG/L	40400.00	34000.	18100.00	18100.	7200.
SULFIDE	MG/L	< 0.10	-	0.4	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	14.00	15.	12.00	14.	13.5
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	0.105	-	0.06	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	54000.00	69300.	26450.00	26800.	10600.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.754	1.31	0.114	0.0233	0.0268
VANADIUM	MG/L	20.50	18.4	9.15	8.31	1.78
ZINC	MG/L	14.9	-	6.3	-	< 0.005

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		595-01 06/26/85		595-01 10/27/87		596-01 06/26/85		596-01 12/17/85		598-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	652.00		809.		660.00		578.		1715.00	
ALUMINUM	MG/L	0.80		0.26		< 0.10		0.4		< 0.10	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	990.		1830.		400.00		210.		310.00	
ANTIMONY	MG/L	0.003		-		0.005		-		< 0.003	
ARSENIC	MG/L	< 0.01		0.025		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	< 0.10		0.02		0.20		-		< 0.10	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		0.1		-		-		-	
CADMIUM	MG/L	0.001		0.005		< 0.001		-		< 0.001	
CALCIUM	MG/L	651.00		389.		451.		348.		370.	
CHLORIDE	MG/L	570.00		630.		760.00		670.		580.00	
CHROMIUM	MG/L	0.03		< 0.01		0.02		-		0.05	
COBALT	MG/L	0.05		-		< 0.05		-		< 0.05	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	10000.00		18800.		6000.00		8000.		9000.00	
COPPER	MG/L	< 0.02		-		< 0.02		-		0.01	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	3.10		6.53		0.34		-		0.98	
GROSS ALPHA	PCI/L	< 2.00		-		< 2.		190.	80.	88.	21.
GROSS BETA	PCI/L	67.00	13.00	-		84.	6.	220.	40.	140.00	7.
IRON	MG/L	1.03		3.37		2.13		0.03		15.40	
LEAD	MG/L	< 0.01		< 0.01		< 0.01		-		< 0.01	
MAGNESIUM	MG/L	138.00		111.		309.		287.		341.	
MANGANESE	MG/L	23.30		13.9		24.20		4.02		20.80	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	9.20		2.24		0.01		0.2		0.04	
NICKEL	MG/L	0.06		-		< 0.04		-		0.04	
NITRATE	MG/L	19.00		< 0.1		253.		920.		2.2	
NITRITE	MG/L	-		< 0.1		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	4.40		-		62.00		-		0.8	
ORG. CARBON	MG/L	25.00		-		16.00		-		66.00	
PB-210	PCI/L	< 1.50		-		-		3.3	1.3	-	
PH	SU	6.80		6.79		7.14		7.05		7.13	
PHOSPHATE	MG/L	0.70		6.93		< 0.10		-		0.30	
PO-210	PCI/L	< 1.00		-		-		0.1	0.5	-	
POTASSIUM	MG/L	100.00		110.		100.00		110.		150.00	
RA-226	PCI/L	4.90	2.40	0.3	0.2	-		0.4	0.2	-	
RA-228	PCI/L	< 1.00		0.9	1.1	-		0.	1.	-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.022		0.425		0.095		< 0.005		0.018	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	16.70		10.7		17.50		-		24.00	
SILVER	MG/L	< 0.01		-		< 0.01		-		< 0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		595-01 06/26/85	595-01 10/27/87	596-01 06/26/85	596-01 12/17/85	598-01 06/26/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	2800.00	5070.	2300.00	3000.	3400.00
STRONTIUM	MG/L	2.50	-	6.00	-	4.00
SULFATE	MG/L	9500.00	15700.	7590.00	6800.	8840.00
SULFIDE	MG/L	< 0.10	< 0.1	0.8	-	< 0.10
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.00	13.4	16.00	10.	15.00
TH-230	PCI/L	11.60 1.20	-	-	0. 0.1	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	0.177	-	0.039	-	0.021
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	13000.00	22800.	11106.	11100.	12610.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.29	0.408	0.014	-	0.665
VANADIUM	MG/L	1.12	0.22	< 0.01	0.44	0.05
ZINC	MG/L	1.24	0.539	0.50	-	0.1

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		598-01 12/16/85		599-01 06/26/85		599-01 12/13/85		599-01 10/28/87		600-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	816.		1053.00		832.		915.		788.00	
ALUMINUM	MG/L	0.4		< 0.10		0.2		0.21		0.10	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	320.		320.		490.		639.		1380.00	
ANTIMONY	MG/L	-		< 0.003		-		-		< 0.003	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		0.005		< 0.01	
BARIUM	MG/L	-		< 0.10		-		0.03		0.10	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		< 0.1		-	
CADMIUM	MG/L	-		< 0.001		< 0.001		< 0.005		< 0.001	
CALCIUM	MG/L	442.		436.		42.4		486.		430.	
CHLORIDE	MG/L	850.		1290.00		850.		710.		610.00	
CHROMIUM	MG/L	-		0.25		-		< 0.01		0.01	
COBALT	MG/L	-		< 0.05		-		-		< 0.05	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	11000.		13500.00		14000.		14500.		11000.00	
COPPER	MG/L	-		0.03		-		-		< 0.02	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		0.72		-		0.82		1.90	
GROSS ALPHA	PCI/L	660.	160.	48.	47.00	-		-		< 2.	
GROSS BETA	PCI/L	520.	70.	158.	8.	-		-		74.	5.
IRON	MG/L	0.17		3.56		0.15		0.11		30.70	
LEAD	MG/L	-		< 0.01		-		< 0.01		< 0.01	
MAGNESIUM	MG/L	450.		523.		363.		206.		144.	
MANGANESE	MG/L	10.6		22.60		9.7		6.15		27.70	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.38		0.02		0.23		0.28		7.30	
NICKEL	MG/L	-		0.06		-		-		< 0.04	
NITRATE	MG/L	700.		177.		1.		4.5		15.5	
NITRITE	MG/L	-		-		-		< 0.1		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		46.00		-		-		4.90	
ORG. CARBON	MG/L	-		45.00		-		-		17.00	
PB-210	PCI/L	17.	2.	-		-		-		-	
PH	SU	7.58		7.05		7.08		6.9		7.00	
PHOSPHATE	MG/L	-		< 0.10		-		8.31		0.20	
PO-210	PCI/L	2.6	1.4	-		-		-		-	
POTASSIUM	MG/L	228.		280.00		340.		215.		200.00	
RA-226	PCI/L	0.1	0.3	-		-		0.1	0.2	-	
RA-228	PCI/L	0.	0.9	-		-		1.3	1.4	-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.041		< 0.005		0.295		0.02	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		15.60		-		14.4		10.50	
SILVER	MG/L	-		< 0.01		-		-		< 0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		598-01 12/16/85		599-01 06/26/85		599-01 12/13/85		599-01 10/28/87		600-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY
SODIUM	MG/L	5010.		5500.00		5500.		3630.		4300.00	
STRONTIUM	MG/L	-		10.40		-		-		2.50	
SULFATE	MG/L	12000.		14000.00		12600.		9740.		11600.00	
SULFIDE	MG/L	-		< 0.10		-		< 0.1		< 0.10	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	9.5		13.00		11.		15.0		12.00	
TH-230	PCI/L	0.	0.1	-		-		-		-	
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	-		0.095		-		-		0.125	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	19300.		21700.		19500.		15000.		16650.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	-		0.907		0.676		0.447		0.163	
VANADIUM	MG/L	0.45		< 0.01		0.42		0.05		1.70	
ZINC	MG/L	-		0.014		-		0.020		0.2	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		600-01 12/17/85		600-01 10/27/87		601-01 06/26/85		602-01 06/26/85		602-01 12/11/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	920.		897.		533.00		931.00		617.	
ALUMINUM	MG/L	0.4		0.21		0.30		0.90		0.4	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	1500.		1420.		340.		1.30		1.2	
ANTIMONY	MG/L	-		-		0.009		0.004		-	
ARSENIC	MG/L	< 0.01		0.047		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	-		0.02		< 0.10		< 0.10		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		< 0.1		-		-		-	
CADMIUM	MG/L	-		0.031		0.002		< 0.001		< 0.001	
CALCIUM	MG/L	406.		383.		537.		589.00		299.	
CHLORIDE	MG/L	790.		780.		450.00		200.00		120.	
CHROMIUM	MG/L	-		< 0.01		0.02		0.01		-	
COBALT	MG/L	-		-		< 0.05		< 0.05		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	18000.		19400.		6000.00		3100.00		2100.	
COPPER	MG/L	-		-		0.03		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		2.60		0.92		0.38		-	
GROSS ALPHA	PCI/L	120.	130.	-		< 2.00		31.00	29.00	-	
GROSS BETA	PCI/L	320.	70.	-		65.	5.	6.00	5.00	-	
IRON	MG/L	3.52		0.18		< 0.03		39.80		7.83	
LEAD	MG/L	-		< 0.01		< 0.01		0.02		-	
MAGNESIUM	MG/L	184.		153.		128.		190.00		124.	
MANGANESE	MG/L	15.4		12.0		22.20		7.04		2.56	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	4.08		2.83		8.00		0.01		0.1	
NICKEL	MG/L	-		-		< 0.04		< 0.04		-	
NITRATE	MG/L	1.		45.0		301.		< 0.4		3.	
NITRITE	MG/L	-		< 0.1		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		71.00		< 0.10		-	
ORG. CARBON	MG/L	-		-		17.00		18.00		-	
PB-210	PCI/L	3.6	1.3	-		-		-		-	
PH	SU	6.76		6.8		6.64		6.90		7.	
PHOSPHATE	MG/L	-		6.87		0.20		< 0.10		-	
PO-210	PCI/L	0.	0.5	-		-		-		-	
POTASSIUM	MG/L	209.		156.		120.00		16.00		8.9	
RA-226	PCI/L	0.4	0.2	0.4	0.2	-		-		-	
RA-228	PCI/L	0.	1.1	0.7	1.5	-		-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.421		0.14		0.007		< 0.005	
SILICON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		9.24		8.60		20.70		-	
SILVER	MG/L	-		-		< 0.01		< 0.01		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		600-01 12/17/85	600-01 10/27/87	601-01 06/26/85	602-01 06/26/85	602-01 12/11/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	5760.	5580.	1900.00	600.00	451.
STRONTIUM	MG/L	-	-	1.80	4.30	-
SULFATE	MG/L	16100.	15200.	5240.00	1890.00	1400.
SULFIDE	MG/L	-	< 0.1	< 0.10	1.2	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	15.8	14.00	9.00	10.
TH-230	PCI/L	0. 0.1	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	0.023	0.008	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	25000.	21500.	8740.	4040.00	3020.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	-	0.116	0.071	0.039	0.0265
VANADIUM	MG/L	0.43	0.29	6.74	0.03	0.25
ZINC	MG/L	-	0.840	0.3	0.2	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		603-01 06/26/85		603-01 12/11/85		603-02 12/11/85		603-03 12/11/85		603-04 12/11/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	781.00		608.		608.		608.		608.	
ALUMINUM	MG/L	< 0.10		0.4		0.4		0.4		0.4	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	1.80		1.3		1.3		1.3		1.3	
ANTIMONY	MG/L	< 0.003		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	< 0.10		-		-		-		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		-		-	
CADMIUM	MG/L	< 0.001		< 0.001		< 0.001		< 0.001		< 0.001	
CALCIUM	MG/L	458.00		397.		400.		397.		400.	
CHLORIDE	MG/L	244.00		320.		320.		320.		320.	
CHROMIUM	MG/L	< 0.01		-		-		-		-	
COBALT	MG/L	< 0.05		-		-		-		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2500.00		3900.		3900.		3900.		3900.	
COPPER	MG/L	< 0.02		-		-		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.34		-		-		-		-	
GROSS ALPHA	PCI/L	45.00	33.00	-		-		-		-	
GROSS BETA	PCI/L	28.00	11.00	-		-		-		-	
IRON	MG/L	0.10		0.2		0.2		0.2		0.2	
LEAD	MG/L	< 0.01		-		-		-		-	
MAGNESIUM	MG/L	198.00		201.		200.		200.		200.	
MANGANESE	MG/L	2.54		1.83		1.84		1.83		1.84	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.01		0.08		0.08		0.09		0.08	
NICKEL	MG/L	< 0.04		-		-		-		-	
NITRATE	MG/L	24.80		28.		26.		29.		28.	
NITRITE	MG/L	-		-		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	5.6		-		-		-		-	
ORG. CARBON	MG/L	9.30		-		-		-		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	6.70		6.94		6.94		6.94		6.94	
PHOSPHATE	MG/L	< 0.10		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	190.00		18.		18.		18.		18.	
RA-226	PCI/L	-		-		-		-		-	
RA-228	PCI/L	-		-		-		-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		< 0.005		< 0.005		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	15.20		-		-		-		-	
SILVER	MG/L	< 0.01		-		-		-		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		603-01 06/26/85	603-01 12/11/85	603-02 12/11/85	603-03 12/11/85	603-04 12/11/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	600.00	973.	973.	975.	973.
STRONTIUM	MG/L	4.00	-	-	-	-
SULFATE	MG/L	1820.00	2820.	2820.	2820.	2830.
SULFIDE	MG/L	0.8	-	-	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	8.00	11.	11.	11.	11.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	4140.00	5480.	5470.	5480.	5480.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.128	0.0716	0.0636	0.0689	0.0649
VANADIUM	MG/L	< 0.01	0.6	0.58	0.59	0.6
ZINC	MG/L	0.2	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		603-05 12/11/85		603-01 10/28/87		605-01 06/26/85		609-01 06/26/85		609-01 12/10/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	608.		517.		469.00		402.00		407.	
ALUMINUM	MG/L	0.4		0.11		< 0.10		< 0.10		0.4	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	1.3		2.5		0.10		31.		43.	
ANTIMONY	MG/L	-		-		< 0.003		0.004		-	
ARSENIC	MG/L	< 0.01		0.005		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	-		0.03		< 0.10		< 0.10		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		< 0.1		-		-		-	
CADMIUM	MG/L	< 0.001		< 0.005		< 0.001		0.001		< 0.001	
CALCIUM	MG/L	397.		176.		424.00		177.		330.	
CHLORIDE	MG/L	320.		91.		700.00		134.00		250.	
CHROMIUM	MG/L	-		< 0.01		< 0.01		< 0.01		-	
COBALT	MG/L	-		-		< 0.05		< 0.05		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	3900.		1950.		3450.00		2300.00		3700.	
COPPER	MG/L	-		-		< 0.02		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		0.44		0.29		0.66		3700.	
GROSS ALPHA	PCI/L	-		-		< 2.00		28.	16.	-	
GROSS BETA	PCI/L	-		-		< 3.00		28.00	7.	-	
IRON	MG/L	0.2		0.07		2.84		0.19		0.65	
LEAD	MG/L	-		< 0.01		< 0.01		< 0.01		-	
MAGNESIUM	MG/L	200.		91.3		164.00		93.		146.	
MANGANESE	MG/L	1.84		0.90		2.95		1.5		3.86	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.08		0.11		< 0.01		0.05		0.22	
NICKEL	MG/L	-		-		< 0.04		< 0.04		-	
NITRATE	MG/L	27.		6.6		0.40		16.80		25.	
NITRITE	MG/L	-		< 0.1		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		0.10		3.80		-	
ORG. CARBON	MG/L	-		-		5.30		11.00		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	6.94		6.95		6.90		7.00		7.04	
PHOSPHATE	MG/L	-		4.57		< 0.10		< 0.10		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	18.		6.86		52.00		23.00		45.	
RA-226	PCI/L	-		0.0	0.1	-		-		-	
RA-228	PCI/L	-		0.0	1.3	-		-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.025		0.007		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		13.4		18.80		13.70		-	
SILVER	MG/L	-		-		< 0.01		< 0.01		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		603-05 12/11/85	603-01 10/28/87	605-01 06/26/85	609-01 06/26/85	609-01 12/10/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	972.	422.	830.00	550.00	920.
STRONTIUM	MG/L	-	-	2.30	2.40	-
SULFATE	MG/L	2810.	1040.	1900.00	920.00	2730.
SULFIDE	MG/L	-	< 0.1	1.9	< 0.10	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	11.	10.5	11.50	10.00	11.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	0.015	0.011	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	5480.	2170.	4560.00	2840.	4700.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0742	0.0352	0.004	0.147	0.0543
VANADIUM	MG/L	0.58	0.03	< 0.01	< 0.01	0.15
ZINC	MG/L	-	< 0.005	0.2	0.09	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		609-01 10/28/87		610-01 06/26/85		610-01 10/28/87		611-01 06/26/85		611-01 12/17/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	607.		688.00		629.		1727.00		1431.	
ALUMINUM	MG/L	0.14		< 0.10		0.13		< 0.10		0.6	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	57.0		190.		115.		2840.		2400.	
ANTIMONY	MG/L	-		0.008		-		< 0.003		-	
ARSENIC	MG/L	0.010		< 0.01		0.010		0.02		< 0.01	
BARIUM	MG/L	0.03		< 0.10		0.02		0.10		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	< 0.1		-		< 0.1		-		-	
CADMIUM	MG/L	< 0.005		< 0.001		< 0.005		< 0.001		-	
CALCIUM	MG/L	245.		168.		123.		479.		441.	
CHLORIDE	MG/L	146.		225.00		170.		1410.00		1300.	
CHROMIUM	MG/L	< 0.01		0.02		< 0.01		< 0.01		-	
COBALT	MG/L	-		< 0.05		-		0.09		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	3600.		3500.00		3160.		26000.00		25000.	
COPPER	MG/L	-		< 0.02		-		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.56		2.20		2.10		5.60		-	
GROSS ALPHA	PCI/L	-		213.	74.	-		< 2.		250.	180.
GROSS BETA	PCI/L	-		134.	17.	-		65.	5.	290.	80.
IRON	MG/L	0.06		0.03		0.04		49.30		33.4	
LEAD	MG/L	< 0.01		0.01		< 0.01		< 0.01		-	
MAGNESIUM	MG/L	125.		110.		85.0		307.		288.	
MANGANESE	MG/L	1.86		8.03		1.57		18.8		15.7	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.15		3.00		0.93		0.08		2.25	
NICKEL	MG/L	-		< 0.04		-		< 0.04		-	
NITRATE	MG/L	39.9		25.		50.5		10.60		< 1.	
NITRITE	MG/L	< 0.1		-		< 0.1		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		7.40		-		2.40		-	
ORG. CARBON	MG/L	-		7.50		-		72.00		-	
PB-210	PCI/L	-		-		-		< 1.50		1.6	1.3
PH	SU	7.0		7.14		7.1		7.07		7.15	
PHOSPHATE	MG/L	5.95		0.10		4.66		1.60		-	
PO-210	PCI/L	-		-		-		< 1.00		0.	0.4
POTASSIUM	MG/L	24.7		50.00		28.5		190.00		211.	
RA-226	PCI/L	0.0	0.1	-		0.1	0.2	< 0.6		0.5	0.3
RA-228	PCI/L	0.0	1.4	-		0.4	1.6	< 1.00		1.2	0.9
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.056		0.008		0.066		0.039		0.2	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	14.3		22.50		21.8		16.30		-	
SILVER	MG/L	-		< 0.01		-		< 0.01		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		609-01 10/28/87		610-01 06/26/85		610-01 10/28/87		611-01 06/26/85		611-01 12/17/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
SODIUM	MG/L	830.		810.00		681.		10800.00		7350.	
STRONTIUM	MG/L	-		2.10		-		8.40		-	
SULFATE	MG/L	2200.		2150.00		1550.		30300.00		21300.	
SULFIDE	MG/L	< 0.1		< 0.10		< 0.1		< 0.10		-	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	12.0		13.00		13.1		11.00		12.	
TH-230	PCI/L	-		-		-		10.50	2.50	0.	0.1
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	-		0.012		-		0.189		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	3850.		3690.		2800.		37940.		27300.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	0.0915		0.428		0.312		0.476		0.67	
VANADIUM	MG/L	0.04		0.50		0.84		0.41		0.8	
ZINC	MG/L	< 0.005		0.051		< 0.005		0.5		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		611-01 05/21/86		611-01 11/02/87		612-01 06/26/85		612-01 12/14/85		612-01 05/22/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	1343.		1478.		835.00		1425.		1340.	
ALUMINUM	MG/L	-		0.24		< 0.10		0.4		-	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	2610.		2620.		217.		1300.		300.	
ANTIMONY	MG/L	-		-		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		0.067		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	-		0.03		< 0.10		-		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		0.8		-		-		-	
CADMIUM	MG/L	< 0.001		< 0.005		< 0.001		< 0.001		0.005	
CALCIUM	MG/L	461.		427.		521.		462.		445.	
CHLORIDE	MG/L	1240.		1200.		1010.00		1300.		1020.	
CHROMIUM	MG/L	-		< 0.01		< 0.01		-		-	
COBALT	MG/L	-		-		< 0.05		-		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	23000.		27000.		12500.00		24000.		23500.	
COPPER	MG/L	-		-		< 0.02		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		3.74		0.54		-		-	
GROSS ALPHA	PCI/L	-		-		< 2.00		-		-	
GROSS BETA	PCI/L	-		-		25.	4.	-		-	
IRON	MG/L	36.1		16.5		4.65		21.5		19.9	
LEAD	MG/L	-		< 0.01		< 0.01		-		-	
MAGNESIUM	MG/L	273.		276.		239.		354.		302.	
MANGANESE	MG/L	15.1		12.6		3.8		10.5		9.02	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	1.55		1.46		0.05		1.36		0.95	
NICKEL	MG/L	-		-		< 0.04		-		-	
NITRATE	MG/L	-		1.3		4.00		< 1.		-	
NITRITE	MG/L	-		< 0.1		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		0.9		-		-	
ORG. CARBON	MG/L	-		-		37.00		-		-	
PB-210	PCI/L	-		-		< 1.50		-		-	
PH	SU	6.9		7.10		7.48		7.33		7.1	
PHOSPHATE	MG/L	-		< 0.1		0.90		-		-	
PO-210	PCI/L	-		-		17.00	8.00	-		-	
POTASSIUM	MG/L	149.		151.		47.00		163.		112.	
RA-226	PCI/L	-		0.1	0.2	3.00	1.00	-		-	
RA-228	PCI/L	-		0.0	2.2	< 1.00		-		-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.631		0.026		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		13.0		12.40		-		-	
SILVER	MG/L	-		-		< 0.01		-		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		611-01 05/21/86	611-01 11/02/87	612-01 06/26/85	612-01 12/14/85	612-01 05/22/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	9180.	6820.	1500.00	10100.	9260.
STRONTIUM	MG/L	-	-	29.80	-	-
SULFATE	MG/L	24500.	20800.	13800.00	24100.	21100.
SULFIDE	MG/L	-	< 0.1	0.20	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	11.5	12.5	12.00	12.	12.
TH-230	PCI/L	-	-	< 1.00	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	0.023	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	37400.	34300.	18800.00	35000.	34500.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.42	0.224	0.17	0.193	0.33
VANADIUM	MG/L	-	0.18	0.05	0.5	-
ZINC	MG/L	-	0.048	0.04	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		612-01 11/02/87		613-01 06/26/85		613-02 06/26/85		613-03 06/26/85		613-04 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	1220.		1335.00		1335.00		1335.00		1335.00	
ALUMINUM	MG/L	0.25		< 0.10		< 0.10		< 0.10		< 0.10	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	2190.		2280.		2550.		233.		2540.	
ANTIMONY	MG/L	-		< 0.003		< 0.003		< 0.003		< 0.003	
ARSENIC	MG/L	0.062		< 0.01		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	0.02		0.10		< 0.10		0.10		< 0.10	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	0.5		-		-		-		-	
CADMIUM	MG/L	< 0.005		< 0.001		< 0.001		< 0.001		< 0.001	
CALCIUM	MG/L	422.		484.		442.		429.		445.	
CHLORIDE	MG/L	910.		1140.00		1140.00		1140.00		1140.00	
CHROMIUM	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		0.01	
COBALT	MG/L	-		0.21		0.12		0.14		0.09	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	28000.		25500.00		25500.00		25500.00		25500.00	
COPPER	MG/L	-		< 0.02		0.03		0.03		0.03	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	2.82		4.60		4.80		5.00		4.80	
GROSS ALPHA	PCI/L	-		< 2.00		< 2.00		< 2.00		< 2.	
GROSS BETA	PCI/L	-		55.	5.	63.	6.	76.	6.	94.00	14.00
IRON	MG/L	17.3		38.90		37.00		33.10		32.50	
LEAD	MG/L	0.02		< 0.01		< 0.01		< 0.01		< 0.01	
MAGNESIUM	MG/L	258.		234.		232.		232.		232.	
MANGANESE	MG/L	7.47		16.2		17.6		17.1		17.4	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	1.22		0.09		0.08		0.09		0.10	
NICKEL	MG/L	-		0.14		0.13		< 0.04		< 0.04	
NITRATE	MG/L	0.1		< 0.4		< 0.4		< 0.4		< 0.4	
NITRITE	MG/L	< 0.1		-		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		< 0.10		< 0.10		< 0.10		< 0.10	
ORG. CARBON	MG/L	-		56.00		57.00		58.00		56.00	
PB-210	PCI/L	-		< 1.50		< 1.50		2.90	2.40	18.00	3.30
PH	SU	7.15		7.10		7.10		7.10		7.10	
PHOSPHATE	MG/L	< 0.1		1.20		1.00		1.80		1.10	
PO-210	PCI/L	-		< 1.00		< 1.00		< 1.00		10.00	9.00
POTASSIUM	MG/L	134.		180.00		180.00		190.00		170.00	
RA-226	PCI/L	0.0	0.1	< 0.6		< 0.6		< 0.6		< 0.6	
RA-228	PCI/L	0.0	2.3	23.00	5.00	< 1.00		6.00	5.00	< 1.00	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.749		0.069		0.038		0.051		0.15	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	11.3		14.10		14.10		13.70		14.10	
SILVER	MG/L	-		< 0.01		< 0.01		< 0.01		< 0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		612-01 11/02/87		613-01 06/26/85		613-02 06/26/85		613-03 06/26/85		613-04 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
SODIUM	MG/L	7830.		7400.00		9100.00		8700.00		8800.00	
STRONTIUM	MG/L	-		8.10		8.70		7.80		7.80	
SULFATE	MG/L	21900.		25100.00		24600.00		26100.		25100.00	
SULFIDE	MG/L	< 0.1		0.2		< 0.10		< 0.10		< 0.10	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	12.5		11.00		11.00		11.00		11.00	
TH-230	PCI/L	-		63.1	7.4	2.40	0.20	4.40	1.70	5.00	1.80
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	-		0.104		0.125		0.074		0.015	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	36300.		28450.		36500.00		35000.		36390.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	0.208		0.91		0.13		0.431		0.471	
VANADIUM	MG/L	0.16		0.20		0.21		0.21		0.20	
ZINC	MG/L	0.006		0.5		0.8		0.6		0.9	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		613-05 06/26/85		613-01 12/18/85		613-01 05/22/86		613-01 11/02/87		614-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	1335.00		1560.		1390.		1305.		795.00	
ALUMINUM	MG/L	< 0.10		0.5		-		0.24		< 0.10	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	2390.		2900.		3100.		3610.		115.	
ANTIMONY	MG/L	< 0.003		-		-		-		< 0.003	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		0.053		< 0.01	
BARIUM	MG/L	< 0.10		-		-		0.02		< 0.10	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		0.1		-	
CADMIUM	MG/L	< 0.001		-		< 0.001		0.006		< 0.001	
CALCIUM	MG/L	454.		431.		449.		429.		440.	
CHLORIDE	MG/L	1150.00		1200.		1060.		870.		960.00	
CHROMIUM	MG/L	< 0.01		-		-		< 0.01		< 0.01	
COBALT	MG/L	0.13		-		-		-		< 0.05	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	25500.00		33000.		33500.		32000.		11000.00	
COPPER	MG/L	0.03		-		-		-		< 0.02	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	4.80		-		-		7.24		0.35	
GROSS ALPHA	PCI/L	< 2.		340.	230.	-		-		< 2.00	
GROSS BETA	PCI/L	61.	5.	190.	90.	-		-		21.	4.
IRON	MG/L	31.50		37.		35.2		28.4		3.08	
LEAD	MG/L	< 0.01		-		-		0.03		< 0.01	
MAGNESIUM	MG/L	239.		226.		203.		178.		191.	
MANGANESE	MG/L	16.5		15.7		11.2		8.37		2.3	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.09		2.76		1.88		2.17		0.04	
NICKEL	MG/L	0.13		-		-		-		< 0.04	
NITRATE	MG/L	< 0.4		< 1.		-		0.8		1.30	
NITRITE	MG/L	-		-		-		< 0.1		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	< 0.10		-		-		-		0.30	
ORG. CARBON	MG/L	61.00		-		-		-		31.00	
PB-210	PCI/L	< 1.50		2.8	1.	-		-		< 1.50	
PH	SU	7.10		7.11		7.		7.0		7.54	
PHOSPHATE	MG/L	1.90		-		-		< 0.1		< 0.10	
PO-210	PCI/L	< 1.00		0.	0.5	-		-		< 1.00	
POTASSIUM	MG/L	180.00		231.		161.		145.		33.00	
RA-226	PCI/L	< 0.6		0.6	0.4	-		0.1	0.2	< 0.60	
RA-228	PCI/L	< 1.00		1.8	1.1	-		1.6	2.2	< 1.00	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.14		< 0.005		< 0.005		0.688		0.023	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	14.10		-		-		12.3		12.20	
SILVER	MG/L	< 0.01		-		-		-		< 0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		613-05 06/26/85		613-01 12/18/85		613-01 05/22/86		613-01 11/02/87		614-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY	PARAMETER VALUE+/-	UNCERTAINTY
SODIUM	MG/L	8800.00		10000.		10100.		7770.		4600.00	
STRONTIUM	MG/L	8.20		-		-		-		27.30	
SULFATE	MG/L	25300.00		28000.		26800.		25400.		10700.00	
SULFIDE	MG/L	< 0.10		-		-		< 0.1		0.5	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	11.00		12.5		12.		12.5		13.00	
TH-230	PCI/L	4.20	2.10	0.	0.1	-		-		< 1.00	
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	0.475		-		-		-		0.039	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	37050.		44000.		42400.		39200.		15670.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	0.426		-		0.48		0.211		0.308	
VANADIUM	MG/L	0.19		0.42		-		0.22		0.02	
ZINC	MG/L	0.7		-		-		0.484		0.024	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		614-01 05/23/86		615-01 06/26/85		615-01 12/13/85		615-01 10/26/87		616-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	554.		869.00		852.		636.		550.00	
ALUMINUM	MG/L	-		1.10		0.4		0.44		< 0.10	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	28.		860.		700.		387.		570.	
ANTIMONY	MG/L	-		0.003		-		-		0.008	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		0.020		< 0.01	
BARIUM	MG/L	-		0.20		-		0.03		< 0.10	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		< 0.1		-	
CADMIUM	MG/L	< 0.001		< 0.001		0.05		0.005		< 0.001	
CALCIUM	MG/L	692.		415.		30.3		268.		360.	
CHLORIDE	MG/L	1210.		780.00		420.		180.		440.00	
CHROMIUM	MG/L	-		0.03		-		< 0.01		0.01	
COBALT	MG/L	-		0.06		-		-		0.05	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	7200.		9000.00		10000.		6000.		8000.00	
COPPER	MG/L	-		< 0.02		-		-		< 0.02	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		5.80		-		7.12		4.30	
GROSS ALPHA	PCI/L	-		18.	12.	-		-		< 2.00	
GROSS BETA	PCI/L	-		88.	6.	-		-		59.	5.
IRON	MG/L	< 0.03		0.82		0.35		0.11		0.10	
LEAD	MG/L	-		< 0.01		-		< 0.01		< 0.01	
MAGNESIUM	MG/L	297.		228.		93.5		67.6		90.	
MANGANESE	MG/L	2.82		19.00		7.46		3.52		22.50	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.01		9.50		10.8		2.71		2.90	
NICKEL	MG/L	-		0.24		-		-		< 0.04	
NITRATE	MG/L	-		142.		3.		< 0.1		133.	
NITRITE	MG/L	-		-		-		< 0.1		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		33.00		-		-		31.00	
ORG. CARBON	MG/L	-		23.00		-		-		18.00	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.6		6.91		7.05		6.85		6.82	
PHOSPHATE	MG/L	-		0.70		-		4.84		0.30	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	42.1		80.00		60.6		23.0		102.00	
RA-226	PCI/L	-		-		-		0.4	0.2	-	
RA-228	PCI/L	-		-		-		0.6	1.0	-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.009		< 0.005		0.142		0.046	
SILICON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		27.80		-		20.4		15.20	
SILVER	MG/L	-		< 0.01		-		-		< 0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		614-01 05/23/86	615-01 06/26/85	615-01 12/13/85	615-01 10/26/87	616-01 06/26/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	3100.	2900.00	2360.	1020.	2500.00
STRONTIUM	MG/L	-	4.50	-	-	2.70
SULFATE	MG/L	7230.	8670.00	5970.	3280.	5950.00
SULFIDE	MG/L	-	< 0.10	-	< 0.1	< 0.10
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	11.	12.00	13.	13.0	12.00
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	0.111	-	-	0.042
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	13200.	13090.	11700.	4810.	9580.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.044	0.377	0.156	0.390	0.243
VANADIUM	MG/L	-	10.40	26.5	9.86	0.04
ZINC	MG/L	-	2.4	-	0.92	0.8

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		616-01 12/12/85		616-01 10/27/87		618-01 06/26/85		618-01 10/28/87		619-01 06/26/85	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	760.		576.		858.00		671.		425.00	
ALUMINUM	MG/L	0.6		0.23		< 0.10		0.22		< 0.10	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	730.		956.		535.00		570.		250.	
ANTIMONY	MG/L	-		-		< 0.003		-		0.014	
ARSENIC	MG/L	< 0.01		0.015		< 0.01		0.028		< 0.01	
BARIUM	MG/L	-		0.02		< 0.10		0.04		0.20	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		< 0.1		-		< 0.1		-	
CADMIUM	MG/L	0.01		0.021		< 0.001		< 0.005		< 0.001	
CALCIUM	MG/L	45.7		390.		403.		412.		507.	
CHLORIDE	MG/L	630.		500.		860.00		660.		930.00	
CHROMIUM	MG/L	-		< 0.01		< 0.01		< 0.01		< 0.01	
COBALT	MG/L	-		-		< 0.05		-		< 0.05	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	12800.		13500.		11000.00		14220.		7000.00	
COPPER	MG/L	-		-		< 0.02		-		< 0.02	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		5.52		0.25		0.31		1.10	
GROSS ALPHA	PCI/L	-		-		33.	15.	-		39.	16.
GROSS BETA	PCI/L	-		-		96.	6.	-		75.	5.
IRON	MG/L	0.47		1.58		< 0.03		0.08		< 0.03	
LEAD	MG/L	-		< 0.01		< 0.01		< 0.01		0.01	
MAGNESIUM	MG/L	134.		114.		424.		198.		226.	
MANGANESE	MG/L	19.5		14.5		11.60		4.37		2.9	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	2.32		1.35		< 0.01		0.20		5.70	
NICKEL	MG/L	-		-		< 0.04		-		< 0.04	
NITRATE	MG/L	100.		10.0		385.		709.		616.	
NITRITE	MG/L	-		< 0.1		-		< 0.1		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		82.00		-		140.00	
ORG. CARBON	MG/L	-		-		27.00		-		16.00	
PB-210	PCI/L	-		-		-		-		< 1.50	
PH	SU	6.82		6.75		7.03		7.0		7.44	
PHOSPHATE	MG/L	-		6.04		< 0.10		8.59		0.10	
PO-210	PCI/L	-		-		-		-		< 1.00	
POTASSIUM	MG/L	164.		118.		190.00		164.		100.00	
RA-226	PCI/L	-		0.0	0.1	-		0.1	0.2	1.70	1.30
RA-228	PCI/L	-		0.0	1.8	-		0.9	1.6	< 1.00	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.253		0.052		0.295		0.082	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		13.9		15.40		11.6		22.00	
SILVER	MG/L	-		-		< 0.01		-		< 0.01	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		616-01 12/12/85	616-01 10/27/87	618-01 06/26/85	618-01 10/28/87	619-01 06/26/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	4310.	3250.	4200.00	4400.	2200.00
STRONTIUM	MG/L	-	-	8.80	-	4.60
SULFATE	MG/L	10200.	9630.	11800.00	10500.	6250.00
SULFIDE	MG/L	-	< 0.1	< 0.10	< 0.1	0.8
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	12.0	12.00	14.3	11.00
TH-230	PCI/L	-	-	-	-	1.90 1.10
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	0.074	-	0.013
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	16000.	13800.	16620.	16500.	11000.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.111	0.106	0.525	0.300	0.305
VANADIUM	MG/L	0.5	0.19	< 0.01	0.06	0.06
ZINC	MG/L	-	0.777	0.2	0.014	0.4

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		619-01 12/18/85	621-01 05/16/86	621-01 11/03/87	622-01 01/16/86	622-01 05/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	541.	104.	115.	160.	168.
ALUMINUM	MG/L	0.3	< 0.1	0.21	0.5	< 0.1
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	160.	1.8	1.3	0.4	0.5
ANTIMONY	MG/L	-	-	-	< 0.003	-
ARSENIC	MG/L	< 0.01	< 0.01	0.016	< 0.01	< 0.01
BARIUM	MG/L	-	0.33	0.50	0.2	< 0.1
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	0.5	-
BROMIDE	MG/L	-	-	0.2	-	-
CADMIUM	MG/L	0.03	< 0.001	< 0.005	< 0.001	< 0.001
CALCIUM	MG/L	583.	183.	210.	36.5	36.2
CHLORIDE	MG/L	1000.	5490.	4.5	1000.	961.
CHROMIUM	MG/L	-	-	< 0.01	-	-
COBALT	MG/L	-	< 0.05	-	0.03	< 0.05
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	6000.	6300.	12910.	2450.	2500.
COPPER	MG/L	-	0.04	-	0.04	< 0.02
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	10.9	0.57	1.1	1.3
GROSS ALPHA	PCI/L	-	< 230.	-	-	< 60.
GROSS BETA	PCI/L	-	< 78.	-	-	< 20.
IRON	MG/L	0.11	0.083	0.06	0.12	0.033
LEAD	MG/L	-	< 0.01	< 0.01	< 0.01	< 0.01
MAGNESIUM	MG/L	204.	63.3	58.7	9.14	10.6
MANGANESE	MG/L	3.64	0.272	0.18	0.03	0.059
MERCURY	MG/L	-	-	-	< 0.0002	-
MOLYBDENUM	MG/L	3.26	0.037	0.08	0.28	0.142
NICKEL	MG/L	-	< 0.04	-	0.04	< 0.04
NITRATE	MG/L	760.	< 1.	5.8	< 1.	< 1.
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	< 1.5	-	-	< 1.5
PH	SU	7.19	8.8	7.80	8.36	8.1
PHOSPHATE	MG/L	-	-	4.3	< 0.1	-
PO-210	PCI/L	-	< 1.	-	-	< 1.
POTASSIUM	MG/L	120.	15.7	27.7	5.69	4.15
RA-226	PCI/L	-	3.6	1.3 0.4	-	< 1.
RA-228	PCI/L	-	< 1.	5.2 1.9	-	< 1.
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	0.009	0.346	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	9.7	8.15	19.	7.5
SILVER	MG/L	-	-	-	< 0.01	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		619-01 12/18/85	621-01 05/16/86	621-01 11/03/87	622-01 01/16/86	622-01 05/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	3400.	3000.	3710.	736.	670.
STRONTIUM	MG/L	-	10.9	-	1.1	1.3
SULFATE	MG/L	7450.	64.8	43.	459.	140.
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.	13.	12.8	12.	11.
TH-230	PCI/L	-	< 1.	-	-	< 1.
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	< 0.005	-	< 0.005	< 0.005
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	9040.	9480.	10600.	1830.	1920.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.191	< 0.003	0.0020	< 0.0003	< 0.003
VANADIUM	MG/L	0.31	< 0.01	0.03	0.2	< 0.01
ZINC	MG/L	-	0.029	< 0.005	0.044	0.013

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		622-01 11/03/87	623-01 11/19/85	623-01 05/19/86	623-01 11/02/87	624-01 11/22/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	167.	357.	368.	375.	1043.
ALUMINUM	MG/L	0.12	0.3	-	0.26	0.5
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.4	38.	2.7	19.4	1200.
ANTIMONY	MG/L	-	< 0.003	-	-	< 0.003
ARSENIC	MG/L	0.007	< 0.01	< 0.01	0.008	< 0.01
BARIUM	MG/L	0.04	0.2	-	0.03	0.3
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	0.3	-	-	0.1
BROMIDE	MG/L	2.1	-	-	0.8	-
CADMIUM	MG/L	< 0.005	< 0.001	< 0.001	< 0.005	0.004
CALCIUM	MG/L	38.8	521.	479.	483.	489.
CHLORIDE	MG/L	1.5	2300.	2490.	2400.	1000.
CHROMIUM	MG/L	< 0.01	-	-	< 0.01	-
COBALT	MG/L	-	0.13	-	-	0.17
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	2660.	6000.	9300.	8830.	22000.
COPPER	MG/L	-	0.03	-	-	0.06
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	1.15	1.	-	0.35	3.1
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.03	0.15	0.737	1.19	1.33
LEAD	MG/L	< 0.01	< 0.01	-	< 0.01	< 0.01
MAGNESIUM	MG/L	10.3	159.	154.	141.	245.
MANGANESE	MG/L	0.07	1.45	1.11	1.18	14.3
MERCURY	MG/L	-	< 0.0002	-	-	< 0.0002
MOLYBDENUM	MG/L	0.17	0.16	< 0.01	0.13	1.49
NICKEL	MG/L	-	0.11	-	-	0.26
NITRATE	MG/L	< 0.1	40.	-	< 0.1	19.
NITRITE	MG/L	< 0.1	-	-	< 0.1	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.95	7.19	7.2	7.25	7.2
PHOSPHATE	MG/L	1.2	0.3	-	< 0.1	0.3
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	6.68	25.1	29.3	18.5	212.
RA-226	PCI/L	0.3 0.2	-	-	0.0 0.2	-
RA-228	PCI/L	0.0 1.7	-	-	0.6 1.9	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.046	< 0.005	< 0.005	0.119	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	7.12	4.	-	11.8	16.
SILVER	MG/L	-	< 0.01	-	-	< 0.01

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		622-01 11/03/87	623-01 11/19/85	623-01 05/19/86	623-01 11/02/87	624-01 11/22/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	713.	2020.	2370.	2500.	7460.
STRONTIUM	MG/L	-	12.5	-	-	4.4
SULFATE	MG/L	138.	2800.	3110.	3310.	18800.
SULFIDE	MG/L	< 0.1	-	-	< 0.1	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.7	12.5	13.	12.0	12.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	< 0.005	-	-	< 0.005
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	2000.	8080.	8780.	9020.	28300.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0007	0.0082	0.011	0.0053	0.611
VANADIUM	MG/L	< 0.01	0.2	-	0.07	0.3
ZINC	MG/L	< 0.005	0.158	-	0.011	0.267

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		624-01 05/19/86		624-01 11/03/87		625-01 12/06/85		625-01 05/21/86		625-01 11/04/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	1024.		999.		62.		50.		39.	
ALUMINUM	MG/L	-		0.25		0.4		-		0.19	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	1320.		1740.		7.3		3.6		3.2	
ANTIMONY	MG/L	-		-		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		0.013		< 0.01		< 0.01		0.003	
BARIUM	MG/L	-		0.02		3.2		-		2.28	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		0.1		-		-	
BROMIDE	MG/L	-		< 0.1		-		-		0.2	
CADMIUM	MG/L	< 0.001		< 0.005		< 0.001		< 0.001		< 0.005	
CALCIUM	MG/L	435.		428.		326.		308.		323.	
CHLORIDE	MG/L	1170.		11.		8200.		7350.		2.5	
CHROMIUM	MG/L	-		< 0.01		-		-		< 0.01	
COBALT	MG/L	-		-		0.12		-		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	23000.		22500.		12000.		16000.		15500.	
COPPER	MG/L	-		-		0.04		-		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		3.27		0.9		-		0.58	
GROSS ALPHA	PCI/L	-		-		-		-		-	
GROSS BETA	PCI/L	-		-		-		-		-	
IRON	MG/L	13.5		6.86		0.08		0.05		0.12	
LEAD	MG/L	-		0.05		< 0.01		-		< 0.01	
MAGNESIUM	MG/L	282.		245.		51.3		47.9		44.9	
MANGANESE	MG/L	11.9		9.45		0.16		0.133		0.18	
MERCURY	MG/L	-		-		< 0.0002		-		-	
MOLYBDENUM	MG/L	0.9		2.46		0.22		0.03		0.06	
NICKEL	MG/L	-		-		0.12		-		-	
NITRATE	MG/L	-		< 0.1		2.		-		< 0.1	
NITRITE	MG/L	-		< 0.1		-		-		< 0.1	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.5		7.25		9.89		7.8		8.0	
PHOSPHATE	MG/L	-		11.1		0.2		-		2.4	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	177.		261.		32.2		16.5		15.5	
RA-226	PCI/L	-		0.2	0.2	-		-		1.4	0.4
RA-228	PCI/L	-		2.4	2.0	-		-		5.7	2.3
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.527		< 0.005		< 0.005		0.419	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		11.4		5.		-		6.14	
SILVER	MG/L	-		-		< 0.01		-		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		624-01 05/19/86	624-01 11/03/87	625-01 12/06/85	625-01 05/21/86	625-01 11/04/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	6460.	6230.	4900.	4270.	4350.
STRONTIUM	MG/L	-	-	17.1	-	-
SULFATE	MG/L	18300.	17700.	23.6	28.3	21.
SULFIDE	MG/L	-	< 0.1	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	12.5	12.	12.	12.0
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	< 0.005	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	24900.	26100.	12600.	12700.	12600.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.51	0.243	< 0.0003	< 0.003	0.0005
VANADIUM	MG/L	-	0.09	0.3	-	0.04
ZINC	MG/L	-	0.021	0.258	-	< 0.005

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		626-01 05/21/86	627-01 11/20/85	627-02 11/20/85	627-03 11/20/85	627-04 11/20/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	212.	351.	351.	351.	351.
ALUMINUM	MG/L	-	0.2	0.2	0.2	0.2
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	1.3	38.	38.	38.	38.
ANTIMONY	MG/L	-	< 0.003	< 0.003	< 0.003	< 0.003
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BARIUM	MG/L	-	0.3	0.3	0.3	0.3
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	0.1	0.2	0.2	0.2
BROMIDE	MG/L	-	-	-	-	-
CADMIUM	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
CALCIUM	MG/L	89.	36.2	36.2	36.1	36.2
CHLORIDE	MG/L	1920.	1100.	1100.	1100.	1100.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	< 0.05	< 0.05	< 0.05	< 0.05
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	4800.	3400.	3400.	3400.	3400.
COPPER	MG/L	-	< 0.02	< 0.02	< 0.02	< 0.02
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	2.6	2.6	2.6	2.5
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	< 0.03	0.13	0.13	0.13	0.13
LEAD	MG/L	-	< 0.01	< 0.01	< 0.01	< 0.01
MAGNESIUM	MG/L	21.5	19.7	19.7	19.7	19.6
MANGANESE	MG/L	0.07	0.2	0.2	0.2	0.2
MERCURY	MG/L	-	< 0.0002	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM	MG/L	< 0.01	0.21	0.2	0.2	0.2
NICKEL	MG/L	-	< 0.04	< 0.04	0.04	< 0.04
NITRATE	MG/L	-	3.	3.	3.	3.
NITRITE	MG/L	-	-	-	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.05	8.06	8.06	8.06	8.06
PHOSPHATE	MG/L	-	0.2	0.2	0.2	0.2
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	7.93	9.1	9.1	9.1	9.1
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.008	< 0.005	< 0.005	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	3.	3.	3.	3.
SILVER	MG/L	-	< 0.01	< 0.01	< 0.01	< 0.01

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		626-01 05/21/86	627-01 11/20/85	627-02 11/20/85	627-03 11/20/85	627-04 11/20/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	1420.	1030.	1000.	1000.	1000.
STRONTIUM	MG/L	-	1.1	1.1	1.1	1.1
SULFATE	MG/L	539.	594.	594.	594.	595.
SULFIDE	MG/L	-	-	-	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	12.	12.	12.	12.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	< 0.005	< 0.005	< 0.005	< 0.005
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	4110.	3040.	3100.	3100.	3100.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.008	0.0013	0.0014	0.001	0.0012
VANADIUM	MG/L	-	0.12	0.15	0.15	0.16
ZINC	MG/L	-	0.017	0.018	0.016	0.015

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		627-05 11/20/85	627-01 05/21/86	627-01 11/02/87	628-01 12/06/85	628-01 05/21/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	351.	456.	668.	199.	360.
ALUMINUM	MG/L	0.2	-	0.23	0.5	-
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	38.	20.	232.	3.7	3.
ANTIMONY	MG/L	< 0.003	-	-	< 0.003	-
ARSENIC	MG/L	< 0.01	< 0.01	0.007	< 0.01	< 0.01
BARIUM	MG/L	0.3	-	0.02	0.3	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	0.2	-	-	0.1	-
BROMIDE	MG/L	-	-	0.2	-	-
CADMIUM	MG/L	< 0.001	< 0.001	< 0.005	< 0.001	< 0.001
CALCIUM	MG/L	36.3	271.	342.	8.23	2.2
CHLORIDE	MG/L	1100.	1000.	1100.	930.	930.
CHROMIUM	MG/L	-	-	< 0.01	-	-
COBALT	MG/L	< 0.05	-	-	0.06	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	3400.	10900.	13920.	2900.	3250.
COPPER	MG/L	< 0.02	-	-	< 0.02	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	2.6	-	0.85	1.8	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.13	4.43	7.32	0.11	< 0.03
LEAD	MG/L	< 0.01	-	0.03	< 0.01	-
MAGNESIUM	MG/L	19.7	124.	224.	2.4	0.86
MANGANESE	MG/L	0.2	1.2	2.30	0.07	< 0.01
MERCURY	MG/L	< 0.0002	-	-	< 0.0002	-
MOLYBDENUM	MG/L	0.21	0.03	0.22	0.2	< 0.01
NICKEL	MG/L	< 0.04	-	-	0.07	-
NITRATE	MG/L	3.	-	< 0.1	< 1.	-
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.06	7.5	7.10	10.17	10.8
PHOSPHATE	MG/L	0.2	-	< 0.1	0.2	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	9.1	30.7	59.6	165.	21.
RA-226	PCI/L	-	-	0.0 0.1	-	-
RA-228	PCI/L	-	-	0.5 1.7	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	< 0.005	0.255	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	3.	-	10.8	4.	-
SILVER	MG/L	< 0.01	-	-	< 0.01	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		627-05 11/20/85	627-01 05/21/86	627-01 11/02/87	628-01 12/06/85	628-01 05/21/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	1000.	3170.	4210.	800.	874.
STRONTIUM	MG/L	1.1	-	-	0.4	-
SULFATE	MG/L	597.	6460.	9210.	455.	362.
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	12.	12.9	12.	12.
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	-	-	< 0.005	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	3040.	11100.	14800.	2370.	2590.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0006	0.012	0.0185	< 0.0003	< 0.003
VANADIUM	MG/L	0.15	-	0.08	0.21	-
ZINC	MG/L	0.015	-	0.657	0.019	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		629-01 12/07/85	629-01 05/23/86	629-01 11/02/87	630-01 01/10/86	630-01 05/19/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	565.	564.	610.	344.	353.
ALUMINUM	MG/L	0.4	< 0.1	0.24	1.1	-
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	120.	170.	181.	0.7	0.5
ANTIMONY	MG/L	< 0.003	-	-	-	-
ARSENIC	MG/L	< 0.01	< 0.01	0.010	< 0.01	0.01
BARIUM	MG/L	0.1	< 0.1	0.01	-	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	0.1	-	-	-	-
BROMIDE	MG/L	-	-	0.1	-	-
CADMIUM	MG/L	< 0.001	< 0.001	< 0.005	-	< 0.001
CALCIUM	MG/L	579.	542.	446.	3.83	5.
CHLORIDE	MG/L	1200.	1200.	1270.	560.	582.
CHROMIUM	MG/L	-	-	< 0.01	-	-
COBALT	MG/L	0.13	< 0.05	-	-	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	10000.	12100.	11500.	1650.	1850.
COPPER	MG/L	0.04	< 0.02	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	0.6	0.4	0.39	-	-
GROSS ALPHA	PCI/L	-	< 260.	-	7. 12.	-
GROSS BETA	PCI/L	-	< 150.	-	3.8 7.2	-
IRON	MG/L	5.33	4.65	3.93	0.09	< 0.03
LEAD	MG/L	< 0.01	< 0.01	0.03	-	-
MAGNESIUM	MG/L	261.	224.	213.	1.07	0.85
MANGANESE	MG/L	2.85	2.19	2.29	0.03	< 0.01
MERCURY	MG/L	< 0.0002	-	-	-	-
MOLYBDENUM	MG/L	0.24	< 0.01	0.20	0.37	0.15
NICKEL	MG/L	0.14	< 0.04	-	-	-
NITRATE	MG/L	7.	< 1.	< 0.1	3.5	-
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	< 1.5	-	0. 1.3	-
PH	SU	7.03	7.	7.4	8.48	8.5
PHOSPHATE	MG/L	0.3	-	< 0.1	-	-
PO-210	PCI/L	-	< 1.	-	0. 0.5	-
POTASSIUM	MG/L	62.9	40.1	48.1	2.51	1.7
RA-226	PCI/L	-	< 1.	0.0 0.1	4.1 1.4	-
RA-228	PCI/L	-	< 1.	0.8 1.6	0. 1.2	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	< 0.005	0.223	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	< 2.	12.8	11.9	-	-
SILVER	MG/L	< 0.01	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		629-01 12/07/85	629-01 05/23/86	629-01 11/02/87	630-01 01/10/86	630-01 05/19/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	3660.	3490.	3720.	556.	574.
STRONTIUM	MG/L	19.8	17.3	-	-	-
SULFATE	MG/L	8090.	7640.	8020.	78.	70.6
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	12.5	12.5	9.5	10.5
TH-230	PCI/L	-	< 1.	-	0. 0.1	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	< 0.005	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	14300.	13500.	13400.	1450.	1700.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0265	0.024	0.0208	< 0.0003	< 0.003
VANADIUM	MG/L	0.3	< 0.01	0.08	0.08	-
ZINC	MG/L	0.015	0.006	0.019	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		630-01 11/03/87	631-01 01/11/86	631-01 05/19/86	631-01 11/04/87	632-01 01/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	357.	298.	222.	207.	249.
ALUMINUM	MG/L	0.06	1.6	-	0.10	0.8
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	2.6	53.	13.	5.8	1.
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	0.012	< 0.01	< 0.01	0.005	< 0.01
BARIUM	MG/L	0.04	-	-	0.02	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	0.9	-	-	0.4	-
CADMIUM	MG/L	< 0.005	-	< 0.001	< 0.005	< 0.001
CALCIUM	MG/L	4.99	237.	77.3	56.4	34.4
CHLORIDE	MG/L	0.9	500.	514.	1.6	2300.
CHROMIUM	MG/L	< 0.01	-	-	< 0.01	-
COBALT	MG/L	-	-	-	-	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1850.	6000.	2650.	2850.	4950.
COPPER	MG/L	-	-	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	3.47	-	-	2.04	-
GROSS ALPHA	PCI/L	-	2. 39.	-	-	-
GROSS BETA	PCI/L	-	62. 28.	-	-	-
IRON	MG/L	< 0.01	0.89	< 0.03	0.02	0.15
LEAD	MG/L	< 0.01	-	-	< 0.01	-
MAGNESIUM	MG/L	1.04	72.	16.8	9.77	10.4
MANGANESE	MG/L	0.02	0.17	0.081	0.14	0.04
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.18	0.42	0.12	0.11	0.38
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	< 0.1	< 1.	-	0.4	< 1.
NITRITE	MG/L	< 0.1	-	-	0.1	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	0. 1.6	-	-	-
PH	SU	8.30	8.5	8.1	8.0	8.06
PHOSPHATE	MG/L	0.7	-	-	1.4	-
PO-210	PCI/L	-	0. 0.5	-	-	-
POTASSIUM	MG/L	2.26	25.9	5.75	6.83	8.3
RA-226	PCI/L	0.0 0.1	1.7 1.1	-	0.0 0.2	-
RA-228	PCI/L	0.1 2.1	-	-	0.0 2.5	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.042	< 0.005	< 0.005	0.037	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	6.18	-	-	7.36	-
SILVER	MG/L	-	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		630-01 11/03/87	631-01 01/11/86	631-01 05/19/86	631-01 11/04/87	632-01 01/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	553.	2210.	795.	866.	1580.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	88.	4780.	1010.	1170.	73.
SULFIDE	MG/L	< 0.1	-	-	< 0.1	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	11.5	10.	11.	12.0	12.
TH-230	PCI/L	-	0. 0.2	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1430.	7520.	2530.	2650.	4250.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0017	0.0044	0.011	0.0046	0.0009
VANADIUM	MG/L	< 0.01	0.13	-	< 0.01	0.15
ZINC	MG/L	< 0.005	-	-	< 0.005	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		632-01 05/23/86	632-01 11/04/87	633-01 01/13/86	633-01 05/27/86	634-01 01/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	265.	306.	122.	436.	98.
ALUMINUM	MG/L	< 0.1	0.1	0.7	< 0.1	0.6
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.7	0.4	< 0.1	0.3	< 0.1
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	0.013	0.011	< 0.01	0.016	< 0.01
BARIUM	MG/L	0.127	0.11	-	< 0.1	-
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	1.0	-	-	-
CADMIUM	MG/L	< 0.001	< 0.005	< 0.001	< 0.001	< 0.001
CALCIUM	MG/L	31.6	21.2	8.82	7.3	115.
CHLORIDE	MG/L	2180.	1.3	400.	553.	1600.
CHROMIUM	MG/L	-	< 0.01	-	-	-
COBALT	MG/L	< 0.05	-	-	< 0.05	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	5500.	4660.	1400.	2300.	3600.
COPPER	MG/L	< 0.02	-	-	0.024	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	1.7	1.68	-	3.1	-
GROSS ALPHA	PCI/L	< 120.	-	-	< 37.	-
GROSS BETA	PCI/L	< 40.	-	-	< 15.	-
IRON	MG/L	< 0.03	0.02	0.2	< 0.03	0.15
LEAD	MG/L	< 0.01	< 0.01	-	< 0.01	-
MAGNESIUM	MG/L	7.97	5.18	1.15	1.72	21.1
MANGANESE	MG/L	0.019	0.02	0.02	< 0.01	0.06
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.21	0.34	0.82	0.66	0.17
NICKEL	MG/L	< 0.04	-	-	< 0.04	-
NITRATE	MG/L	< 1.	0.9	< 1.	< 1.	< 1.
NITRITE	MG/L	-	< 0.1	-	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	< 1.5	-	-	< 1.5	-
PH	SU	7.95	7.95	10.97	8.4	7.96
PHOSPHATE	MG/L	-	1.0	-	-	-
PO-210	PCI/L	< 1.	-	-	< 1.	-
POTASSIUM	MG/L	5.99	5.90	12.2	2.9	8.55
RA-226	PCI/L	< 1.	0.3 0.2	-	< 1.	-
RA-228	PCI/L	< 1.	0.0 1.5	-	< 1.0	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	0.068	0.006	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	7.8	7.42	-	7.1	-
SILVER	MG/L	-	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		632-01 05/23/86	632-01 11/04/87	633-01 01/13/86	633-01 05/27/86	634-01 01/13/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	1580.	1300.	413.	636.	1070.
STRONTIUM	MG/L	1.62	-	-	0.306	-
SULFATE	MG/L	65.4	73.	203.	131.	349.
SULFIDE	MG/L	-	< 0.1	-	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.	12.2	10.	12.5	9.
TH-230	PCI/L	< 1.	-	-	< 1.	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	-	-	< 0.005	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	4130.	3440.	1110.	1820.	3140.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	< 0.003	0.0017	0.0039	0.0066	0.0007
VANADIUM	MG/L	< 0.01	< 0.01	0.15	< 0.01	0.16
ZINC	MG/L	< 0.005	0.019	-	< 0.005	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		634-01 05/21/86	634-01 10/29/87	640-01 01/16/86	640-01 05/12/86	640-01 11/02/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	87.	64.	209.	227.	288.
ALUMINUM	MG/L	-	0.16	0.5	< 0.1	0.11
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	1.3	1.0	0.4	0.4	0.7
ANTIMONY	MG/L	-	-	0.005	-	-
ARSENIC	MG/L	0.01	0.011	< 0.01	0.01	0.006
BARIUM	MG/L	-	0.10	0.2	< 0.1	0.11
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	0.4	-	-
BROMIDE	MG/L	-	0.6	-	-	5.5
CADMIUM	MG/L	< 0.001	< 0.005	< 0.001	< 0.001	< 0.005
CALCIUM	MG/L	92.	142.	25.8	24.2	30.5
CHLORIDE	MG/L	1370.	1700.	1200.	1360.	1970.
CHROMIUM	MG/L	-	< 0.01	-	-	< 0.01
COBALT	MG/L	-	-	0.03	< 0.05	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	3700.	4300.	3000.	4900.	5140.
COPPER	MG/L	-	-	0.05	< 0.02	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	0.56	1.2	1.8	1.61
GROSS ALPHA	PCI/L	-	-	-	< 80.	-
GROSS BETA	PCI/L	-	-	-	< 26.	-
IRON	MG/L	0.045	0.13	0.11	< 0.03	0.02
LEAD	MG/L	-	< 0.01	< 0.01	< 0.01	< 0.01
MAGNESIUM	MG/L	18.5	27.7	8.67	7.79	8.89
MANGANESE	MG/L	0.058	0.08	0.03	0.039	0.04
MERCURY	MG/L	-	-	< 0.0002	-	-
MOLYBDENUM	MG/L	< 0.01	0.07	0.26	0.142	0.23
NICKEL	MG/L	-	-	0.03	< 0.04	-
NITRATE	MG/L	-	< 0.1	< 1.	< 1.	0.3
NITRITE	MG/L	-	< 0.1	-	-	< 0.1
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	< 1.5	-
PH	SU	8.	7.7	8.13	8.1	8.4
PHOSPHATE	MG/L	-	< 0.1	< 0.1	-	< 0.1
PO-210	PCI/L	-	-	-	< 1.	-
POTASSIUM	MG/L	5.07	6.30	8.05	11.	28.1
RA-226	PCI/L	-	0.2 0.2	-	< 1.	0.8 0.3
RA-228	PCI/L	-	0.5 1.4	-	< 1.	0.4 1.4
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	0.105	< 0.005	< 0.005	0.117
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	7.45	4.	7.3	7.19
SILVER	MG/L	-	-	< 0.01	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		634-01 05/21/86	634-01 10/29/87	640-01 01/16/86	640-01 05/12/86	640-01 11/02/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	914.	1060.	963.	1050.	1490.
STRONTIUM	MG/L	-	-	0.9	0.984	-
SULFATE	MG/L	236.	300.	298.	253.	316.
SULFIDE	MG/L	-	< 0.1	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.5	12.0	14.	14.5	13.8
TH-230	PCI/L	-	-	-	< 1.	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	< 0.005	< 0.005	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	2910.	13400.	2570.	2910.	3930.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	< 0.003	< 0.0003	0.0058	0.006	0.0040
VANADIUM	MG/L	-	0.04	0.2	< 0.01	0.03
ZINC	MG/L	-	< 0.005	0.041	< 0.005	0.440

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		641-01 05/14/86	641-01 10/29/87	642-01 01/15/86	642-01 05/21/86	642-01 11/04/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	249.	280.	2473.	412.	40.
ALUMINUM	MG/L	-	0.08	0.3	-	0.19
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.6	0.4	3.7	4.2	2.7
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.01	0.004	< 0.01	< 0.01	0.002
BARIUM	MG/L	-	0.03	-	-	2.58
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	1.2	-	-	9.3
CADMIUM	MG/L	< 0.001	< 0.005	< 0.001	< 0.001	< 0.005
CALCIUM	MG/L	12.8	12.7	257.	264.	175.
CHLORIDE	MG/L	670.	590.	4300.	3660.	2.5
CHROMIUM	MG/L	-	< 0.01	-	-	< 0.01
COBALT	MG/L	-	-	-	-	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	3300.	3300.	9000.	11000.	11000.
COPPER	MG/L	-	-	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	2.45	-	-	0.55
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.06	0.01	0.04	< 0.03	0.04
LEAD	MG/L	-	< 0.01	-	-	< 0.01
MAGNESIUM	MG/L	4.35	3.92	34.7	0.25	20.0
MANGANESE	MG/L	0.054	0.01	0.01	< 0.01	0.01
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.24	0.25	0.2	< 0.01	0.08
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	< 0.1	2.	-	< 0.1
NITRITE	MG/L	-	< 0.1	-	-	< 0.1
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.7	8.6	12.34	13.	10.9
PHOSPHATE	MG/L	-	< 0.1	-	-	2.1
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	6.87	9.00	54.	108.	37.1
RA-226	PCI/L	-	0.2 0.2	-	-	1.2 0.4
RA-228	PCI/L	-	0.0 1.5	-	-	3.7 1.9
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	0.053	< 0.005	< 0.005	0.233
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	6.33	-	-	5.33
SILVER	MG/L	-	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		641-01 05/14/86	641-01 10/29/87	642-01 01/15/86	642-01 05/21/86	642-01 11/04/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	954.	943.	3340.	2400.	3160.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	880.	973.	37.	22.7	9.
SULFIDE	MG/L	-	< 0.1	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	14.	14.0	11.	10.	12.0
TH-230	PCI/L	-	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	2750.	2590.	8740.	7580.	8790.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.015	0.0040	0.0016	< 0.003	< 0.0003
VANADIUM	MG/L	-	0.03	0.06	-	0.03
ZINC	MG/L	-	< 0.005	-	-	< 0.005

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		643-01 01/15/86		643-01 05/21/86		644-01 01/11/86		644-01 05/13/86		645-01 01/11/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	3607.		2325.		347.		300.		243.	
ALUMINUM	MG/L	0.2		-		0.6		< 0.1		0.8	
AMMONIA	MG/L	-		-		-		-		-	
AMMONIUM	MG/L	1600.		880.		2.3		0.3		< 0.1	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
BARIUM	MG/L	-		-		-		0.11		-	
BERYLLIUM	MG/L	-		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
BROMIDE	MG/L	-		-		-		-		-	
CADMIUM	MG/L	< 0.001		< 0.001		-		< 0.001		-	
CALCIUM	MG/L	256.		419.		10.7		9.5		10.2	
CHLORIDE	MG/L	1100.		945.		1340.		1440.		510.	
CHROMIUM	MG/L	-		-		-		-		-	
COBALT	MG/L	-		-		-		< 0.05		-	
COND,IN-SITU	UMHO/CM	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	16000.		16000.		3400.		3600.		1700.	
COPPER	MG/L	-		-		-		< 0.02		-	
CYANIDE	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	-		-		-		1.9		-	
GROSS ALPHA	PCI/L	-		-		7.	20.	< 78.		1.	9.6
GROSS BETA	PCI/L	-		-		20.	10.	< 26.		7.4	6.
IRON	MG/L	0.14		0.062		0.08		< 0.03		0.09	
LEAD	MG/L	-		-		-		< 0.01		-	
MAGNESIUM	MG/L	34.4		8.97		5.69		3.03		1.87	
MANGANESE	MG/L	0.01		< 0.01		0.04		0.031		0.03	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	5.07		4.42		0.45		0.218		0.17	
NICKEL	MG/L	-		-		-		< 0.04		-	
NITRATE	MG/L	97.		-		2.		< 1.		< 1.	
NITRITE	MG/L	-		-		-		-		-	
NITROGEN,KJL	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	-		-		1.6	0.7	< 1.5		0.7	0.6
PH	SU	10.69		11.1		9.09		8.8		8.46	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		0.	0.5	< 1.		0.	0.4
POTASSIUM	MG/L	54.5		62.3		23.3		10.8		3.4	
RA-226	PCI/L	-		-		0.3	0.2	< 1.		0.2	0.2
RA-228	PCI/L	-		-		0.1	0.8	< 1.		0.	0.9
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	0.006		0.006		< 0.005		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		-		8.2		-	
SILVER	MG/L	-		-		-		-		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		643-01 01/15/86		643-01 05/21/86		644-01 01/11/86		644-01 05/13/86		645-01 01/11/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
SODIUM	MG/L	6290.		6120.		1110.		1050.		519.	
STRONTIUM	MG/L	-		-		-		0.649		-	
SULFATE	MG/L	13900.		11800.		284.		20.4		204.	
SULFIDE	MG/L	-		-		-		-		-	
TEMP,IN-SITU	C-DEGREE	-		-		-		-		-	
TEMPERATURE	C - DEGREE	10.5		12.5		12.		11.5		10.5	
TH-230	PCI/L	-		-		0.2	0.3	< 1.		0.7	0.5
THALLIUM	MG/L	-		-		-		-		-	
TIN	MG/L	-		-		-		< 0.005		-	
TITANIUM	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	22200.		20200.		2860.		2820.		1350.	
TOTAL U	PPM	-		-		-		-		-	
URANIUM	MG/L	0.0673		< 0.003		0.0035		< 0.003		0.0013	
VANADIUM	MG/L	0.06		-		0.1		< 0.01		0.16	
ZINC	MG/L	-		-		-		< 0.005		-	

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		645-01 05/13/86	645-01 11/04/87	646-01 01/14/86	646-01 05/15/86	646-01 10/28/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	260.	272.	186.	153.	141.
ALUMINUM	MG/L	< 0.1	0.07	0.2	-	0.13
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.3	0.4	1.1	1.8	1.9
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.01	0.009	< 0.01	< 0.01	0.007
BARIUM	MG/L	< 0.1	0.04	-	-	1.30
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	1.5	-	-	1.0
CADMIUM	MG/L	< 0.001	< 0.005	< 0.001	< 0.001	< 0.005
CALCIUM	MG/L	7.76	7.34	158.	136.	127.
CHLORIDE	MG/L	475.	0.8	4900.	4890.	5200.
CHROMIUM	MG/L	-	< 0.01	-	-	< 0.01
COBALT	MG/L	< 0.05	-	-	-	-
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1800.	1620.	8500.	10200.	10610.
COPPER	MG/L	< 0.02	-	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	1.3	1.39	-	-	0.76
GROSS ALPHA	PCI/L	< 39.	-	-	-	-
GROSS BETA	PCI/L	< 15.	-	-	-	-
IRON	MG/L	< 0.03	0.01	0.07	0.08	0.14
LEAD	MG/L	< 0.01	< 0.01	-	-	< 0.01
MAGNESIUM	MG/L	1.59	1.30	34.6	29.6	28.7
MANGANESE	MG/L	0.05	0.05	0.2	0.096	0.11
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.051	0.08	0.19	< 0.01	0.08
NICKEL	MG/L	< 0.04	-	-	-	-
NITRATE	MG/L	< 1.	< 0.1	< 1.	-	< 0.1
NITRITE	MG/L	-	< 0.1	-	-	< 0.1
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	< 1.5	-	-	-	-
PH	SU	8.5	8.30	7.69	7.6	7.6
PHOSPHATE	MG/L	-	0.6	-	-	1.84
PO-210	PCI/L	< 1.	-	-	-	-
POTASSIUM	MG/L	2.65	2.60	9.33	8.84	9.06
RA-226	PCI/L	< 1.	0.0 0.2	-	-	1.7 0.5
RA-228	PCI/L	< 1.	0.8 1.9	-	-	3.9 2.0
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	0.037	< 0.005	< 0.005	0.156
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	7.4	6.63	-	-	6.65
SILVER	MG/L	-	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		645-01 05/13/86	645-01 11/04/87	646-01 01/14/86	646-01 05/15/86	646-01 10/28/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	500.	478.	3040.	3040.	3200.
STRONTIUM	MG/L	0.354	-	-	-	-
SULFATE	MG/L	188.	229.	78.	31.	25.
SULFIDE	MG/L	-	< 0.1	-	-	< 0.1
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	12.5	12.0	11.	10.	11.2
TH-230	PCI/L	< 1.	-	-	-	-
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	< 0.005	-	-	-	-
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1460.	1300.	7500.	8500.	8670.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	< 0.003	0.0004	0.0005	< 0.003	0.0005
VANADIUM	MG/L	< 0.01	< 0.01	0.05	-	0.03
ZINC	MG/L	< 0.005	0.037	-	-	< 0.005

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		647-01 01/14/86	647-01 05/15/86	647-01 10/28/87	650-01 01/14/86	650-01 05/23/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	283.	280.	270.	193.	162.
ALUMINUM	MG/L	1.4	-	0.03	0.2	< 0.1
AMMONIA	MG/L	-	-	-	-	-
AMMONIUM	MG/L	0.3	0.4	0.4	14.	4.1
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.01	< 0.01	0.007	< 0.01	< 0.01
BARIUM	MG/L	-	-	0.04	-	< 0.1
BERYLLIUM	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
BROMIDE	MG/L	-	-	0.8	-	-
CADMIUM	MG/L	< 0.001	< 0.001	< 0.005	< 0.001	< 0.001
CALCIUM	MG/L	5.99	4.1	3.96	20.1	19.1
CHLORIDE	MG/L	560.	480.	490.	2200.	2180.
CHROMIUM	MG/L	-	-	< 0.01	-	-
COBALT	MG/L	-	-	-	-	< 0.05
COND,IN-SITU	UMHO/CM	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1650.	1800.	1900.	6000.	6100.
COPPER	MG/L	-	-	-	-	< 0.02
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	-	-	2.28	-	-
GROSS ALPHA	PCI/L	-	-	-	-	< 110.
GROSS BETA	PCI/L	-	-	-	-	< 39.
IRON	MG/L	0.06	< 0.03	< 0.01	0.08	< 0.03
LEAD	MG/L	-	-	< 0.01	-	< 0.01
MAGNESIUM	MG/L	1.84	1.3	1.27	28.8	15.2
MANGANESE	MG/L	0.03	< 0.01	< 0.01	0.03	< 0.01
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	0.2	< 0.01	0.11	0.41	0.25
NICKEL	MG/L	-	-	-	-	< 0.04
NITRATE	MG/L	< 1.	-	< 0.1	18.	4.
NITRITE	MG/L	-	-	< 0.1	-	-
NITROGEN,KJL	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	< 1.5
PH	SU	8.5	8.9	8.4	9.74	9.1
PHOSPHATE	MG/L	-	-	0.58	-	-
PO-210	PCI/L	-	-	-	-	< 1.
POTASSIUM	MG/L	3.09	2.42	1.78	65.3	28.1
RA-226	PCI/L	-	-	0.0 0.1	-	< 1.
RA-228	PCI/L	-	-	0.0 1.9	-	< 1.0
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	< 0.005	< 0.005	0.023	< 0.005	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	6.42	-	6.5
SILVER	MG/L	-	-	-	-	-

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		647-01 01/14/86	647-01 05/15/86	647-01 10/28/87	650-01 01/14/86	650-01 05/23/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
SODIUM	MG/L	589.	558.	555.	1810.	1730.
STRONTIUM	MG/L	-	-	-	-	1.9
SULFATE	MG/L	247.	234.	209.	890.	454.
SULFIDE	MG/L	-	-	< 0.1	-	-
TEMP,IN-SITU	C-DEGREE	-	-	-	-	-
TEMPERATURE	C - DEGREE	10.	11.	10.5	11.	11.
TH-230	PCI/L	-	-	-	-	< 1.
THALLIUM	MG/L	-	-	-	-	-
TIN	MG/L	-	-	-	-	< 0.005
TITANIUM	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	1460.	1560.	1450.	5120.	4580.
TOTAL U	PPM	-	-	-	-	-
URANIUM	MG/L	0.0003	< 0.003	0.0011	0.0162	0.013
VANADIUM	MG/L	0.06	-	< 0.01	0.2	< 0.01
ZINC	MG/L	-	-	< 0.005	-	< 0.005

Table E.2.14 Groundwater quality data by location, New Rifle site (Continued)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		651-01 01/15/86	651-01 05/23/86	651-01 11/03/87		
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	2679.	189.	187.		
ALUMINUM	MG/L	70.4	< 0.1	0.12		
AMMONIA	MG/L	-	-	-		
AMMONIUM	MG/L	51.	0.5	1.0		
ANTIMONY	MG/L	-	-	-		
ARSENIC	MG/L	< 0.01	< 0.01	0.007		
BARIUM	MG/L	-	< 0.1	0.09		
BERYLLIUM	MG/L	-	-	-		
BORON	MG/L	-	-	-		
BROMIDE	MG/L	-	-	1.0		
CADMIUM	MG/L	< 0.001	< 0.001	< 0.005		
CALCIUM	MG/L	1660.	18.5	72.8		
CHLORIDE	MG/L	4200.	556.	722.		
CHROMIUM	MG/L	-	-	< 0.01		
COBALT	MG/L	-	< 0.05	-		
COND,IN-SITU	UMHO/CM	-	-	-		
CONDUCTANCE	UMHO/CM	6000.	2600.	3650.		
COPPER	MG/L	-	< 0.02	-		
CYANIDE	MG/L	-	-	-		
FLUORIDE	MG/L	-	3.2	1.38		
GROSS ALPHA	PCI/L	-	< 56.	-		
GROSS BETA	PCI/L	-	< 20.	-		
IRON	MG/L	152.	0.03	0.03		
LEAD	MG/L	-	< 0.01	< 0.01		
MAGNESIUM	MG/L	271.	4.	14.6		
MANGANESE	MG/L	17.9	< 0.01	0.07		
MERCURY	MG/L	-	-	-		
MOLYBDENUM	MG/L	0.23	0.02	0.05		
NICKEL	MG/L	-	< 0.04	-		
NITRATE	MG/L	24.	1.	< 0.1		
NITRITE	MG/L	-	-	< 0.1		
NITROGEN,KJL	MG/L	-	-	-		
NO2 & NO3	MG/L	-	-	-		
ORG. CARBON	MG/L	-	-	-		
PB-210	PCI/L	-	< 1.5	-		
PH	SU	9.9	8.55	8.00		
PHOSPHATE	MG/L	-	-	1.50		
PO-210	PCI/L	-	< 1.	-		
POTASSIUM	MG/L	60.	3.72	5.85		
RA-226	PCI/L	-	< 1.	0.5	0.3	
RA-228	PCI/L	-	< 1.0	1.6	2.5	
REDOX POTENT	MVOLTS	-	-	-		
SELENIUM	MG/L	< 0.005	< 0.005	0.055		
SILCON	MG/L	-	-	-		
SILICA	MG/L	-	7.1	7.68		
SILVER	MG/L	-	-	-		

Table E.2.14 Groundwater quality data by location, New Rifle site (Concluded)

FORMATION OF COMPLETION: NO RECOVERY OF DATA FOR CLASSIFYING
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE					
		651-01 01/15/86	651-01 05/23/86	651-01 11/03/87			
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY			
SODIUM	MG/L	400.	842.	1090.			
STRONTIUM	MG/L	-	0.732	-			
SULFATE	MG/L	2810.	811.	1370.			
SULFIDE	MG/L	-	-	< 0.1			
TEMP,IN-SITU	C-DEGREE	-	-	-			
TEMPERATURE	C - DEGREE	11.	11.	12.0			
TH-230	PCI/L	-	< 1.	-			
THALLIUM	MG/L	-	-	-			
TIN	MG/L	-	< 0.005	-			
TITANIUM	MG/L	-	-	-			
TOTAL SOLIDS	MG/L	10300.	2430.	3370.			
TOTAL U	PPM	-	-	-			
URANIUM	MG/L	0.12	0.0043	0.0014			
VANADIUM	MG/L	0.45	0.011	< 0.01			
ZINC	MG/L	-	0.007	0.015			

MAPPER DATA FILE NAME: RFN01*UDPGWQ103018

Table E.2.15 Background water quality and contaminant concentrations in alluvial groundwater, New Rifle site

Background wells: RFO 603, 604 and RFN 591, 592 On-site and downgradient wells: 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 593, 594, 595, 596, 598, 599, 600, 601, 602, 603, 604, 605, 608, 608, 610, 615, 616, 618, 619

		BACKGROUND CONCENTRATIONS					DOWNGRADIENT CONCENTRATIONS					
Parameter	MCL (mg/l)	Background sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)	Downgradient sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)
Proposed EPA Groundwater Protection Standards (40 CFR 192):													
Arsenic	0.05	13	0.005	592	0.005	0.001	0.006	75	1.240	582	0.084	0.342	0.769
Barium	1.0	9	0.055	591	0.041	0.020	0.081	59	0.200	596,619	0.050	0.052	0.153
Cadmium	0.01	12	0.004	592	0.002	0.002	0.007	50	0.090	584	0.009	0.019	0.047
Chromium	0.05	9	0.030	592	0.013	0.025	0.063	59	0.128	599	0.036	0.054	0.143
Lead	0.05	9	0.008	603	0.006	0.002	0.009	39	0.060	593	0.010	0.011	0.033
Mercury	0.00	0	0.000	ALL	0.000	N.A.	N.A.	3	0.000	ALL	0.000	N.A.	N.A.
Molybdenum	0.10	13	0.110	592	0.105	0.063	0.230	75	11.250	593	2.788	3.140	9.070
Nitrate	44.0	12	9.1	604	8.5	9.3	27.1	61	688.0	619	121.7	243.0	607.6
Selenium	0.01	13	0.021	603	0.010	0.007	0.024	75	0.347	589	0.090	0.155	0.399
Silver	0.05	5	0.008	592	0.006	0.002	0.010	24	0.020	584	0.008	0.006	0.019
Uranium	0.04	12	0.094	591	0.053	0.035	0.123	51	1.032	593	0.239	0.269	0.778
Ra 226/228 (pCi/L)	5.	5	1.7	603	0.8	1.0	2.8	24	3.3	595	1.2	1.8	4.8
Gross Alpha (pCi/L)	15.	5	16.5	RFO 603	4.1	8.3	20.6	26	85.8	596	4.7	19.2	43.1
Appendix I Inorganic Constituents (40 CFR 192):													
Antimony	None	5	0.012	592	0.006	0.009	0.024	23	0.140	584	0.021	0.047	0.116
Beryllium	None	1	0.005	N.A.	0.005	N.A.	N.A.	3	0.005	ALL	0.005	N.A.	N.A.
Carbon Disulphide	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Cobalt	None	5	0.025	ALL	0.025	N.A.	N.A.	44	0.670	593	0.075	0.117	0.310
Copper	None	4	0.015	592	0.012	0.004	0.021	43	0.245	590	0.073	0.104	0.280
Cyanide	None	1	0.005	592	N.A.	N.A.	N.A.	3	0.005	ALL	0.005	N.A.	N.A.
Fluorine	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Nickel	None	5	0.030	592	0.024	0.009	0.042	24	1.430	593	0.138	0.292	0.721
Sulfide	None	8	0.425	603	0.188	0.276	0.739	35	1.900	605	0.210	0.408	1.026
Thallium	None	1	0.005	592	0.005	N.A.	N.A.	3	0.020	581	0.017	0.006	0.028
Tin	None	5	0.006	592	0.004	0.003	0.010	23	0.177	595	0.057	0.047	0.150
Vanadium	None	13	0.182	591	0.125	0.170	0.465	75	19.450	593	1.975	4.694	11.360
Zinc	None	9	0.072	592	0.039	0.068	0.175	58	14.900	593	0.860	2.144	5.147
Detection Constituents:													
Calcium	None	13	212.2	603	175.8	54.6	285.0	75	697.0	593	434.5	184.8	804.1
Chloride	None	13	85.3	603	60.0	24.2	108.4	75	1415.0	593	572.6	386.4	1346.0
Iron	None	13	1.2	592	0.6	0.6	1.8	75	56.2	593	11.4	18.9	49.3
Magnesium	None	13	164.0	603	133.2	35.0	203.2	75	395.5	598	171.7	100.1	371.9
Manganese	None	13	2.5	591	1.3	1.2	3.7	75	35.0	593	13.3	11.1	35.6
Potassium	None	13	10.0	603	7.0	2.9	12.8	75	412.3	589	131.7	111.2	354.1
Sodium	None	13	323.7	603	271.2	70.7	412.5	75	12063.0	584	4657.6	4034.0	12730.0
Sulfate	None	13	1242.0	603	942.7	316.0	1574.0	75	37200.0	593	12790.0	10520.0	33820.0
TDS	None	13	2613.0	603	2049.0	636.0	3321.0	71	61650.0	593	20128.0	16470.0	53070.0
Alkalinity	None	13	628.0	591	572.3	115.9	804.2	74	2019.5	593	832.4	389.6	1611.0
pH	None	13	7.1	592	7.1	N.A.	N.A.	75	7.4	585	7.0	N.A.	N.A.

LEGEND

△ BACKGROUND WELL

o WELL COMPLETED THROUGH THE TAILINGS

• DOWNGRADIENT OR CROSSGRADIENT WELL

(TRILINEAR SCALES ARE PERCENTAGES OF EQUIVALENTS PER LITER OF MAJOR IONS.)

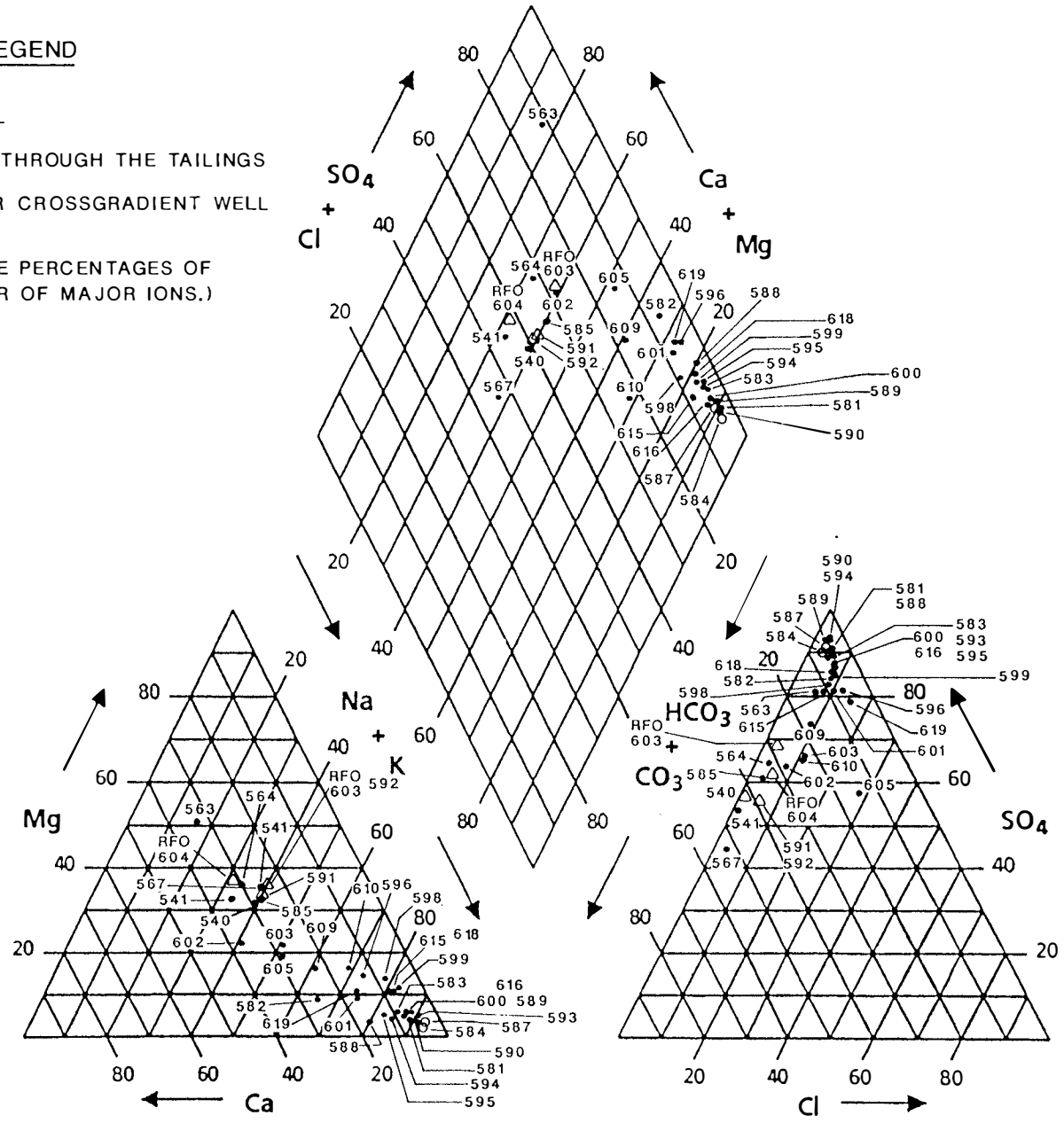


FIGURE E.2.22
TRILINEAR DIAGRAM OF ALLUVIAL GROUNDWATER
NEW RIFLE SITE

Background groundwater from the Wasatch Formation at the New Rifle site is summarized in Table E.2.16. In general, groundwater from the Wasatch Formation contains relatively high concentrations of sodium and TDS with considerable natural variability in constituent concentrations. Background concentrations of barium, molybdenum, selenium, and activities of gross alpha and radium-226 and -228 combined exceed the proposed EPA groundwater protection standards. Uncontaminated groundwater from the Wasatch Formation is a sodium sulfate type of water (Figure E.2.23).

Tailings and milling process characterization

Major sources of contamination at the New Rifle site are seepage from the tailings pile and from the vanadium ponds east of the tailings (Figure E.2.4). The vanadium ponds cover an area of 6 acres and are currently dry, although surface runoff may accumulate in them during the spring. The tailings pile at the New Rifle site is 33 acres in area and contains an estimated 2,415,000 cubic yards of tailings. The tailings are a mixture of sands and slimes and consist of the processed ore material and the chemicals used in the milling processes.

The milling processes used at the New Rifle site included the separation and purification of the uranium products with solvent extraction (Merritt, 1971). Ores containing uranium and low vanadium contents were separated by direct acid leaching, while ores with higher vanadium contents were initially salt roasted. The ores were then water- and acid-leached to remove the sodium vanadate and to dissolve the uranium. Solvent extraction using di (2-ethylhexyl) phosphoric acid (EHPA) was conducted to recover the uranium and vanadium. The vanadium was precipitated with sodium chlorite and sodium carbonate, and by heating and the addition of sulfuric acid. Finally, the precipitates were purified by redissolving them in ammoniacal solution and crystallizing ammonium metavanadate by adding ammonium chloride (Merritt, 1971).

The chemical characteristics of the contaminant source at the New Rifle site were evaluated from analyses of groundwater beneath the tailings and analyses of water extracts from the tailings (Markos and Bush, 1983). The average contaminant concentrations in groundwater from monitor wells 584, 586, 587, 593, and 594 screened in the alluvium beneath the tailings or adjacent to the vanadium ponds are presented in Table E.2.17. The estimated contaminant source concentrations, back-calculated from these data and extrapolated from the water extracts, are also presented in Table E.2.17.

Table E.2.16 Background water quality and contaminant concentrations in Wasatch Formation groundwater, New Rifle site

Background wells: 640, 641, 644, 645, 646, 647 On-site and downgradient wells: 611, 612, 613, 614, 621, 622, 623, 624, 625, 626, 627, 629, 630, 631, 632, 633, 634, 651

		BACKGROUND CONCENTRATIONS					DOWNGRADIENT CONCENTRATIONS					
Parameter	MCL (mg/l)	Background sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)	Downgradient sample size	Maximum (mg/l)	Well	Mean (mg/l)	Standard deviation	Statistical maximum (mg/l)
Proposed EPA Groundwater Protection Standards (40 CFR 192):													
Arsenic	0.05	16	0.007	640	0.006	0.002	0.009	52	0.024	611	0.010	0.013	0.036
Barium	1.00	9	1.300	646	0.214	0.411	1.036	52	2.740	625	0.276	0.678	1.632
Cadmium	0.01	14	0.002	641,645	0.001	0.001	0.003	31	0.002	613,624	0.001	0.001	0.004
Chromium	0.05	5	0.005	ALL	0.005	N.A.	N.A.	19	0.005	ALL	0.005	0.000	0.006
Lead	0.05	9	0.005	ALL	0.005	N.A.	N.A.	31	0.028	624	0.009	0.011	0.031
Mercury	0.002	0	0.000	ALL	0.000	N.A.	N.A.	6	0.000	ALL	0.000	N.A.	N.A.
Molybdenum	0.10	16	0.334	644	0.168	0.114	0.395	52	1.725	613	0.524	0.726	1.975
Nitrate	44.0	13	1.3	644	0.5	0.5	1.5	40	20.0	623	3.3	7.8	18.8
Selenium	0.01	16	0.354	646	0.026	0.046	0.118	52	0.218	611	0.092	0.186	0.465
Silver	0.05	0	0.005	640	0.005	N.A.	N.A.	10	0.005	ALL	0.005	N.A.	N.A.
Uranium	0.04	16	0.10	641	0.003	0.004	0.010	51	0.455	624	0.115	0.187	0.489
Ra-226/228 (pCi/L)	5.0	10	5.6	646	1.1	1.7	4.5	28	7.1	625	1.9	2.8	7.5
Gross Alpha (pCi/L)	15.0	5	36.3	640	22.4	13.4	49.2	14	113.8	621	28.1	43.7	115.4
Appendix I Inorganic Constituents (40 CFR 192):													
Antimony	None	1	0.005	640	0.005	N.A.	N.A.	10	0.002	ALL	0.002	N.A.	N.A.
Beryllium	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Carbon Disulphide	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Cobalt	None	4	0.028	640	0.026	0.003	0.031	16	0.210	613	0.065	0.054	0.173
Copper	None	4	0.030	640	0.020	0.020	0.060	18	0.060	624	0.024	0.016	0.056
Cyanide	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Fluorine	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Nickel	None	4	0.025	640	0.023	0.005	0.033	16	0.260	624	0.060	0.068	0.196
Sulphide	None	5	0.050	ALL	0.050	N.A.	N.A.	19	0.500	614	0.083	0.107	0.297
Thallium	None	0	N.A.	N.A.	N.A.	N.A.	N.A.	0	N.A.	N.A.	N.A.	N.A.	N.A.
Tin	None	4	0.003	ALL	0.003	N.A	N.A.	16	0.189	611	0.024	0.051	0.125
Vanadium	None	13	0.078	640	0.053	0.064	0.180	40	0.463	611	0.151	0.174	0.498
Zinc	None	9	0.020	645	0.059	0.144	0.347	31	0.592	613	0.109	0.201	0.511
Detection Constituents:													
Calcium	None	16	140.3	646	36.7	52.3	141.3	52	583.8	651	302.7	279.9	862.4
Chloride	None	16	4996.7	646	1629.7	1743.0	5116.0	52	5184.2	625	1437.4	1614.0	4665.0
Iron	None	9	0.1	646	0.0	0.0	0.1	52	50.7	651	10.4	23.8	57.9
Magnesium	None	16	31.0	646	9.0	11.3	31.5	52	288.3	611	129.2	116.9	363.1
Manganese	None	16	0.1	646	0.1	0.0	0.1	52	15.6	611	4.2	6.0	16.3
Potassium	None	16	17.1	644	8.8	7.4	23.6	52	216.7	624	62.0	75.0	212.0
Sodium	None	15	3093.3	646	1252.4	956.5	3165.0	52	9107.5	613	3270.7	3214.0	10150.0
Sulfate	None	16	926.5	641	279.3	271.2	821.7	52	26360.0	613	8076.5	9942.0	27960.0
TDS	None	16	8223.0	646	3355.0	2540.0	8436.0	52	40069.0	613	14643.5	13280.0	41200.0
Alkalinity	None	16	323.5	644	249.3	54.7	358.6	52	1419.8	611	622.3	570.9	1764.0
pH	None	16	8.9	644	8.1	N.A.	N.A.	52	8.7	633	7.4	N.A.	N.A.

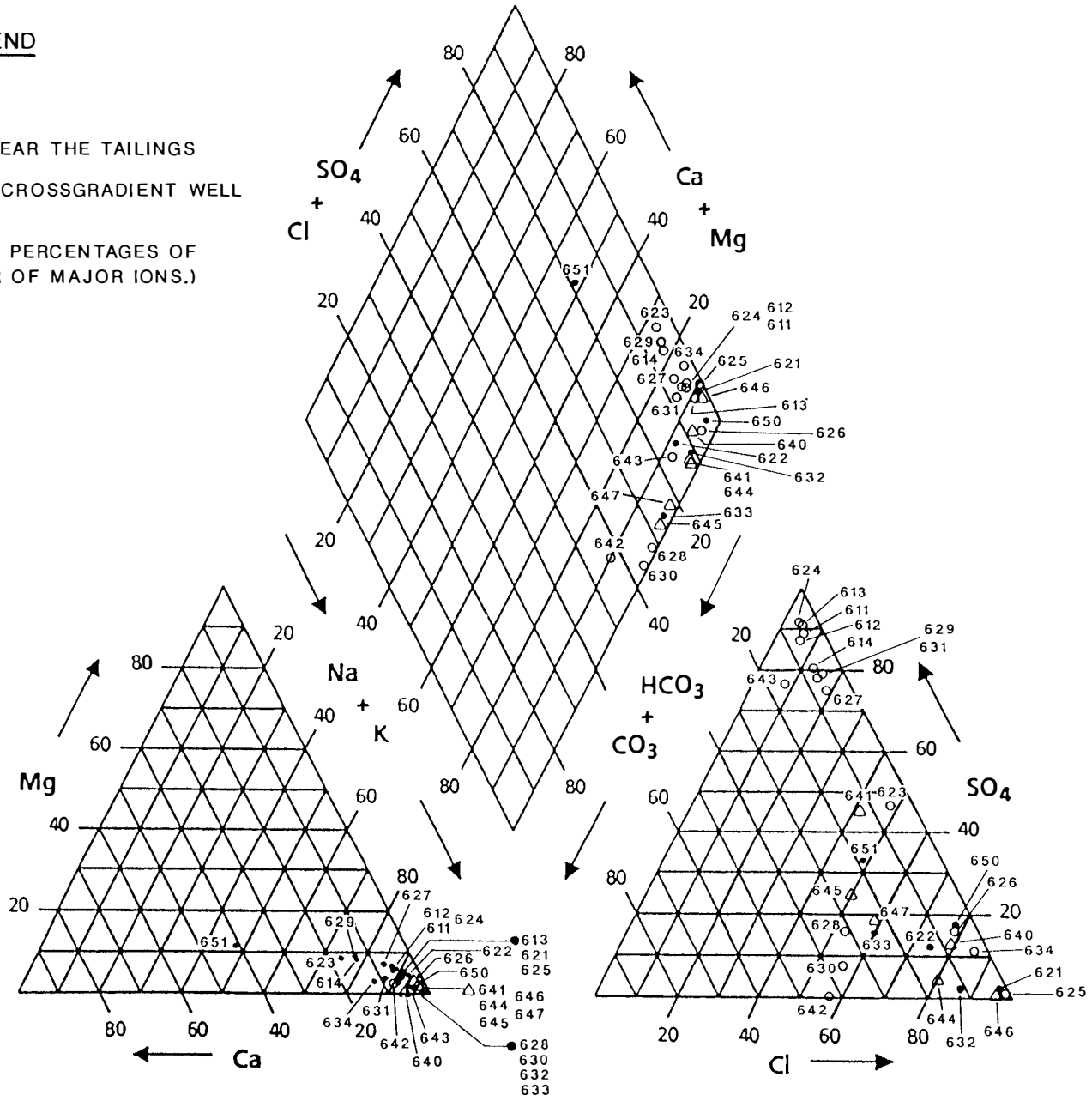


FIGURE E.2.23
TRILINEAR DIAGRAM OF WASATCH FORMATION GROUNDWATER
NEW RIFLE SITE

Table E.2.17 Contaminant source concentrations, New Rifle Site

Parameter	MCL (mg/l)	Sample size	Maximum subpile conc. (mg/l)	Average subpile conc. (mg/l)	Back-calculated source (mg/l)	Tailings leach conc. (mg/l)
Proposed EPA groundwater protection standards (40 CFR 192):						
Arsenic	0.05	13	2.39	0.215	1.646	6.1
Barium	1.0	11	0.23	0.0505	0.11	28.5
Cadmium	0.01	7	0.09	0.0255	0.191	NA
Chromium	0.05	11	0.18	0.066	0.481	2.63
Lead	0.05	5	0.06	0.029	0.187	1.88
Mercury	0.002	2	<0.0002	<0.0002	<0.0002	NA
Molybdenum	0.1	13	12.7	4.859	37.181	6.78
Nitrate	44.0	8	310	39.99	251.5	NA
Selenium	0.01	13	0.21	0.054	0.346	7.76
Silver	0.05	4	0.02	0.0125	0.063	NA
Uranium	0.044	7	1.31	0.327	2.309	0.78
Ra-226/228 (pCi/l)	5.0	0	NA	NA	NA	NA
Gross Alpha (pCi/l)	15.0	2	62	31.5	49.913	7.14
Appendix IX Inorganic constituents (40 CFR 192):						
Antimony	None	4	0.14	0.0597	0.455	NA
Beryllium	None	2	0.005	0.005	NA	NA
Carbon disulfide	None	0	NA	NA	NA	NA
Cobalt	None	10	0.67	0.1497	0.997	DL
Copper	None	10	0.41	0.11	0.79	NA
Cyanide	None	2	<0.01	<0.01	<0.01	NA
Fluorine	None	0	NA	NA	NA	NA
Nickel	None	4	1.43	0.525	3.959	4
Sulfide	None	3	0.4	0.1667	NA	NA
Thallium	None	2	0.02	0.015	NA	NA
Tin	None	4	0.105	0.0585	0.434	NA
Vanadium	None	13	20.5	4.999	38.213	80
Detection constituents:						
Calcium	None	13	813	583.5	3338.4	NA
Chlroide	None	13	1430	767.7	5569.6	NA
Iron	None	13	97	32.4	249.303	NA
Magnesium	None	13	362	148.4	228.364	NA
Manganese	None	13	51.1	18.27	135.73	NA
Potassium	None	13	205	104.4	759.86	NA
Sodium	None	13	16400	7445	56270.2	NA
Sulfate	None	13	40400	19577	146108.5	59843
TDS	None	11	69300	35884	265808.8	NA
Alkalinity	None	13	2068	1044.6	4608	NA
pH	None	13	8.4	7.09	NA	NA

The contaminant source concentrations were back-calculated using relative mass rates of inflow based on annual precipitation and estimated recharge through the tailings and on groundwater underflow and background and contaminant concentrations in the alluvial groundwater. The source concentrations were developed using simple mixing calculations and do not account for geochemical attenuation. For this reason, the back-calculated source concentrations are not conservative. All calculations are on file at the UMTRA Project Office in Albuquerque, New Mexico.

Estimates of contaminant concentrations in the tailings fluids were also obtained by leaching the tailings with deionized water (Markos and Bush, 1983). The water extracts were then analyzed to yield the concentrations of leachable constituents in the tailings. These results were used with the average moisture content of the tailings to estimate the tailings pore fluid concentrations (Table E.2.19). The calculations are conservative, as they assume that all leachable concentrations of contaminants occur in the (undiluted) tailings pore fluids. These calculations are on file in the UMTRA Project Office in Albuquerque.

Five lysimeters were installed in the New Rifle tailings and in a vanadium pond in October 1988; however, all were dry. Two samples of tailings and one sample of sludge from a vanadium pond have been analyzed for Appendix IX (40 CRF 264) organics. The herbicide 2,4-D and Silvex (2,4,5-TP) were found in the vanadium pond sludge at concentrations of 410 ppb and 62 ppb, respectively.

The seepage flux of tailings leachate into groundwater may be estimated using Darcy's Law. The lowest saturated hydraulic conductivity in a stratified geologic system controls the seepage flux perpendicular to the strata under saturated conditions. Based on triaxial permeability tests, the saturated hydraulic conductivity of the tailings at the New Rifle site ranges from 0.01 cm/s to 7.2×10^{-7} cm/s (DOE, 1987), and average (geometric mean) 1.7×10^{-4} cm/s. Although the New Rifle tailings contain considerably more slimes than the Old Rifle tailings, the slimes are discontinuous throughout the pile and the average hydraulic conductivity is relatively high. For this reason, infiltration is still controlled by precipitation. Based on the average precipitation of 11 inches per year and assuming a conservative 20 percent net infiltration, the total annual seepage through the New Rifle tailings pile from precipitation averages 5400 gallons per day (3.8 gpm). This does not include infiltration due to irrigation for dust control purposes, and actual infiltration may be somewhat greater when the tailings are being irrigated.

Extent of contamination

Alluvium

The seepage of tailings and vanadium pond fluids has significantly affected groundwater quality in the alluvium at the New Rifle site. The areal extent of contamination is much greater than at the Old Rifle site (Figures E.2.24 and E.2.25) and the concentrations of contaminants exceed the EPA MCLs by a greater margin.

The contaminant plume in the alluvium extends over an area of more than 400 acres at the New Rifle site. Groundwater in the entire depth of alluvium has been contaminated, with the highest concentrations of contaminants occurring immediately beneath and downgradient of the tailings pile and vanadium ponds. Most of the contamination occurs within 4000 feet of the New Rifle tailings pile (Figures E.2.24 and E.2.25), although concentrations of sulfate, total dissolved solids (TDS), and chloride exceed background concentrations in monitor well 605 located 8000 feet west of the tailings. Contaminated groundwater in the alluvium discharges into the Colorado River southwest of the pile but does not affect the river water quality (Section E.1.3.1).

The distribution of nitrate and uranium concentrations (Figure E.2.24 and E.2.25) were used to define the approximate area extent of the contamination in the alluvium. Both of these constituents are relatively mobile in groundwater and are found beneath the site in concentrations greatly above background. Sulfate, however, is a more conservative constituent than uranium and is a better indicator of the actual extent of the contamination.

Tailings seepage has affected groundwater quality beneath the pile. Average water quality analyses of groundwater samples from monitor wells 584, 586, 587, and 588 are presented in Table E.2.17. The groundwater is a sodium sulfate type of water (Figure E.2.22). High concentrations of uranium, TDS, sulfate, chloride, and vanadium occur in groundwater beneath the pile, and maximum concentrations of some constituents exceeded the proposed EPA groundwater protection standards. Concentrations of arsenic, cadmium, chromium, molybdenum, nitrate, selenium, silver, and uranium, and activities of gross alpha exceeded the proposed EPA groundwater protection standards.

Table E.2.15 summarizes the downgradient groundwater quality in the alluvium at the New Rifle site. Tailings seepage has significantly affected groundwater quality in the alluvium and resulted in concentrations of a number of constituents exceeding the proposed EPA groundwater protection

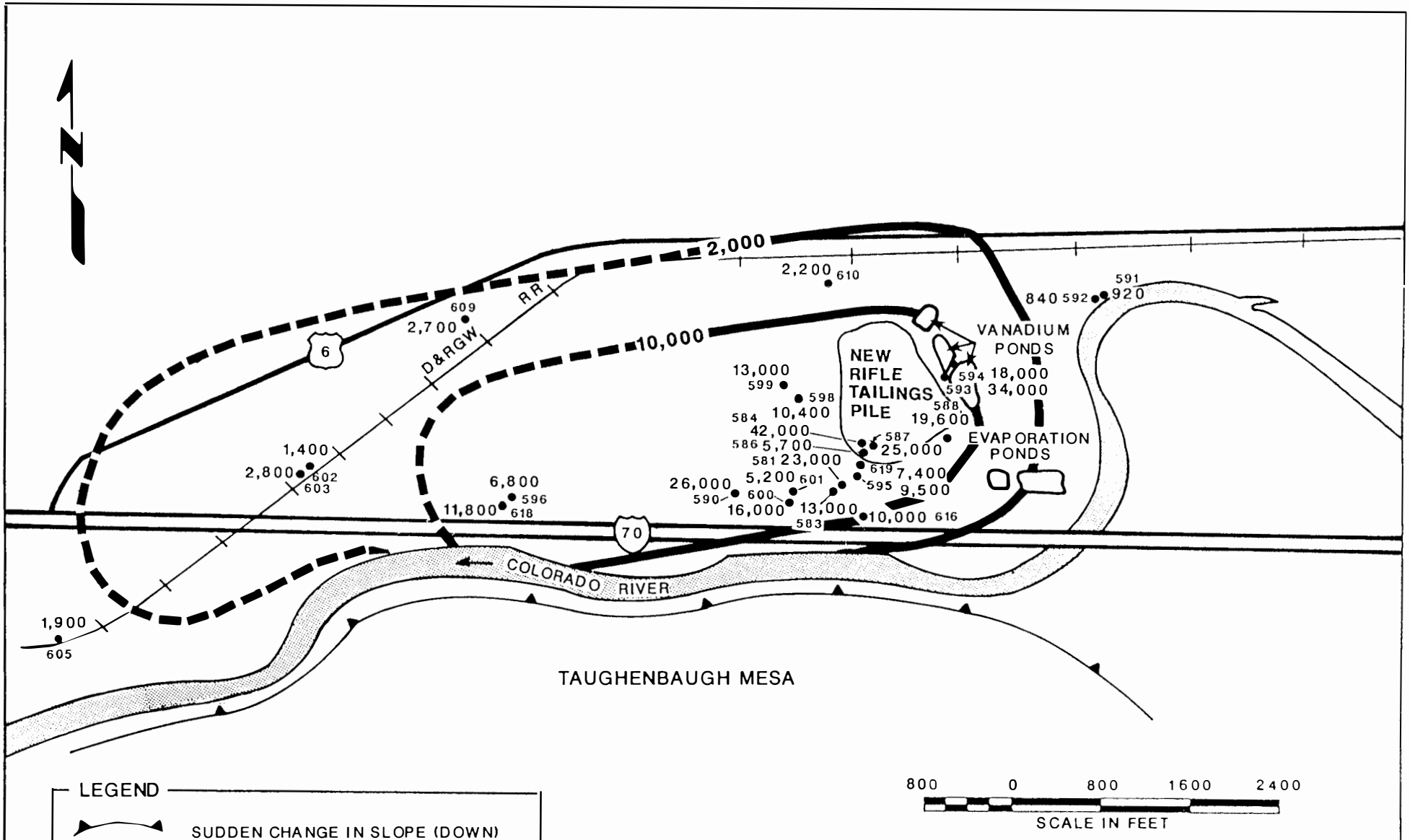


FIGURE E.2.24
SULFATE CONCENTRATIONS IN ALLUVIAL GROUNDWATER, NEW RIFLE SITE

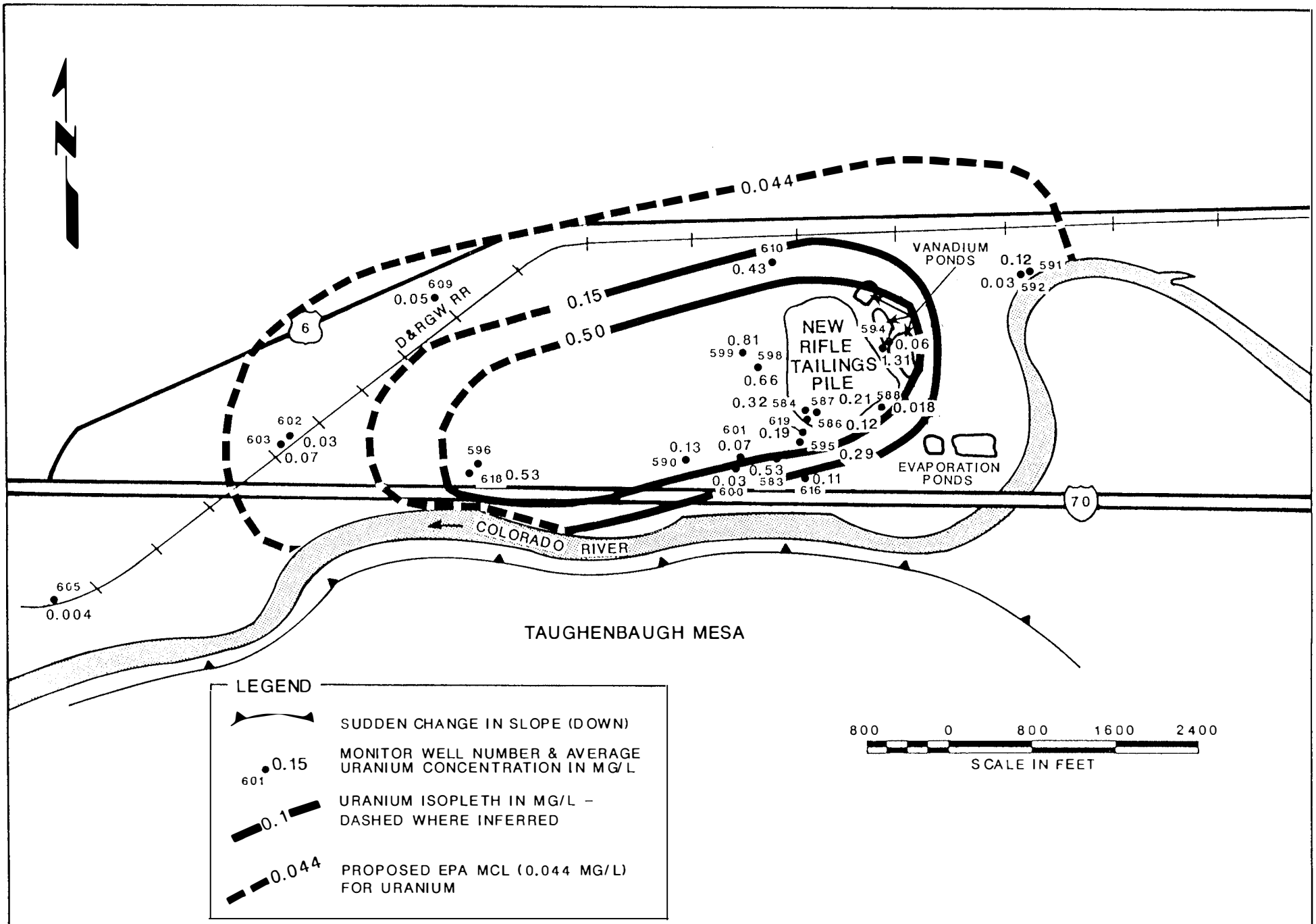


FIGURE E.2.25
URANIUM CONCENTRATIONS IN ALLUVIAL GROUNDWATER, NEW RIFLE SITE

standards. Maximum concentrations of arsenic, cadmium, chromium, lead, molybdenum, nitrate, selenium, uranium, and gross alpha activity exceed the proposed EPA groundwater protection standards in groundwater from monitor wells completed in the alluvium downgradient of the site. In addition, downgradient concentrations of the Appendix IX constituents antimony, cobalt, copper, nickel, thallium, tin, vanadium, and zinc are elevated above background concentrations in the alluvium at the New Rifle site.

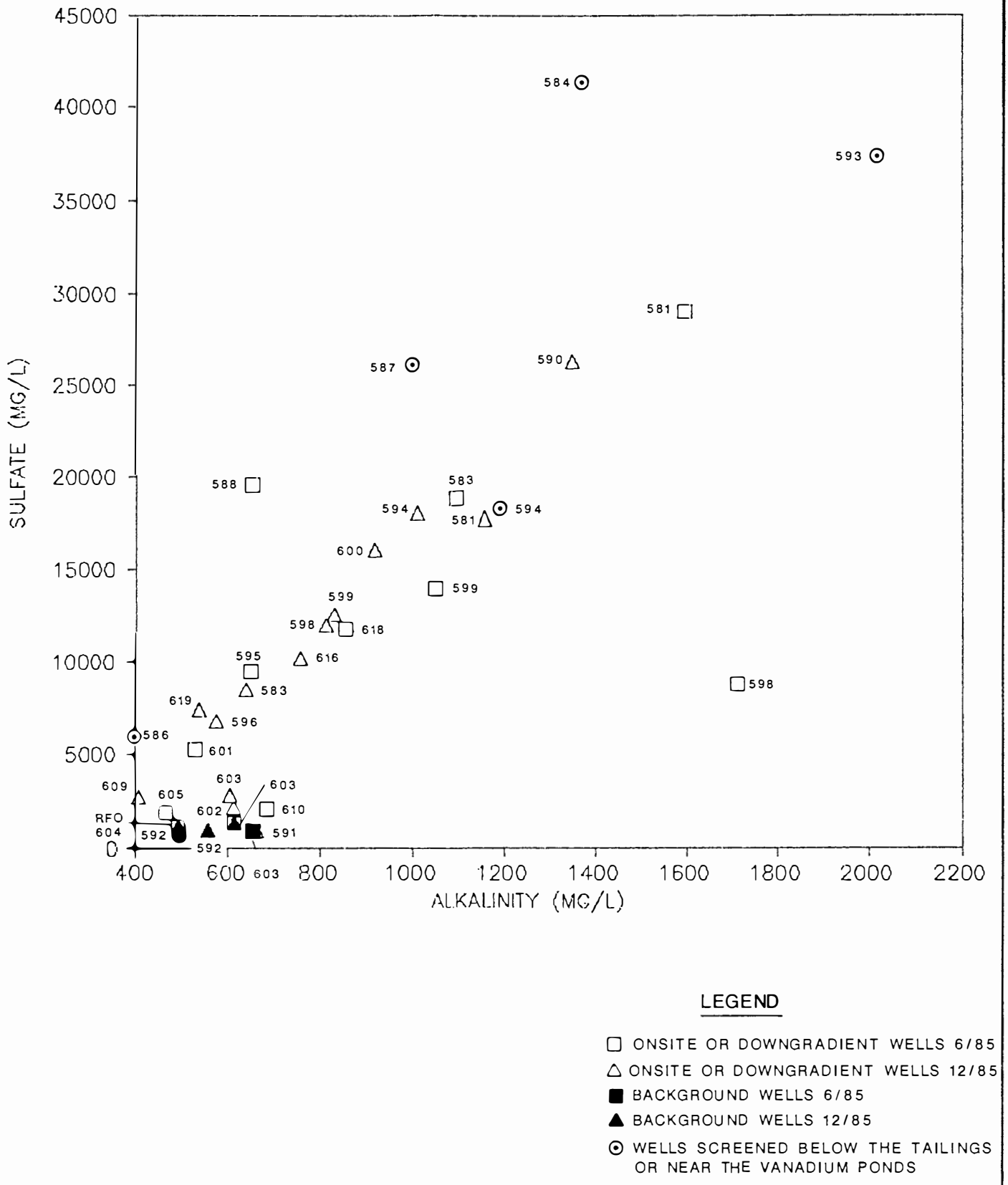
Groundwater samples from alluvial monitor wells at the New Rifle site are shown in a trilinear diagram in Figure E.2.22. Background samples are a calcium sulfate type of water while groundwater samples commingled with tailings fluids are a sodium sulfate type of water. A distinct mixing zone is apparent, with samples from monitor wells further downgradient from the tailings pile representing the water quality of background samples.

A bivariate plot (Figure E.2.26) of alkalinity and sulfate concentrations in the alluvial monitor wells provides additional evidence of the degrees of mixing of the groundwater and tailings fluids. The concentrations of alkalinity and sulfate are high in monitor wells near the tailings pile and vanadium ponds, and decrease downgradient and toward the lateral edges of the contamination.

Wasatch Formation

Downward movement of contamination from the alluvium has affected groundwater quality in the Wasatch Formation at the New Rifle site, but the areal extent of contamination is less than the extent of contamination in the alluvium. Figures E.2.27 and E.2.28 present sulfate and uranium isopleths in the Wasatch Formation. Groundwater in the Wasatch Formation bedrock is contaminated to a depth of at least 90 feet at a distance of up to 3,500 feet downgradient (west) of the tailings. No contamination has been observed in monitor wells completed in the Wasatch Formation south of the Colorado river. Furthermore, no contamination is expected to occur in the Wasatch Formation across the Colorado River, as the formation dips between four and ten degrees to the northwest (see Section D.2.4, Site Geology).

Table E.2.16 is a summary of upgradient and downgradient groundwater quality in the Wasatch Formation at the New Rifle site. Maximum concentrations of barium, molybdenum, selenium, uranium, and activities of radium-226 and -228 combined and gross alpha exceed the proposed EPA groundwater protection standards in the Wasatch Formation downgradient of the New Rifle tailings. Tailings seepage has also resulted in elevated concentrations of the Appendix IX constituents cobalt, nickel, sulfide, tin, vanadium, and zinc.

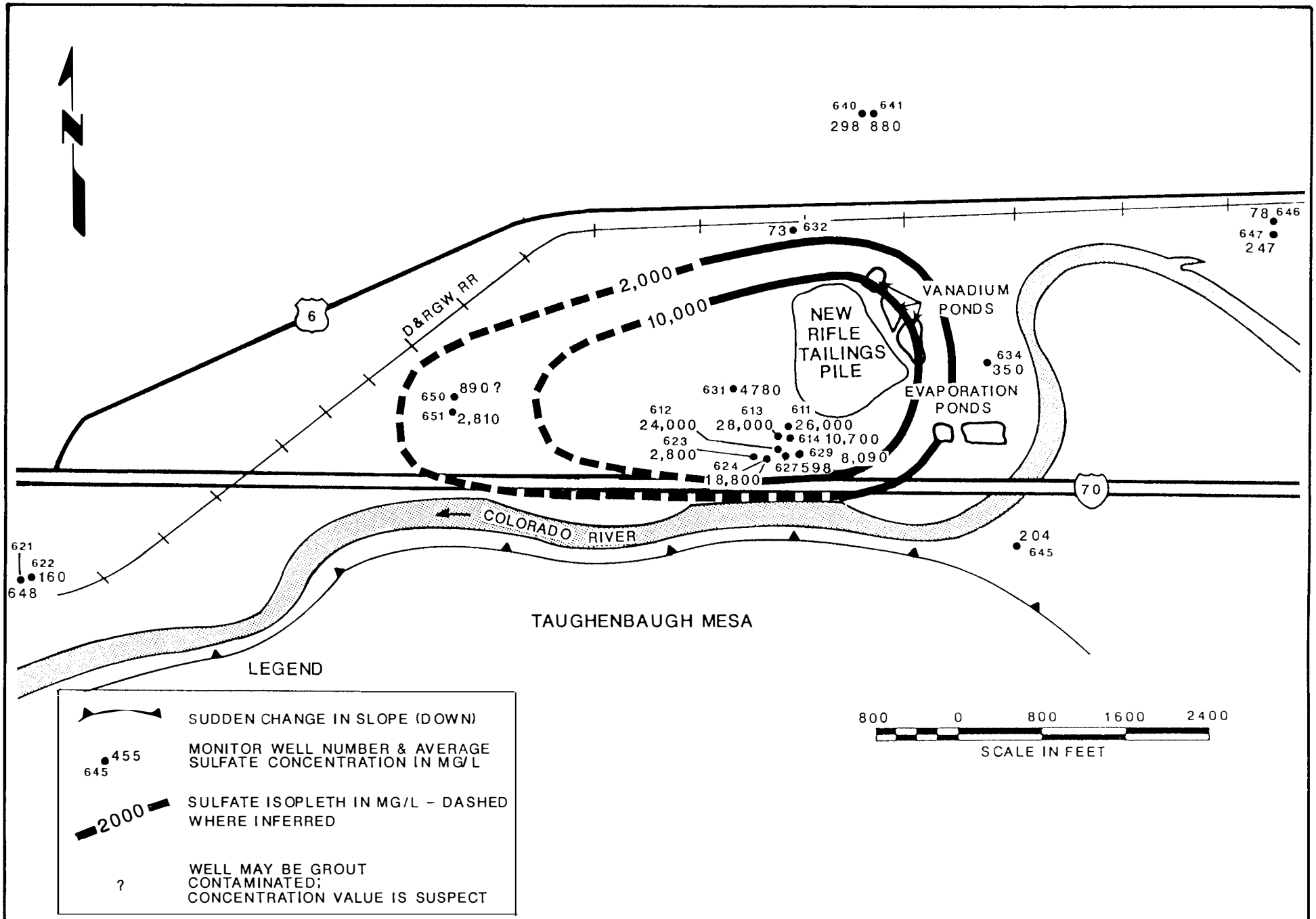


LEGEND

- ☐ ONSITE OR DOWNGRADIENT WELLS 6/85
- △ ONSITE OR DOWNGRADIENT WELLS 12/85
- ■ BACKGROUND WELLS 6/85
- ▲ BACKGROUND WELLS 12/85
- ⊙ WELLS SCREENED BELOW THE TAILINGS OR NEAR THE VANADIUM PONDS

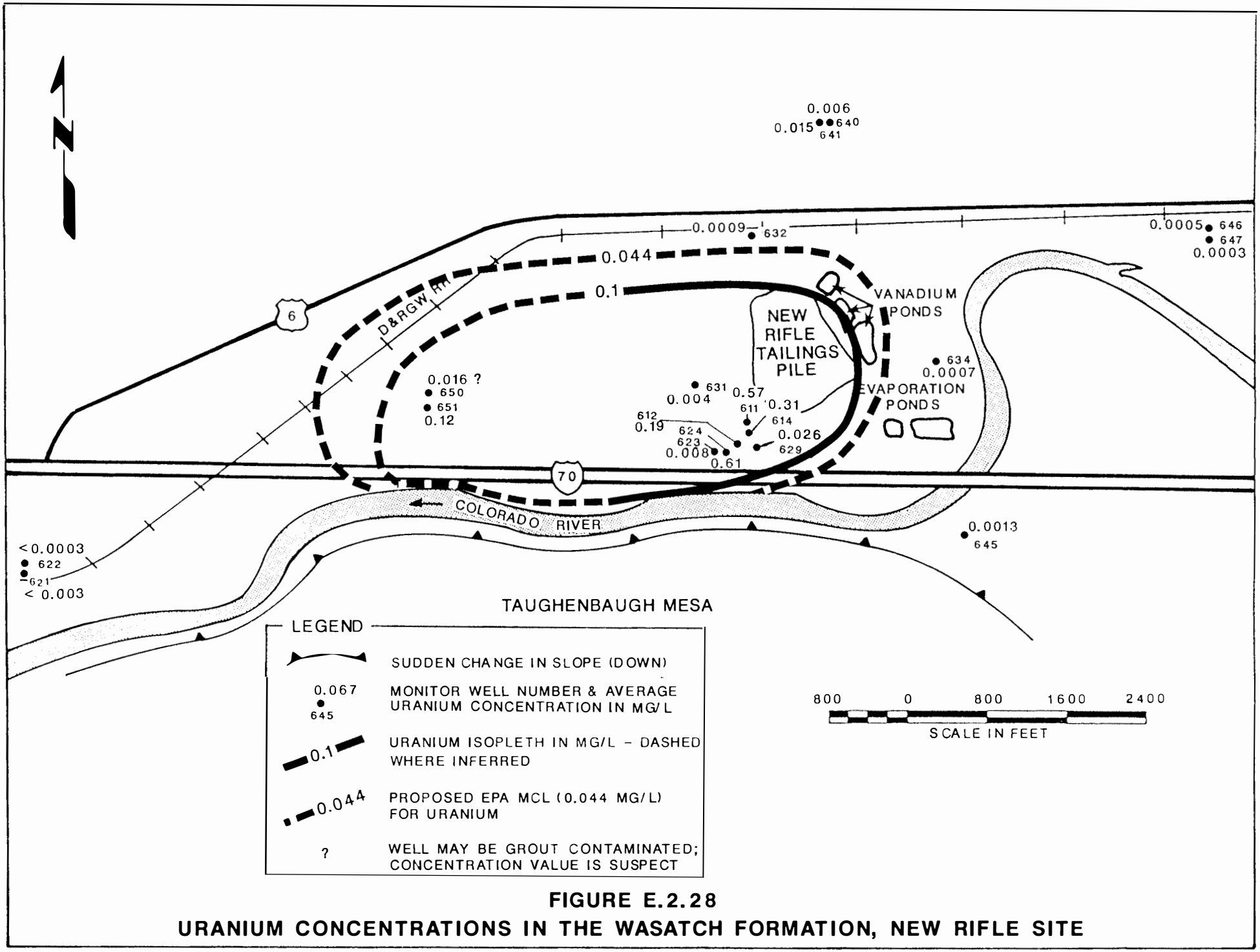
FIGURE E.2.26

BIVARIATE PLOT OF ALKALINITY AND SULFATE CONCENTRATIONS IN ALLUVIAL GROUNDWATER, NEW RIFLE SITE



E-215

FIGURE E.2.27
SULFATE CONCENTRATIONS IN THE WASATCH FORMATION, NEW RIFLE SITE



E-216-3

FIGURE E.2.28

URANIUM CONCENTRATIONS IN THE WASATCH FORMATION, NEW RIFLE SITE

Background and contaminated samples of groundwater from the Wasatch Formation are a sodium sulfate type of water (Figure E.2.23). However, the contaminated samples differ from background samples because the sulfates comprise a greater percentage of the total anions. Contaminated samples are also distinguished on a bivariate plot of alkalinity and sulfate concentrations because they contain higher concentrations of alkalinity and sulfate than background samples (Figure E.2.29).

Aquifer flushing

Alluvium

Preliminary calculations were performed to estimate the natural flushing periods of geochemically-conservative contaminants (such as nitrate and sulfate) in the alluvium at the New Rifle site. The length of time required to flush one pore volume was calculated using the relationships described in Section E.2.3.4. The flushing period for the geochemically conservative constituents nitrate and sulfate to migrate from the upgradient edge of the vanadium ponds to the point where nitrate concentrations are estimated to be at the MCL and where sulfate concentrations are approximately at background was estimated to be 50 years after the tailings have been removed. Thus, it is reasonable to conclude that conservative contaminant species in the alluvium at the New Rifle site would flush to background concentrations within 50 years after the tailings have been removed, and certainly within 100 years after the tailings have been removed. The length of time for natural flushing to remove geochemically nonconservative species (such as metals) cannot be determined at this time. The information required to estimate the time for these species to disperse to background concentrations or to MCLs includes an additional and very detailed geochemical characterization. This more detailed data would be obtained during the separate characterization process that addresses Subpart B of 40 CFR 192. However, it is reasonable to assume that the required flushing time for geochemically less conservative species in the alluvium at the New Rifle site may be considerably greater than 50 years.

Wasatch Formation

Because the hydraulic conductivity of the Wasatch Formation is significantly lower than that of the alluvium, natural flushing of contaminants in the Wasatch Formation will be negligible compared to natural flushing in the alluvium. Therefore, little or no natural flushing is predicted to occur in the Wasatch Formation within 100 years at the New Rifle site.

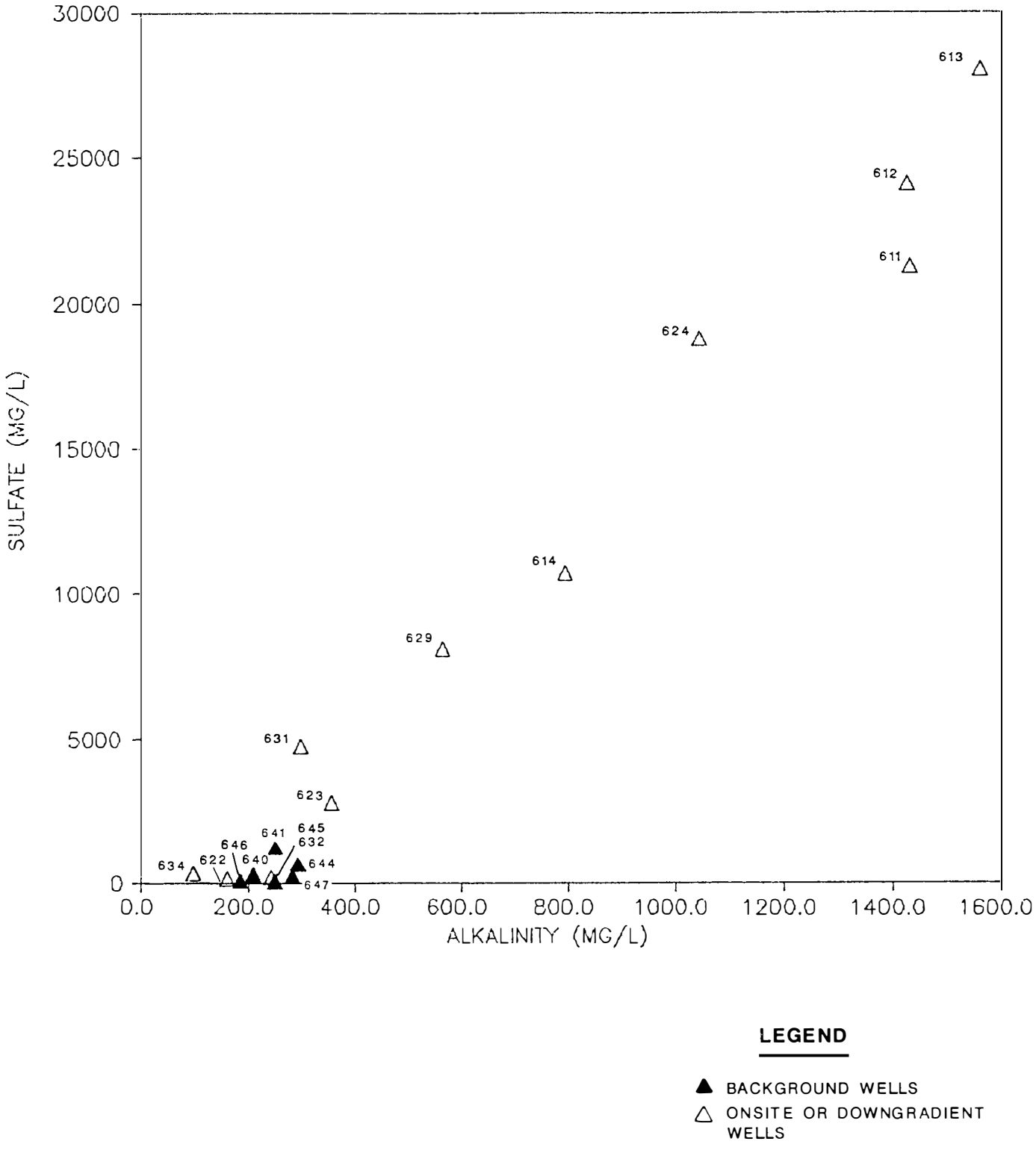


FIGURE E.2.29

BIVARIATE PLOT OF ALKALINITY AND SULFATE CONCENTRATIONS IN WASATCH FORMATION GROUNDWATER, NEW RIFLE SITE

Appendix IX organic contaminants

Limited sampling for organic contaminants has been done at the New Rifle site. Analyses for EPA priority pollutant organics were conducted in 1986 on monitor wells 619 and 643. Low concentrations of the solvent toluene (6.9 ppb and 5.4 ppb, respectively) were detected in monitor wells 619 and 643. The solvent acetone was detected in monitor well 643 at a concentration of 28 ppb.

In December 1988, the DOE sampled on-site monitor wells 581, 584, and 587, and upgradient monitor well 592, for Appendix VIII organic constituents. The solvent toluene was detected in monitor wells 581 and 587 at concentrations of 18 ppb and eight ppb, respectively. The solvent acetone and the herbicide 2,4,5-TP were detected in monitor well 584 at concentrations of 17 ppb and five ppb, respectively.

The acetone and toluene are believed to have been used on the site, although they were not used in the actual solvent extraction milling process. The solvents may have been used for cleaning equipment and machinery in the mill. The herbicide 2,4,5-TP is also believed to have been used on the site for weed control.

Southwest Hazard Control, Inc. conducted an environmental survey of the New Rifle processing site and identified several organic hazardous wastes on the site. These include several halogenated solvents, di(2-ethylhexyl) phosphoric acid (EHPA), PCBs, and herbicides containing 2,4-D and 2,4,5-TP.

E.2.3.6 Estes Gulch site

The Estes Gulch alternate disposal site is six miles north of Rifle on the southwestern flank of the Grand Hogback monocline. The Shire Member of the Wasatch Formation underlies the site and consists of several thousand feet of variegated claystones, siltstones, shales, and fine-grained sandstones. Beneath the site, bedding planes in the Wasatch Formation dip approximately 65 to 75 degrees to the southwest. This dip decreases abruptly to 10 to 20 degrees 500 to 800 feet downslope of the proposed toe of the pile. This abrupt change in the dip occurs along a fault that parallels the Grand Hogback. The fault is typically filled with clay gouge and does not appear to be a significant groundwater transport pathway.

Exploratory drilling encountered other minor faults paralleling the bedding planes and occurring randomly in the steep strata beneath the site. These faults occur as smooth planes with thin clay gouge fillings. Often, closely spaced fractures occur near these minor faults, becoming widely spaced within a few feet of the faults.

Groundwater in the Wasatch Formation beneath the site is believed to flow along the strike of the steeply dipping beds toward the southeast parallel to the Grand Hogback and Government Creek. Flow is controlled by the more transmissive sandstone in the Wasatch Formation; hence, flow will not occur towards Government Creek through the near-vertical clay beds of the formation. However, the hydraulic gradient is unknown because the water levels in monitor wells installed July 1988 have not yet equilibrated.

Approximately 0.25 mile southwest (downdip) of the site, an escarpment drops 100 feet to the floodplain of Government Creek. Flow in Government Creek is seasonal, and the creek is not believed to be hydrologically connected to groundwater in the Wasatch Formation.

In 1986, the DOE installed ten monitor wells at the Estes Gulch site (monitor wells 952 through 969 in Figure E.2.6 and Table E.2.18) ranging in depths from 60 to 301 feet. Eight of the wells are dry. Water was encountered in the deepest well (well 963) at a depth of 270 feet below ground surface, and has slowly risen to a depth of 163 feet below the ground surface. This probably represents the potentiometric surface within the formation. Unfortunately, samples from well 963 appear to be cement grout contaminated from the well construction, with pH values ranging from 11.6 through 12.1 (Table E.2.19).

In July 1988 the DOE installed three additional monitor wells (well numbers 701, 702, and 703) completed to depths of 500 to 545 feet (Figure E.2.6 and Table E.2.18). Monitor well 701 was located south of the fault (mentioned above) in the nearly horizontal beds. Monitor well 702 was located in the fault zone, while monitor well 703 was located in the near-vertical beds north of the fault. All three wells showed little or no water at completion, and water levels were below 490 feet several days after completion. In March 1989, water levels in the three wells ranged from 339 to 478 feet below ground surface, but hydrostatic equilibrium in the wells may not yet have been reached (Table E.2.18).

The vertical saturated hydraulic conductivity of the Wasatch Formation at the Estes Gulch site ranges from 0.004 to 2×10^{-5} ft/day (1×10^{-6} to 8×10^{-9} cm/s) based on laboratory triaxial permeability tests on four rock core samples beneath the site. These values are the hydraulic conductivities of rock matrix and do not reflect secondary hydraulic conductivity due to fracturing.

Table E.2.18 Completion intervals and groundwater levels in monitor wells, Estes Gulch site

Monitor well number[a]	Completion interval[b] (depth in ft)	Groundwater level (ft above mean sea level) 01/14/86	10/20/87
952	245.75 to 250.75	Dry	
955	55.00 to 60.00	Dry	Dry
956	58.00 to 73.00	Dry	Dry
958	106.40 to 116.40	Dry	Dry
959	97.25 to 102.25	Dry	Dry
962	67.25 to 72.25	Dry	Dry
963	296.0 to 301.0	5773.55[c]	5860.75[c]
964	212.50 to 217.50	Dry	Dry
965	97.25 to 102.75	Dry	Dry
969	97.50 to 102.50	Dry	Dry

		7/28/88	12/10/88	3/24/89
701	180 to 545	5455	5581	5640
702	355 to 543	5521	5519	5529
703	420 to 502	5516	5558	5585

[a]Monitor well locations are shown in Figure E.2.6

[b]All monitor wells are completed in the Wasatch Formation and have casing diameters of four inches.

[c]The depth from the land surface to groundwater in monitor well 963 was 270.2 feet on 01/14/86 and 183 feet on 10/20/87.

Table E.2.19 Groundwater quality data by location, Estes Gulch area

FORMATION OF COMPLETION: WASATCH FORMATION - UNDIFFERENTIATED
HYDRAULIC FLOW RELATIONSHIP: BACKGROUND

		LOCATION ID - SAMPLE ID AND LOG DATE									
		701-01 08/26/88		701-02 08/26/88		702-01 08/26/88		703-01 08/26/88		956-01 05/20/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	61.		61.		548.		343.		194.	
ALUMINUM	MG/L	0.3		0.3		0.3		0.5		< 0.1	
AMMONIUM	MG/L	1.7		1.7		7.9		8.1		0.6	
ANTIMONY	MG/L	0.120		0.045		0.006		0.005		-	
ARSENIC	MG/L	0.03		0.02		0.02		0.02		< 0.01	
BARIUM	MG/L	1.65		1.75		0.13		0.19		< 0.1	
BORON	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		-	
BROMIDE	MG/L	0.3		0.3		1.3		1.3		-	
CADMIUM	MG/L	0.013		0.011		0.007		0.005		< 0.001	
CALCIUM	MG/L	2430.		2420.		516.		390.		52.1	
CHLORIDE	MG/L	11500.		10300.		4460.		3950.		196.	
CHROMIUM	MG/L	0.24		0.25		2.87		0.99		-	
COBALT	MG/L	< 0.05		< 0.05		< 0.05		< 0.05		< 0.05	
CONDUCTANCE	UMHO/CM	21000.		21000.		13000.		11500.		1325.	
COPPER	MG/L	0.04		0.04		0.09		0.05		< 0.02	
CYANIDE	MG/L	< 0.01		< 0.01		0.02		0.03		-	
FLUORIDE	MG/L	1.3		1.3		0.3		0.8		1.2	
GROSS ALPHA	PCI/L	0.	110.	80.	120.	0.	43.	2.	47.	< 21.	
GROSS BETA	PCI/L	120.	80.	100.	70.	240.	50.	150.	40.	29.	
IRON	MG/L	0.10		0.11		0.08		0.25		0.152	
LEAD	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
MAGNESIUM	MG/L	32.6		30.3		0.44		0.29		10.1	
MANGANESE	MG/L	0.17		0.16		0.01		< 0.01		0.367	
MERCURY	MG/L	< 0.0002		< 0.0002		< 0.0002		< 0.0002		-	
MOLYBDENUM	MG/L	0.25		0.26		2.65		1.56		< 0.01	
NICKEL	MG/L	< 0.04		< 0.04		< 0.04		< 0.04		< 0.04	
NITRATE	MG/L	< 0.1		1.4		4.1		2.1		< 1.	
NITRITE	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	< 1.0		< 1.0		< 1.0		< 1.0		-	
PB-210	PCI/L	0.6	1.7	0.0	1.3	0.1	0.9	0.6	1.1	12.9	
PH	SU	8.91		8.91		11.94		11.78		7.3	
PHOSPHATE	MG/L	0.4		0.4		0.3		< 0.1		-	
PO-210	PCI/L	1.0	0.6	0.0	0.4	0.0	0.6	0.0	0.4	5.2	
POTASSIUM	MG/L	32.		30.		320.		128.		15.1	
RA-226	PCI/L	1.0	0.6	1.1	1.3	0.4	0.2	0.2	0.2	< 1.	
RA-228	PCI/L	10.	3.	11.	3.	1.5	0.9	0.9	1.0	< 1.0	
SELENIUM	MG/L	0.975		0.948		0.354		0.212		< 0.005	
SILICA	MG/L	8.		8.		6.		15.		14.4	
SILVER	MG/L	0.04		0.04		0.02		0.02		-	
SODIUM	MG/L	4780.		4770.		3110.		2350.		275.	
STRONTIUM	MG/L	53.5		51.5		15.3		8.5		0.463	
SULFATE	MG/L	503.		497.		1840.		974.		326.	
SULFIDE	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		-	
TEMPERATURE	C - DEGREE	16.		16.		15.0		15.0		14.	
TH-230	PCI/L	0.0	0.6	0.0	0.6	0.0	0.6	0.0	0.5	< 1.	
TIN	MG/L	0.131		0.131		0.071		0.077		< 0.005	

Table E.2.19 Groundwater quality data by location, Estes Gulch area (Continued)

FORMATION OF COMPLETION: WASATCH FORMATION - UNDIFFERENTIATED
HYDRAULIC FLOW RELATIONSHIP: BACKGROUND

		LOCATION ID - SAMPLE ID AND LOG DATE				
		701-01 08/26/88	701-02 08/26/88	702-01 08/26/88	703-01 08/26/88	954-01 05/20/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	25100.	23500.	10200.	8260.	1050.
URANIUM	MG/L	0.0012	0.0012	< 0.0003	< 0.0003	0.014
VANADIUM	MG/L	0.08	0.08	0.05	0.06	0.016
ZINC	MG/L	0.102	0.087	0.006	< 0.005	0.006

Table E.2.19 Groundwater quality data by location, Estes Gulch area (Continued)

FORMATION OF COMPLETION: WASATCH FORMATION - UNDIFFERENTIATED
HYDRAULIC FLOW RELATIONSHIP: NOT KNOWN

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE: 963-01 01/14/86	963-01 05/20/86	963-01 11/05/87	983-01 11/05/87	984-01 11/05/87
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	702.	274.	1350.	207.	195.
ALUMINUM	MG/L	0.3	< 0.1	0.29	0.07	0.10
AMMONIUM	MG/L	< 0.1	0.5	2.8	< 0.1	0.1
ANTIMONY	MG/L	< 0.003	-	-	-	-
ARSENIC	MG/L	< 0.01	< 0.01	0.004	0.003	0.005
BARIUM	MG/L	0.2	0.268	0.69	0.01	0.01
BORON	MG/L	< 0.1	-	-	-	-
BROMIDE	MG/L	-	-	< 0.1	0.1	0.1
CADMIUM	MG/L	0.006	< 0.001	< 0.005	< 0.005	< 0.005
CALCIUM	MG/L	28.4	156.	117.	26.3	48.0
CHLORIDE	MG/L	420.	1780.	780.	95.	230.
CHROMIUM	MG/L	-	-	< 0.01	< 0.01	< 0.01
COBALT	MG/L	< 0.05	< 0.05	-	-	-
CONDUCTANCE	UMHO/CM	3600.	5500.	6810.	2180.	2760.
COPPER	MG/L	0.13	0.031	-	-	-
CYANIDE	MG/L	-	-	-	-	-
FLUORIDE	MG/L	1.8	1.8	1.46	1.76	1.98
GROSS ALPHA	PCI/L	-	< 110.	-	-	-
GROSS BETA	PCI/L	-	48.	-	-	-
IRON	MG/L	0.15	< 0.03	0.03	< 0.01	0.03
LEAD	MG/L	0.56	0.025	0.84	< 0.01	< 0.01
MAGNESIUM	MG/L	0.124	5.56	0.25	1.19	12.1
MANGANESE	MG/L	0.03	< 0.01	< 0.01	< 0.01	0.07
MERCURY	MG/L	< 0.0002	-	-	-	-
MOLYBDENUM	MG/L	0.2	0.05	0.10	0.10	0.03
NICKEL	MG/L	< 0.04	< 0.04	-	-	-
NITRATE	MG/L	22.	24.	15.5	0.9	1.3
NITRITE	MG/L	-	-	0.2	< 0.1	< 0.1
NO2 & NO3	MG/L	-	-	-	-	-
PB-210	PCI/L	-	< 1.5	-	-	-
PH	SU	12.09	11.6	11.65	8.00	7.75
PHOSPHATE	MG/L	0.2	-	1.2	1.0	1.10
PO-210	PCI/L	-	< 1.	-	-	-
POTASSIUM	MG/L	2.95	26.	146.	1.56	2.04
RA-226	PCI/L	-	< 1.	1.0 0.3	0.1 0.2	0.1 0.2
RA-228	PCI/L	-	< 1.0	0.0 2.8	0.0 2.5	0.6 2.3
SELENIUM	MG/L	< 0.005	0.021	0.048	0.047	0.045
SILICA	MG/L	6.	9.2	5.28	6.01	7.49
SILVER	MG/L	< 0.01	-	-	-	-
SODIUM	MG/L	518.	1440.	1140.	667.	835.
STRONTIUM	MG/L	4.6	4.28	-	-	-
SULFATE	MG/L	272.	710.	443.	1130.	1420.
SULFIDE	MG/L	-	-	< 0.1	< 0.1	< 0.1
TEMPERATURE	C - DEGREE	11.	14.	12.7	14.2	13.4
TH-230	PCI/L	-	< 1.	-	-	-
TIN	MG/L	< 0.005	< 0.005	-	-	-

Table E.2.19 Groundwater quality data by location, Estes Gulch area (Continued)

FORMATION OF COMPLETION: WASATCH FORMATION - UNDIFFERENTIATED
HYDRAULIC FLOW RELATIONSHIP: NOT KNOWN

		LOCATION ID - SAMPLE ID AND LOG DATE				
		963-01 01/14/86	963-01 05/20/86	963-01 11/05/87	983-01 11/05/87	984-01 11/05/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	1880.	4100.	3390.	1930.	2560.
URANIUM	MG/L	0.0027	0.0068	< 0.0003	0.0013	0.0007
VANADIUM	MG/L	0.1	0.025	0.02	< 0.01	< 0.01
ZINC	MG/L	0.19	< 0.005	0.250	0.181	1.10

Table E.2.19 Groundwater quality data by location, Estes Gulch area (Continued)

FORMATION OF COMPLETION: WASATCH FORMATION - UNDIFFERENTIATED
HYDRAULIC FLOW RELATIONSHIP: NOT KNOWN

		LOCATION ID - SAMPLE ID AND LOG DATE									
		985-01 11/05/87		986-01 11/09/87		987-01 11/09/87					
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	24.		340.		521.					
ALUMINUM	MG/L	0.30		0.09		0.14					
AMMONIUM	MG/L	1.0		< 0.1		< 0.1					
ANTIMONY	MG/L	-		-		-					
ARSENIC	MG/L	0.021		0.003		0.006					
BARIUM	MG/L	0.08		< 0.01		0.01					
BORON	MG/L	-		-		-					
BROMIDE	MG/L	0.3		< 0.1		< 0.1					
CADMIUM	MG/L	< 0.005		< 0.01		< 0.005					
CALCIUM	MG/L	667.		56.8		132.					
CHLORIDE	MG/L	6160.		140.		110.					
CHROMIUM	MG/L	< 0.01		< 0.01		< 0.01					
COBALT	MG/L	-		-		-					
CONDUCTANCE	UMHO/CM	13310.		1270.		2250.					
COPPER	MG/L	-		-		-					
CYANIDE	MG/L	-		-		-					
FLUORIDE	MG/L	0.83		0.73		0.56					
GROSS ALPHA	PCI/L	-		-		-					
GROSS BETA	PCI/L	-		-		-					
IRON	MG/L	0.15		0.02		0.09					
LEAD	MG/L	< 0.01		< 0.01		< 0.01					
MAGNESIUM	MG/L	9.80		30.1		93.7					
MANGANESE	MG/L	1.07		< 0.01		0.32					
MERCURY	MG/L	-		-		-					
MOLYBDENUM	MG/L	0.03		0.03		0.11					
NICKEL	MG/L	-		-		-					
NITRATE	MG/L	< 0.1		0.3		12.0					
NITRITE	MG/L	< 0.1		< 0.1		< 0.1					
NO2 & NO3	MG/L	-		-		-					
PB-210	PCI/L	-		-		-					
PH	SU	8.00		7.55		7.25					
PHOSPHATE	MG/L	2.2		2.4		5.7					
PO-210	PCI/L	-		-		-					
POTASSIUM	MG/L	5.48		5.16		1.11					
RA-226	PCI/L	0.4	0.2	0.0	0.1	0.0	0.1				
RA-228	PCI/L	1.9	2.1	1.8	1.9	0.0	1.6				
SELENIUM	MG/L	0.278		0.023		0.038					
SILICA	MG/L	6.97		7.89		15.3					
SILVER	MG/L	-		-		-					
SODIUM	MG/L	4090.		452.		525.					
STRONTIUM	MG/L	-		-		-					
SULFATE	MG/L	477.		679.		1110.					
SULFIDE	MG/L	< 0.1		< 0.1		< 0.1					
TEMPERATURE	C - DEGREE	13.8		11.2		12.					
TH-230	PCI/L	-		-		-					
TIN	MG/L	-		-		-					

Table E.2.19 Groundwater quality data by location, Estes Gulch area (Concluded)

FORMATION OF COMPLETION: WASATCH FORMATION - UNDIFFERENTIATED
HYDRAULIC FLOW RELATIONSHIP: NOT KNOWN

		LOCATION ID - SAMPLE ID AND LOG DATE		
		985-01 11/05/87	986-01 11/09/87	987-01 11/09/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	11100.	1180.	2260.
URANIUM	MG/L	< 0.0003	0.0051	0.0177
VANADIUM	MG/L	0.04	< 0.01	0.02
ZINC	MG/L	< 0.005	0.019	0.060

MAPPER DATA FILE NAME: RFL08*UDPGWQ103014

Recent packer tests conducted on boreholes at the site indicate that the hydraulic conductivity in the upper 20 feet of weathered bedrock ranges from 0.03 to 0.3 ft/day (1×10^{-5} to 1×10^{-4} cm/s) (Table E.2.21). These higher conductivity values are due to somewhat more extensive fracturing in the weathered zone. However, packer tests in fractured areas below the weathered bedrock indicate that the fractures close with depth and are relatively impermeable. This may be due to the confining pressure of the overlying bedrock and the clay gouge fill encountered in the fractures.

The average hydraulic conductivity of the Wasatch Formation decreases several orders of magnitude below the weathered zone, to 6×10^{-5} ft/day (2×10^{-8} cm/s), based on constant head permeability tests conducted on four monitor wells at Estes Gulch (Table E.2.20). This hydraulic conductivity value is more representative of the formation as a whole, and reflects both matrix permeability and the fracture permeability of the bedrock in which the wells are screened. Monitor well 965 was screened in the fault zone south of the proposed pile, yet shows no significantly higher hydraulic conductivity due to fracturing. Thus, the fault is not believed to be a significant groundwater flow route.

Although the groundwater gradient at Estes Gulch is unknown, the maximum linear groundwater velocities can be estimated assuming a hydraulic gradient of one. The maximum linear groundwater velocity in the non-weathered Wasatch

Table E.2.20 Hydraulic conductivity for the Wasatch Formation, Estes Gulch site

Monitor well number	Method	Hydraulic conductivity (cm/s)	Hydraulic conductivity (ft/day)
952	Constant head permeability test	4.0×10^{-9}	1.1×10^{-5}
964	Constant head permeability test	2.0×10^{-9}	5.8×10^{-6}
965[b]	Constant head permeability test	6.2×10^{-8}	1.7×10^{-4}
969	Constant head permeability test	2.5×10^{-7}	7.0×10^{-4}
	Geometric mean:	2×10^{-8}	

[a]Monitor well locations shown in Figure E.2.6.
[b]Monitor well 965 is located in the fault zone south of the disposal site.

Table E.2.21 Borehole depths and saturated hydraulic conductivities measured in the Wasatch Formation, Estes Gulch site

Borehole number	Packer test interval (ft below ground surface)	Material description	Saturated hydraulic conductivity (ft/day)	Saturated hydraulic conductivity (cm/s)
711	2.45-35	Silty, clayey sandstone, widely fractured	0.001	5×10^{-7}
	52-60	Clayey shale, closely fractured	< 0.0003[a]	$< 1 \times 10^{-7}$
	87-97	Clayey shale and sandstone, closely fractured	0.05	2×10^{-5}
712	40-50	Clayey sandstone, very closely to closely fractured	18.0	6.3×10^{-3}
	62-74	Shale and shaley sandstone, close to medium fracture spacing	0.004	1.5×10^{-6}
	92-105	Shaley sandstone, medium to widely spaced fractures	0.007	2.4×10^{-6}
	117-127	Shaley sandstone, massive	0.007	2.3×10^{-6}
713	52-66	Clayey sandstone and clayey shale, moderately fractured	0.2	7×10^{-5}
	74-84	Clayey sandstone, closely to widely spaced fractures	< 0.0003[a]	$< 1 \times 10^{-7}$
	91-101	Closely fractured clay shale, widely fractured sandstone	0.03	9×10^{-6}
	128-140	Clay shale, massive	< 0.0003[a]	$< 1 \times 10^{-7}$
714	47-55	Clay shale, very closely spaced fractures	0.01	5.2×10^{-6}
	87-97	Silty, clayey sandstone, widely fractured	< 0.0003[a]	$< 1 \times 10^{-7}$
	113-126	Mostly silty, clayey sandstone, widely fractured, with some conglomerate, widely fractured	< 0.0003[a]	$< 1 \times 10^{-7}$
	131-145	Closely to widely fractured clay shale, widely fractured clay sandstone	< 0.0003[a]	$< 1 \times 10^{-7}$
715	43-57	Mostly clay shale, closely fractured; some massive sandstone	0.7	2.6×10^{-4}
	83-92	Massive clay shale, some medium spaced fracturing	< 0.0003[a]	$< 1 \times 10^{-7}$
	123-143	Mostly massive clayey sandstone; some massive shale	< 0.0003[a]	$< 1 \times 10^{-7}$

[a]Value represents quantitative lower limit of the packer testing, i.e., no measurable flow into the bedrock was detected.

Formation is 0.1 ft/yr, assuming a gradient of unity, a saturated hydraulic conductivity of 6 to 10^{-5} ft/day (2 X 10^{-8} cm/s), and a porosity of 20 percent (measured in four core samples).

Groundwater from the Wasatch Formation is a sodium sulfate or sodium chloride type, based on samples from monitor wells 701, 702, and 703. Table E.2.19 contains water quality analyses of groundwater samples from these monitor wells and from three low-yield domestic wells located 0.75 mile west of (crossgradient to) the site. The locations of the on-site monitor wells are presented in Figure E.2.6 and the vicinity domestic and other well locations are presented in Figures E.2.30 and E.2.31. Figure E.2.32 is a trilinear diagram of groundwater samples from the wells completed in the Wasatch Formation at Estes Gulch, and Figure E.2.33 is a Stiff diagram of the samples. The predominance of sulfate and chloride in the groundwater and the hydraulic properties of the Wasatch Formation indicate that groundwater has a long residence time in the bedrock (Freeze and Cherry, 1979) and infiltration from precipitation is low.

Based on the trilinear diagram (Figure E.2.32) and the Stiff diagram (Figure E.2.33), monitor well 963 is grout contaminated, as shown by its high pH values (11.6 - 12.1) and its relatively high alkalinity. Groundwater from monitor wells 702 and 703 also contains high pH values (11.6 and 11.7, respectively), but these wells are not believed to have been grout contaminated during construction. Both the trilinear diagram and the Stiff diagram indicate that samples from these wells, unlike samples from monitor well 963, plot within the background range for the Wasatch Formation. These high pH values reflect background water quality because relatively high pH (10 to 11) values were also measured in the slurries of drill cuttings from these wells.

Groundwater in the Wasatch Formation beneath the site is Class III groundwater. Class III groundwater is groundwater that is not a current or potential source of drinking water because (1) the concentration of total dissolved solids is in excess of 10,000 mg/l, (2) widespread, ambient contamination unrelated to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up using treatment methods reasonably employed in public water supply systems, or (3) the quantity of water available is less than 150 gallons per day (gpd) (40 CFR 192.11 (e)). Groundwater in the Wasatch Formation at Estes Gulch satisfies the second and third criteria, and may satisfy the first criterion.

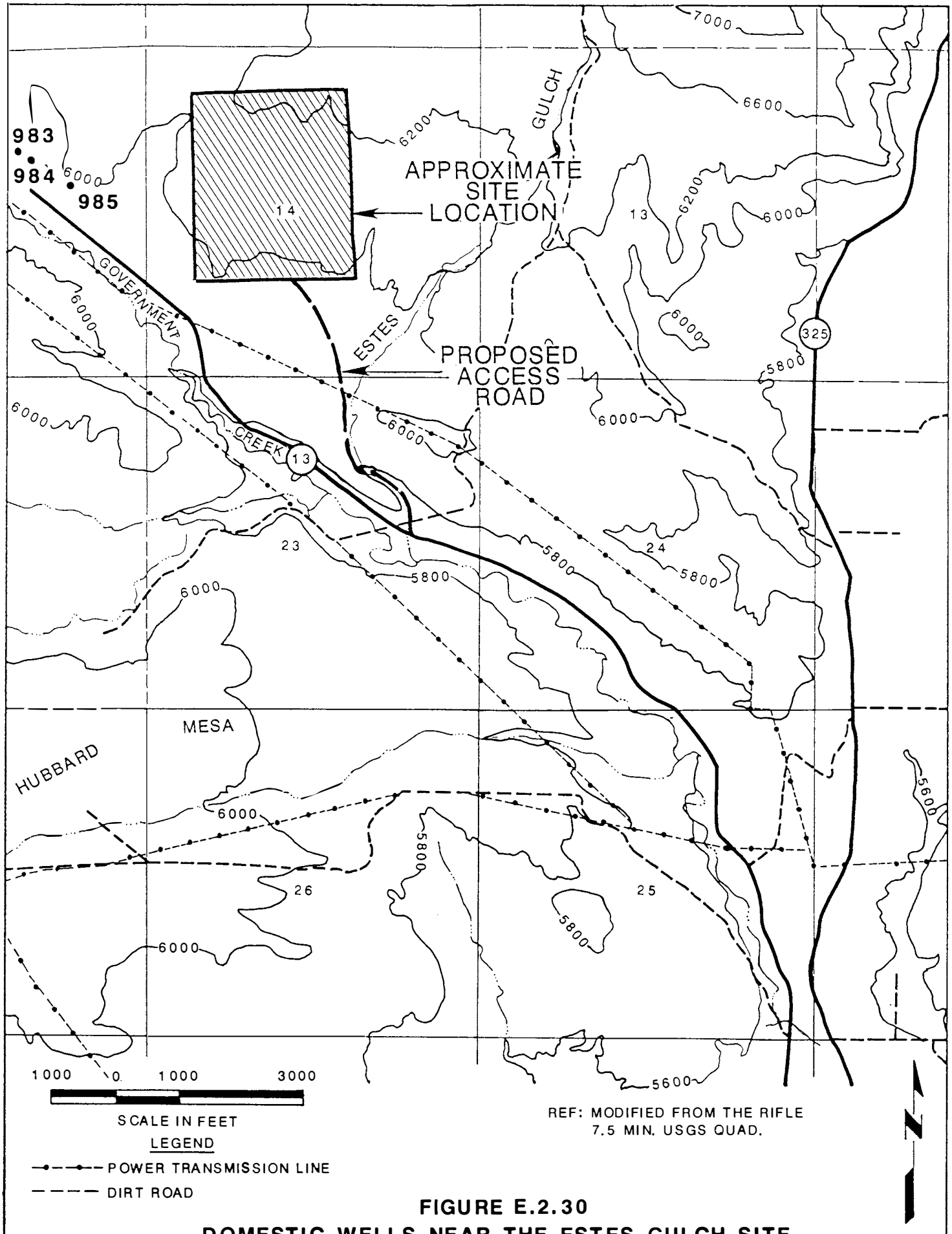


FIGURE E.2.30
DOMESTIC WELLS NEAR THE ESTES GULCH SITE

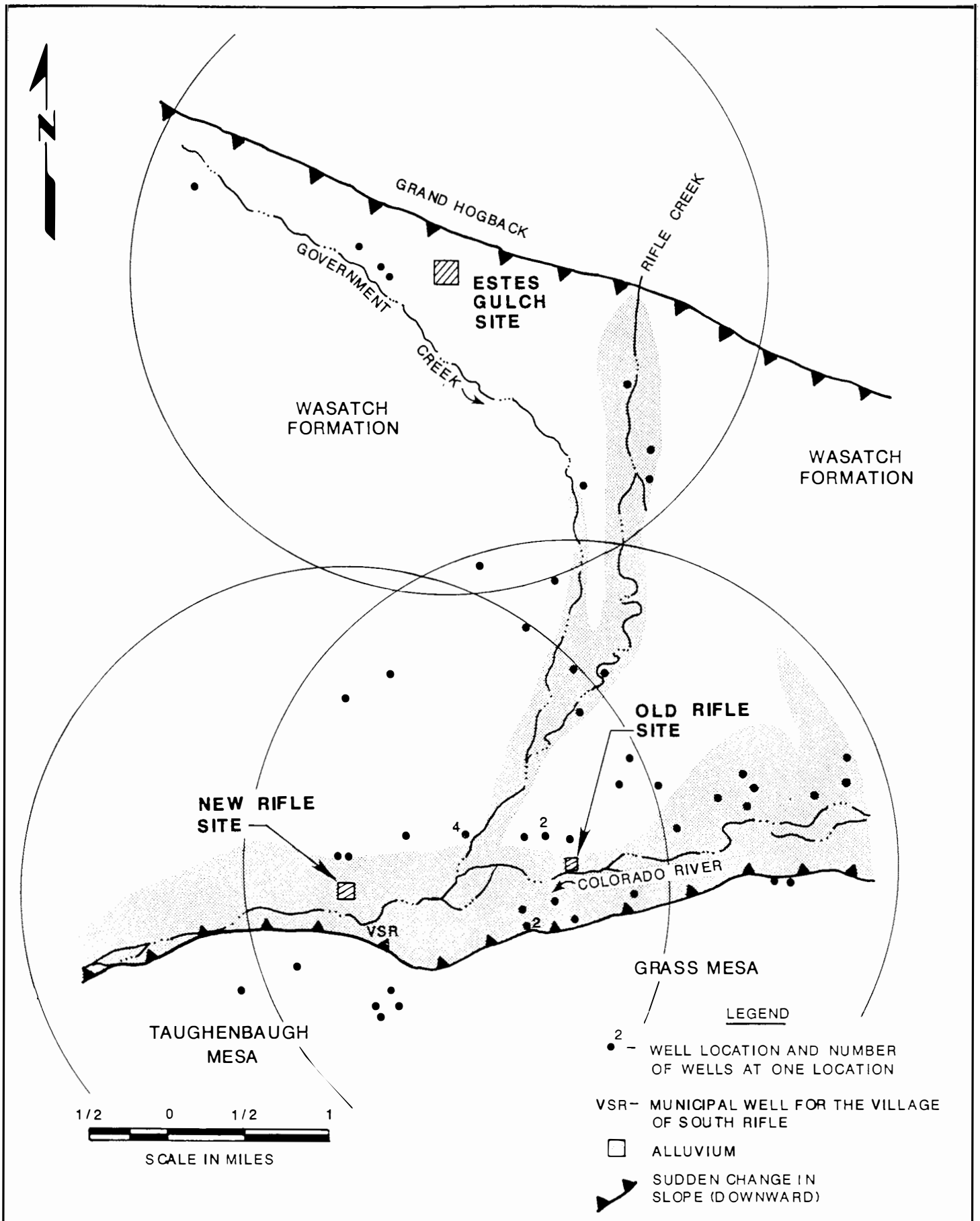
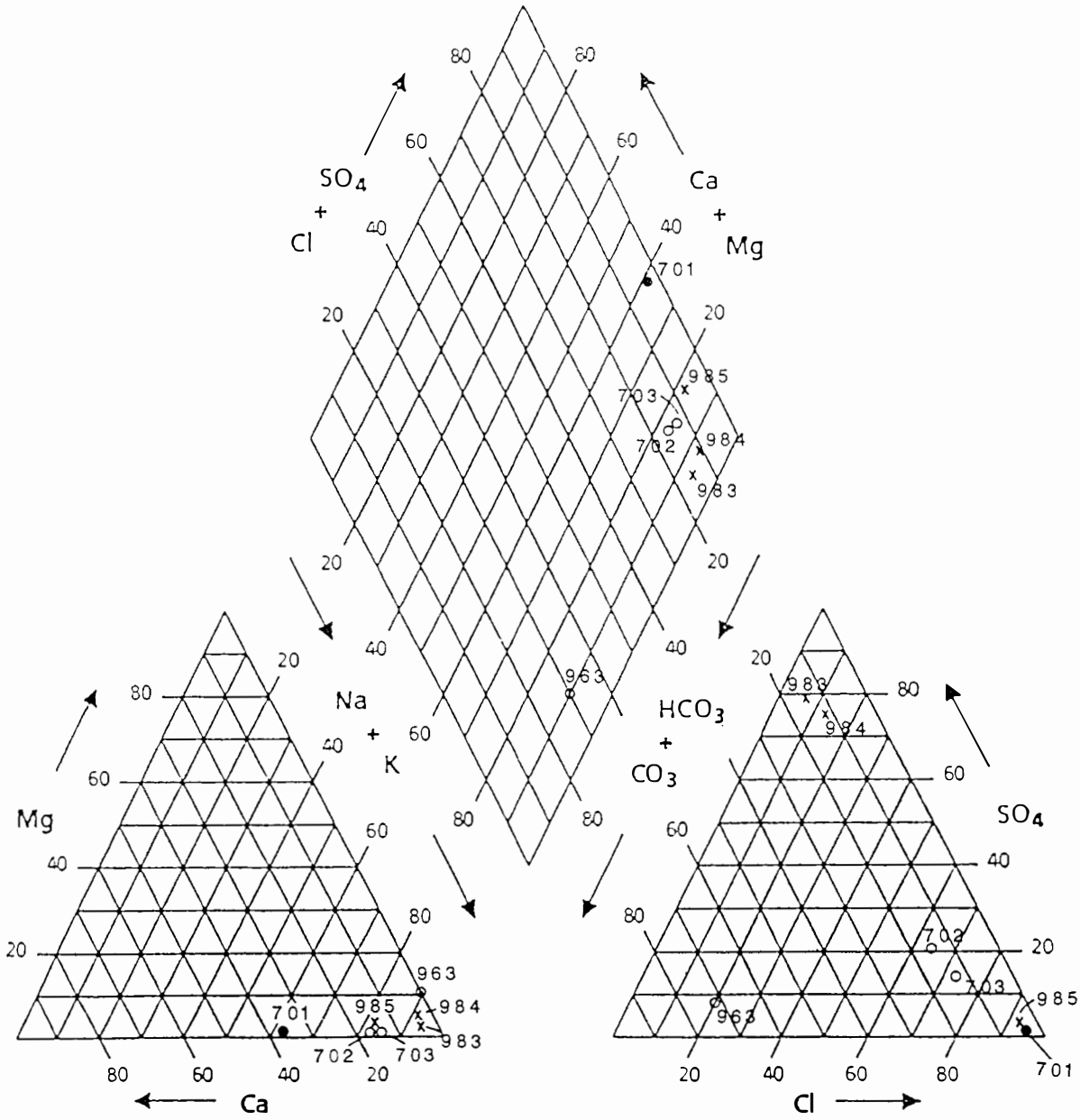


FIGURE E.2.31
EXISTING WELLS WITHIN A TWO-MILE RADIUS OF THE OLD RIFLE, NEW RIFLE, AND ESTES GULCH SITES



LEGEND

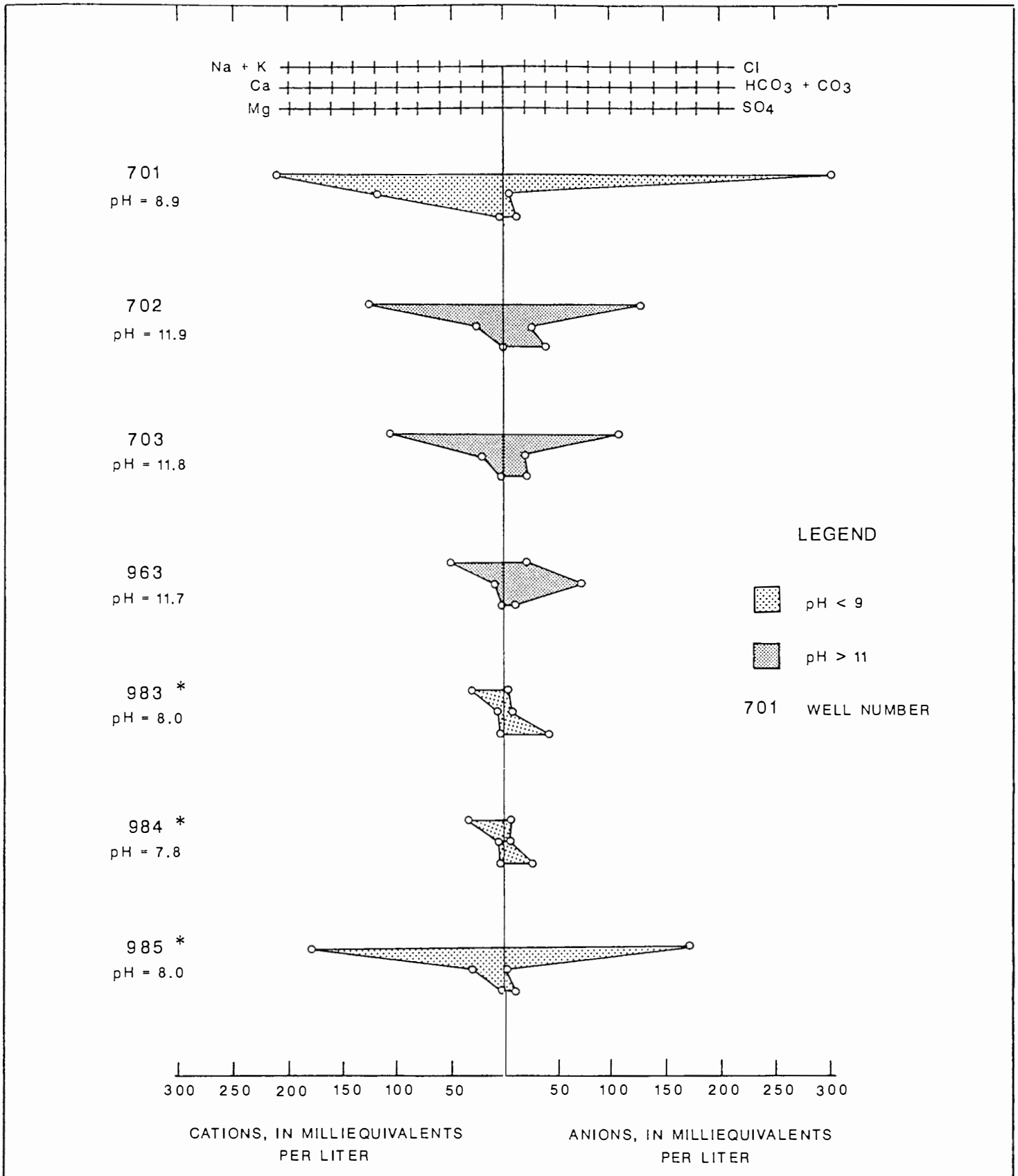
x OFF SITE DOMESTIC WELL (pH ~ 8)

o HIGH pH (> 11) MONITOR WELL

● LOW pH (< 9) MONITOR WELL

(TRILINEAR SCALES ARE PERCENTAGES OF EQUIVALENTS PER LITER OF MAJOR IONS)

FIGURE E.2.32
TRILINEAR DIAGRAM OF WASATCH FORMATION GROUNDWATER, VICINITY OF ESTES GULCH SITE



* OFFSITE DOMESTIC WELL

FIGURE E.2.33
STIFF DIAGRAM OF WASATCH FORMATION GROUNDWATER, VICINITY OF ESTES GULCH SITE

Because groundwater in the Wasatch Formation beneath the disposal cell is essentially formation water, it is of extremely poor quality, with TDS concentrations ranging from 8,260 to 24,300 mg/l. It also contains high concentrations of naturally occurring contaminants (Table E.2.19). Selenium concentrations in the groundwater range from 0.212 to 0.962 mg/l; the average selenium concentration was 50 times the proposed EPA groundwater protection standards. Molybdenum concentrations are 15 times greater than the proposed EPA groundwater protection standards. Barium, cadmium, and lead also exceed the proposed EPA groundwater protection standards.

The classification of groundwater at the Estes Gulch site as Class III may be based on the criterion that the groundwater contains widespread ambient contamination, and that this contamination cannot be cleaned up using methods reasonably employed by public water supply systems. The EPA has provided guidance in their draft guidelines for groundwater classification on the treatability of groundwater (EPA, 1986). The primary constituent of concern in groundwater in the Wasatch Formation at the Estes Gulch site is selenium, since background concentrations are substantially above Federal drinking water standards. Selenium can be removed by several types of treatment approaches, the majority of which are too inefficient to remove enough selenium from the groundwater at the Estes Gulch site to make the water potable. However, three treatment technologies--desalination, ion exchange, and ozonation--remove 97, 98, and 99 percent selenium, respectively (EPA, 1986). The EPA's groundwater classification guidelines provide information by EPA region on the number of public water supply systems using various treatment technologies. None of the three treatment technologies discussed are used on a widespread basis. The EPA has found all three technologies applied in some region of the country. For EPA Region VIII, one public water supply system uses desalination, two use ion exchange, and none use ozonation. Desalination has high capital, operation, and maintenance costs, as does the ion exchange process. Given the infrequency of use of these treatment technologies (e.g, not reasonably employed), the high capital and operational costs, the low yield aquifer, and the low population density, the Wasatch Formation could be classified as Class III due to widespread ambient contamination that cannot be cleaned up using methods reasonably employed for public water supply systems.

The three domestic wells completed in the Wasatch Formation 0.75 mile west of the site are not within the same hydrostratigraphic unit of the Wasatch Formation as the disposal site. These wells are located crossgradient to the disposal site and across the fault. The beds are nearly horizontal in this area, whereas, beneath the disposal site the beds of the Wasatch Formation are steeply inclined. The

domestic wells are near Government Creek in an area of the Wasatch Formation that is believed to be recharged by the creek. On the other hand, groundwater beneath the disposal site is believed to be connate (formation) water. The differing sources for groundwater in the Wasatch Formation are reflected in the pH values of groundwater from the wells; monitor wells completed south of the fault contain pH values less than 9.0, while groundwater from wells north of the fault typically contains high pH values (Figure E.2.33).

A drilling log for one of the domestic wells indicates that the wells are completed in a portion of the stratigraphic section where considerably more sandstone occurs than was encountered at the Estes Gulch site. This would explain why the yield of the Wasatch Formation is high enough to support domestic use near Government Creek, while yield is considerably lower beneath the Estes Gulch disposal site.

The Wasatch Formation beneath the Estes Gulch disposal site cannot yield 150 gpd to a well, based on preliminary calculations using the Theis Equation, and groundwater beneath the site may also be designated as Class III based on this limited yield. The Theis calculations assumed a 6-inch well, 200 feet of available drawdown, and a hydraulic conductivity of 10^{-4} ft/day. If the Wasatch Formation is pumped at an average rate of 150 gpd, the calculated drawdown within 30 days is greater than 200 feet. This drawdown exceeds the available drawdown in a typical well completed in the Wasatch Formation, and demonstrates that the formation cannot support a pumping rate of 150 gpd. These calculations are on file at the UMTRA Project office in Albuquerque, New Mexico.

E.2.3.7 Lucas Mesa site

The Lucas Mesa alternate disposal site is located on an old pediment surface underlain by the Shire Member of the Wasatch Formation (Tweto et al., 1978). The site, which lies west of Battlement Mesa, ranges in elevation from 5,600 to 6,100 feet above mean sea level. The mesa slopes gently five to 10 degrees to the north-northwest, but its flanks drop steeply downward to Moffat Gulch on the southwest, Smith Gulch on the northeast, and the Colorado River on the northwest (CGS, 1982). The Colorado River channel is approximately two miles from the site at an elevation of about 5,100 feet.

The Lucas Mesa site is underlain by approximately 30 to 90 feet (and perhaps as much as 203 feet, according to one drilling log) of pediment sands, gravels, cobbles, and boulders in a clay-silt matrix. Most of the gravels, cobbles, and boulders are comprised of basalt and are heavily coated with calcium carbonate (CGS, 1982). The upper surface of the mesa is a thin layer of red-brown silty soil ranging in thickness from a few inches to a few feet.

The Shire Member of the Wasatch Formation underlies the unconsolidated pediment materials that cap the mesa. It consists of approximately 200 to 400 feet of predominantly shale and claystone (CGS, 1982) with some sandstone interlayers. Bedding planes in the Wasatch Formation dip two to three degrees to the northeast (CGS, 1982).

The Shire member overlies the Molina and Atwell Gulch Members of the Wasatch Formation. The Shire and Atwell Gulch Members contain relatively little groundwater, but the Molina Member is capable of producing significant quantities of water (CGS, 1982).

In 1982, the DOE (NUS, 1984) installed three monitor wells (GWLM 1 through GWLM 3) and six boreholes (GLM 1 through GLM 6) at Lucas Mesa. The locations of these wells and boreholes are shown in Figure E.2.7. The wells, which were all dry, were completed in the unconsolidated pediment materials and ranged in depth from 50 to 203 feet (Table E.2.22). The boreholes ranged in depth from 49 feet to 63 feet, and were packer-tested to determine the saturated hydraulic conductivity of the unconsolidated materials. The results of this testing are discussed below.

In 1984, the DOE installed two additional wells in the unconsolidated pediment materials. These wells (510 and 511) were completed to depths of 35 and 92 feet and were also dry. In addition, ten test pits (651 through 660) that were dug to depths of 9 to 15 feet were dry. The locations of these wells are also shown in Figure E.2.7.

Table E.2.22 Completion intervals and groundwater levels in monitor wells, Lucas Mesa site

Monitor well number	Completion interval (depth in ft)	Groundwater level (ft above MSL)
GWLM-1	187.6 - 203.0	Dry
GWLM-2	29.0 - 50.5	Dry
GWLM-3	30.5 - 51.0	Dry
510	21 - 35	Dry
511	83 - 92	Dry

Groundwater was not encountered in any of the five monitor wells completed at the Lucas Mesa site, and no springs, seeps, or moist areas have been noted around the flanks of the mesa (CGS, 1982). However, limited natural infiltration of precipitation may occur. Although no perched groundwater was observed while drilling at Lucas Mesa, localized perched groundwater zones may exist within the unconsolidated materials or at the bedrock interface.

Limited quantities of groundwater probably occur in the underlying Wasatch Formation, although the Shire Member of the Formation generally has very low yields (CGS, 1982). Lucas Mesa may be a groundwater recharge zone, with limited infiltration occurring downward through the unconsolidated materials into the Wasatch Formation. Groundwater flow in the Wasatch Formation is probably structurally controlled, with groundwater flowing downdip in bedding planes towards the northeast.

In 1982, the DOE conducted packer tests in six boreholes drilled into the unconsolidated pediment materials of Lucas Mesa. The hydraulic conductivity of the unconsolidated materials ranges from 0.6 ft/day to 0.003 ft/day, with a geometric mean of 0.02 ft/day (Table E.2.23).

The hydraulic conductivity of the Shire Member of the Wasatch Formation at Lucas Mesa is unknown, but it is probably similar to that of the Wasatch Formation at Estes Gulch (approximately 10^{-5} ft/day). Because of the typically low hydraulic conductivity of the Wasatch Formation (Section E.2.3.6 and CGS, 1982), groundwater velocities beneath the site are low.

Groundwater quality in the Wasatch Formation beneath the Lucas Mesa site has not been determined. However, it is most likely poor in quality due to the limited recharge and the low hydraulic conductivity of the formation. Consequently, TDS concentrations are probably high and groundwater would likely be classified as Class III.

E.2.4 GROUNDWATER IMPACTS

There are four alternatives for the Rifle sites, including no action and three remedial action alternatives. All four alternatives include interim actions at both the Old and New Rifle sites to remove asbestos from the unstable mill structures, demolition of the mill structures, and removal of a variety of chemicals from the New Rifle site. The first action alternative would involve consolidation and stabilization of all tailings and contaminated materials at the New Rifle site. The preferred alternative, disposal at the Estes Gulch site, would involve removal of all the tailings and contaminated materials to the Estes Gulch site. The third action alterative would

Table E.2.23 Borehole depths and saturated hydraulic conductivities measured in the unconsolidated materials, Lucas Mesa site

Borehole number	Packer test interval (ft below ground surface)	Material description	Saturated hydraulic conductivity (ft/day)	Saturated hydraulic conductivity (cm/s)
GLM-1	8-18	Clayey silt, gravel and cobbles	0.2	7×10^{-5}
	18-28	Clayey silt, gravel and cobbles	0.6	2×10^{-4}
	28-38	Clayey silt, sand and gravel	0.01	5×10^{-6}
	38-48	Clayey silt, sand and gravel	0.006	2×10^{-6}
GLM-2	18-28	Clayey silt with gravel, cobbles, and boulders of basalt	0.09	3×10^{-5}
	28-38	Clayey silt, gravel, claystone and basalt	0.06	2×10^{-5}
GLM-3	8-18	Clayey silt, cobbles of basalt	0.01	4×10^{-5}
	18-28	Clayey silt with gravel size sandstone and claystone	0.06	2×10^{-5}
	27-38	Clayey silt with gravel size sandstone and claystone	0.01	5×10^{-5}
	37-48	Clayey silt with gravel, cobbles and basalt boulders	0.003	9×10^{-7}
GLM-4	10-28	Clayey silt, fine gravel	0.02	6×10^{-6}
	18-28	Clayey silt, fine gravel	0.009	3×10^{-6}
	28-38	Clayey silt, basalt cobbles and gravel	0.006	2×10^{-6}
	38-48	Clayey silt, gravel size basalt and claystone	0.006	2×10^{-6}
GLM-5	8-18	Clayey silt with basalt	0.03	1×10^{-5}
	18-28	Clayey silt, basalt and claystone	0.03	1×10^{-5}
	29-39	Clayey silt, gravel, basalt and claystone	0.09	3×10^{-5}
	38-50	Clayey silt, gravel, basalt and claystone	0.006	2×10^{-6}
GLM-6	8-18	Clayey silt, cobbles of basalt, gravel size siltstone and claystone	0.03	1×10^{-5}
	18-29	Clayey silt, boulders and cobbles of basalt	0.03	1×10^{-5}
	29-39	Clayey silt, gravels of basalt and sandstone	0.03	1×10^{-5}
		Average hydraulic conductivity	0.02	7×10^{-6}

involve removal of all contaminated materials to the Lucas Mesa site. Each remedial action alternative would include the construction of a compacted earthen radon barrier over the stabilized tailings and contaminated materials. This radon barrier would have a low hydraulic conductivity and would limit the infiltration of precipitation through the stabilized tailings pile. The effects of each remedial action alternative on groundwater and the water resources protection strategy for each alternative are summarized below.

E.2.4.1 Alternative action: interim actions at the Old and New Rifle sites, but no remedial action

Under this alternative, no action would be taken to minimize the infiltration of precipitation through the Old and New Rifle tailings piles, or to prevent the rise of groundwater into the tailings. Seepage from the tailings piles would continue to contaminate groundwater until all contaminants have been leached from the tailings. Groundwater contamination would persist for an indefinite period of time and then decrease as the concentrations in the tailings seepage decrease.

Performance of the interim actions would include removal of the chemicals, solvents, oils, and other materials that are found at the New Rifle site. Removal of these materials would remove potential sources of additional groundwater contamination.

E.2.4.2 Alternative action: stabilization at the New Rifle site

Under this alternative action, the tailings at the Old Rifle site would be codisposed at the New Rifle site in a disposal cell. The disposal cell at the New Rifle site would comply with 40 CFR 192, Subparts A and C of the EPA groundwater protection standards for inactive uranium mill sites. This is based on an assessment of the hydrogeologic characteristics of the site, design analysis of the disposal cell, and performance assessment of the disposal site. During steady-state conditions, the disposal cell would meet concentration limits that are defined as either the proposed EPA MCLs or background water quality, whichever is higher, at the point of compliance (POC) in the uppermost aquifer. The DOE defines POCs for all UMTRA disposal sites as the downgradient edge of the engineered facility. At the New Rifle site, the alluvium is the uppermost aquifer. However, because of transient tailings drainage and the potential for periodic releases of additional contaminants related to flooding of the Colorado River, alternate concentration limits (ACLs) could be necessary to ensure compliance with the groundwater protection standards.

Design considerations

Under the alternative action, the tailings and contaminated materials from both the Old and New Rifle sites would be consolidated and stabilized in an above-grade disposal cell at the present location of the New Rifle tailings pile.

A cover system would be constructed over the tailings and contaminated materials. The disposal cell cover at the New Rifle site would consist of the following (in ascending order): 1) a compacted clay radon barrier; 2) an infiltration barrier with a saturated hydraulic conductivity of 10-9 cm/s (using CLAYMAX^{R}, a thin layer of bentonite sandwiched between two geotextile layers, or its equivalent); 3) a lower filter layer of sand; 4) an earthen frost protection layer; 5) an upper filter (bedding) layer of sand; and 6) a layer of erosion protection riprap.

The infiltration barrier would limit steady state vertical seepage through the tailings to 10-9 cm/s. Groundwater mounding (as a result of tailings seepage) would not be a problem in the alluvium because of the high hydraulic conductivity of the alluvium. However, because the disposal cell at the New Rifle site would be located in the floodplain of the Colorado River, groundwater in the alluvium may occasionally encroach upon the tailings during periods of flooding of the Colorado River, inundating the lower tailings and releasing contaminants into groundwater for limited periods of time.

Groundwater protection standards for disposal

Eighteen hazardous constituents (from 40 CFR 192 and Appendix IX of 40 CFR 264) were identified within the tailings at the Rifle processing sites at concentrations exceeding the MCLs or organic detection limits. These are arsenic, chromium, molybdenum, selenium, uranium, radium-226 and -228 combined, beryllium, vanadium, benzene, diethyl phthalate, benzo [a] anthracene, benzo [a] pyrene, chrysene, fluoranthene, indeno (1,2,3-ed) pyrene, pyrene, acrylonitrile, 2,4-D, and Silvex (2,4,5-TP). The proposed concentration limits for these constituents are the MCLs or background concentrations, whichever are higher.

Metals such as molybdenum and uranium are typically geochemically nonconservative constituents, which are reactive. Their concentrations will be affected by geochemical processes such as sorption, oxidation/reduction, precipitation, etc. Anions such as chloride, nitrate, and sulfate are typically geochemically conservative constituents, which are relatively nonreactive. These constituents will not be affected by the geochemical processes described above. Therefore, changes in concentrations will directly reflect groundwater flow.

Performance assessment

Following remedial action, contaminant concentrations in groundwater beneath the disposal cell would gradually decrease until equilibrium with the steady state seepage flux of 10-9 cm/s is reached. At this time, the proposed concentration limits for the hazardous constituents would be met at the POC.

Initially, there would be a transient drainage period during which the moisture content of the tailings would gradually decrease until it is at equilibrium with the steady state seepage flux through the disposal cell cover. Contaminant concentrations in groundwater within the alluvium would gradually decrease to background concentrations. The MCLs for the hazardous constituents may initially be exceeded while the tailings are draining and until existing contamination in the alluvium is flushed to background concentrations. Consequently, the EPA groundwater protection standards would be met during this transition period by design modification or the application of ACLs. These ACLs would be developed following detailed modeling and analysis of the transient drainage from the tailings.

Because the New Rifle disposal cell would be located within the floodplain of the Colorado River, the proposed EPA groundwater MCLs could temporarily be exceeded following periods of flooding of the Colorado River. Flooding could result in elevated groundwater levels that could encroach upon the lower portions of the tailings and release contaminants into groundwater. In this case, ACLs would also be considered as a means to ensure compliance with the EPA protection standards.

In the event that compliance with the EPA groundwater protection standards cannot be achieved with the proposed conceptual design for the New Rifle alternative, ACLs would also be considered. The ACL(s) would be established only if it could be demonstrated that a given constituent would not pose a substantial threat or potential hazard to human health or the environment as long as the ACL is not exceeded (40 CFR 264.94(b)). After considering corrective actions, ACLs could be applied provided that a determination can be made that the lower of the values given by the standard for setting ACLs in 40 CFR 264.94(b) is satisfied, and the concentrations established as a result of the corrective action are as low as reasonably achievable.

Currently, there is plenty of good-quality water available from the Colorado River for drinking water and other purposes. The continued supply of water from this source makes it unlikely that groundwater in the alluvium downgradient of the processing sites would be needed for future water supplies. The probability of a present or potential hazard to human health is low.

Closure performance assessment

The disposal cell would comply with the closure performance standards of 40 CFR 192.02(a)(4). Active maintenance of the disposal cell would be minimized because it would be constructed with durable, natural materials that would meet the longevity requirements of 40 CFR 192.02. Other safety factors have been incorporated into the disposal cell design so that the cell should operate for longer than the required 1000-year design life. For example, the pile has been designed to accommodate natural forces such as erosion and frost heave.

Groundwater performance monitoring program

A Surveillance and Maintenance (S&M) Plan would be developed to address the various monitoring needs of the disposal cell, including groundwater monitoring, biointrusion, soil erosion, and runoff from the pile. The data collected would be used to evaluate the performance of the disposal cell.

The DOE would develop an integrated groundwater monitoring program in the S&M Plan. This program would be conducted after completion of the remedial action to demonstrate that the performance of the cell complies with the groundwater protection standards and the closure performance standards. The program would include compliance monitoring wells in groundwater at the POC and upgradient of the disposal cell. The compliance monitoring wells would be sampled quarterly during the first year following completion of the remedial action. The wells would then be sampled semiannually or annually through the end of the performance monitoring period. Constituents to be analyzed from monitor well samples would include all the hazardous constituents of concern, major anions and cations, and the standard suite of field parameters (alkalinity, pH, temperature, and specific conduction).

Corrective action plan

Should contaminated groundwater migrate beyond the POC during the 1000-year design life of the disposal cell, it would not significantly affect human health or the environment. There are no users of contaminated groundwater from the alluvium downgradient of the New Rifle site. Furthermore, future development of the groundwater in the alluvium immediately downgradient of the site is unlikely due to the poor quality of the water (see Section E.2.5, Groundwater Use, Value and Alternate Supplies).

However, if the concentration limits are exceeded for any hazardous constituent at the POC, the DOE would investigate

methods of corrective action to bring the disposal cell into compliance. Any excursion at the POC detected by saturated zone monitoring would require resampling and analysis at least once for verification of the excursion. Details of these procedures would be presented in the S&M Plan.

Should corrective action be required, it may be necessary to implement ACLs or modify the disposal cell cover. The DOE must demonstrate that this corrective action can be formulated and initiated within 18 months of the finding of exceedance of the groundwater protection standards.

Cleanup and control of existing contamination

The need for and extent of aquifer restoration at the Rifle processing sites would be determined based on the extent of existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability (from an engineering perspective) of restoring the aquifer.

Preliminary calculations were conducted to estimate the time required for natural flushing (or passive restoration) to remove geochemically conservative contaminants to background concentrations in the alluvium at the Rifle processing sites. These calculations indicate that natural flushing would reduce concentrations of conservative contaminant species to background concentrations in the alluvium at the Old Rifle site within 10 years after the tailings have been removed. However, natural flushing of nonconservative (geochemically reactive) species may require considerably more time, and aquifer restoration could be required to ensure compliance with the proposed standards. Because of its low hydraulic conductivity, natural flushing in the underlying Wasatch Formation would be negligible in 100 years. Under the New Rifle disposal alternative, flushing at the New Rifle site cannot be accurately modeled without additional characterization of the transient drainage from the tailings at the New Rifle site.

The need for and extent of aquifer restoration will be evaluated when the final groundwater protection standards are promulgated. If it can be demonstrated that natural flushing will reduce concentrations of hazardous constituents in groundwater to background or MCLs within 100 years (as required by Subpart B of 40 CFR 192), then natural flushing with institutional controls will be used to comply with the groundwater standards. However, if natural flushing is not sufficient to reduce concentrations to MCLs or background, then active aquifer restoration, active restoration in combination with natural flushing, or ACLs would be required.

Under UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards, and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

The DOE has defined existing and background water quality at the processing and disposal sites, and adverse impacts on groundwater quality from the remedial action can be identified. The remedial action should not interfere with any aquifer restoration activities at the Old Rifle site, should aquifer restoration be necessary. However, transient drainage from the tailings in the disposal cell at the New Rifle site would affect natural flushing of contaminants from the alluvium, and could interfere with aquifer restoration at the New Rifle site if aquifer restoration is determined to be necessary in the future.

Because the period of construction would be relatively short at the Rifle sites, and because there are no users of the groundwater contaminated by tailings seepage at the Rifle sites, there would be little or no risk to human health or the environment by leaving groundwater contamination in place during the interim period between remedial action and evaluation of groundwater cleanup.

E.2.4.3 Preferred alternative: tailings disposal at the Estes Gulch site

The disposal cell at Estes Gulch would comply with 40 CFR 192, Subparts A and C of the EPA groundwater protection standards for inactive uranium mill sites. This is based on an assessment of the hydrogeologic characteristics of the site, design analysis of the disposal cell, and performance assessment of the disposal site. The disposal cell would meet concentration limits that are defined as either the proposed EPA MCLs, or background water quality (whichever is higher), at the POC in the uppermost water-bearing unit. At the Estes Gulch site, the Wasatch Formation is the uppermost water-bearing unit. Approximately 100 feet of riprap lie between the compacted tailings and the POC.

Design considerations

Under the preferred alternative, the tailings and contaminated materials from the Old and New Rifle sites would be placed in a partially below-grade disposal cell at the Estes Gulch disposal site. The foundation of the disposal cell would be the naturally occurring fine-grained materials overlying the Wasatch Formation. The clay would be compacted to 90 percent compaction beneath the tailings. Groundwater occurs in the Wasatch Formation at the Estes Gulch disposal site approximately 163 feet below the ground surface, and fluctuations in groundwater elevations would not offset the performance of the disposal cell.

A cover system would be constructed over the tailings and contaminated materials. The disposal cell cover at Estes Gulch would consist of the following (in ascending order): 1) a clay radon/infiltration barrier with a hydraulic conductivity of 10-8 cm/s; 2) a lower filter layer of sand; 3) an earthen frost protection layer; 4) an upper filter (bedding) layer of sand; and 5) a layer of riprap for erosion protection.

The radon barrier would limit steady state vertical seepage through the tailings to 10-8 cm/s. This seepage (flux) is within the drainage capacity of the underlying bedrock, preventing tailings seepage from perching along low hydraulic conductivity strata beneath the disposal cell. No groundwater mounding in the underlying Wasatch Formation would occur into the disposal cell because the depth to groundwater is 163 feet.

The natural vegetation on the 14-acre upland drainage area above the disposal cell would be replaced with erosion protection riprap. The potential for increased infiltration and artificially induced groundwater perching on the contact of the Wasatch Formation would be minimized by compacting the foundation material for the upland drainage area to 95 percent compaction.

Groundwater protection standards for disposal

Eighteen hazardous constituents (from 40 CFR 192 and Appendix IX of 40 CFR 264) were identified within the tailings at the Rifle processing sites at concentrations exceeding the MCLs or organic detection limits. These are arsenic, chromium, molybdenum, selenium, uranium, radium-226 and -228 combined, beryllium, vanadium, benzene, diethyl phthalate, benzo [a] anthracene, benzo [a] pyrene, chrysene, fluoranthene, indeno (1,2,3-ed) pyrene, pyrene, acrylonitrile, 2,4-D, and Silvex (2,4,5-TP). The proposed concentration limits for these constituents are the MCLs or background concentrations, whichever are higher.

Performance assessment

Seepage from the disposal cell would not cause concentration limits to be exceeded at the POC. The cell would comply with the proposed EPA groundwater protection standards because the average linear velocity in the Wasatch Formation is less than 0.1 ft/yr. Consequently, contaminated groundwater would travel less than 100 feet in 1000 years, the design life of the disposal cell. This is approximately the distance from the perimeter of the tailings to the downgradient edge of the riprap (the POC).

Closure performance assessment

The disposal cell would comply with the closure performance standards of 40 CFR 192.02(a)(4). Active maintenance of the disposal cell would be minimized because it would be constructed with durable, natural materials that would meet the longevity requirements of 40 CFR 192.02. Other safety factors have been incorporated into the disposal cell design so that the cell should operate for longer than the required 1000-year design life. For example, the pile has been designed to accommodate natural forces such as erosion and frost heave.

Groundwater performance monitoring program

An S&M Plan would be developed to address the various monitoring needs of the disposal cell, including groundwater monitoring, biointrusion, soil erosion, and runoff from the pile. The data collected would be used to evaluate the performance of the disposal cell.

The DOE would develop an integrated groundwater monitoring program in the S&M Plan. This program would be conducted after completion of the remedial action to demonstrate that the performance of the cell complies with the groundwater protection standards and the closure performance standards. The program would include compliance monitoring wells in groundwater at the POC and upgradient of the disposal cell. The compliance monitoring wells would be sampled quarterly during the first year following completion of the remedial action. The wells would then be sampled semiannually or annually through the end of the performance monitoring period. Constituents to be analyzed from monitor well samples would include all the hazardous constituents of concern, major anions and cations, and the standard suite of field parameters (alkalinity, pH, temperature, and specific conduction).

Corrective action plan

In the unlikely event that contaminated groundwater migrates beyond the POC within 1000 years, it would not significantly affect human health or the environment. Groundwater in the Wasatch Formation beneath the Estes Gulch disposal cell could be classified as Class III, based on the high concentrations of naturally occurring contaminants and on the low yield of the Wasatch Formation. Furthermore, there are no downgradient users of Wasatch Formation groundwater in the immediate vicinity of the disposal site. Because of the naturally occurring poor quality of groundwater in the Wasatch Formation, the low yield of the formation at Estes Gulch, the remote location, and Federal ownership of the site, Wasatch Formation groundwater resources in the immediate vicinity of the disposal cell at Estes Gulch would probably continue to remain undeveloped.

However, should the proposed concentration limits be exceeded for any hazardous constituent at the POC, the DOE would investigate methods of corrective action to bring the disposal cell into compliance. Any excursion at the POC detected by saturated zone monitoring would require resampling and analysis at least once for verification of the excursion. Details of these procedures would be presented in the S&M Plan for Rifle.

If corrective action is required, it could require disposal cell cover modification, application of supplemental standards based on the Class III characteristics of the groundwater, or aquifer restoration. The DOE must demonstrate that the corrective action can be formulated and initiated within 18 months of the finding of exceedance of the groundwater protection standards.

Cleanup and control of existing contamination

The need for and extent of aquifer restoration at the Rifle processing sites would be determined based on the extent of existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability (from an engineering perspective) of restoring the aquifer.

Preliminary calculations were conducted to estimate the time required for natural flushing (or passive restoration) to remove geochemically conservative contaminants to background concentrations in the alluvium at the Rifle processing sites. These calculations indicate that natural flushing would reduce concentrations of conservative contaminant species to background concentrations in the alluvium at the Old Rifle site within 10 years after the tailings have been removed, and within 50 years at the New Rifle site. However, natural

flushing of nonconservative (geochemically reactive) species could require considerably more time, and active aquifer restoration could be required. Because of the low hydraulic conductivity of the Wasatch Formation, natural flushing would be negligible within 100 years.

The need for and extent of aquifer restoration will be evaluated when the final groundwater protection standards are promulgated. If it can be demonstrated that natural flushing will reduce concentrations of hazardous constituents in groundwater to background or MCLs within 100 years (as required by Subpart B of 40 CFR 192), then natural flushing with institutional controls will be used to comply with the groundwater standards. However, if natural flushing is not sufficient to reduce concentrations to MCLs or background, then active aquifer restoration, active restoration in combination with natural flushing, or ACLs would be required.

Under UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards, and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

By defining existing and background water quality at the processing and disposal sites, the DOE has demonstrated that the present water quality at these locations is distinguishable from future adverse impacts on groundwater quality, and that any adverse impacts from the remedial action can be identified. Construction of the disposal cell would not interfere with any future aquifer restoration activities if active restoration is determined to be necessary at some point in the future. Because the period of construction will be relatively short at Rifle, and because there are no users of the groundwater contaminated by tailings seepage at the Rifle sites, there would be little or no risk to human health or the environment by leaving groundwater contamination in place during the interim period between remedial action and evaluation of groundwater cleanup.

E.2.4.4 Alternative action: tailings disposal at the Lucas Mesa site

The disposal cell at Lucas Mesa would comply with 40 CFR 192, Subparts A and C of the EPA groundwater protection standards for inactive uranium mill sites. This is based on an assessment of the hydrogeologic characteristics of the site, design analysis of the disposal cell, and performance assessment of the disposal site. The disposal cell would meet concentration limits, which are defined as either the MCLs or background water quality, whichever is higher, at the POC in the uppermost water-bearing unit. The Wasatch Formation is the uppermost water-bearing unit at the Lucas Mesa site. Approximately 100 feet of riprap lie between the compacted tailings and the POC.

Design considerations

Under the Lucas Mesa disposal alternative, the tailings and contaminated materials from the Old and New Rifle sites would be placed in a partially below-grade disposal cell at the Lucas Mesa disposal site. The below-grade excavation of the disposal area would extend to an average depth of 15 feet. The base of the excavation would be scarified, moisture conditioned, and recompacted. Because no groundwater occurs beneath the Lucas Mesa disposal cell to a depth of at least 200 feet, fluctuations in groundwater elevations would not offset the performance of the disposal cell.

A cover system would be constructed over the tailings and contaminated materials. The disposal cell cover at Lucas Mesa would consist of the following (in ascending order): 1) a clay radon/infiltration barrier with a hydraulic conductivity of 10-8 cm/s; 2) a lower filter layer of sand; 3) an earthen frost protection layer; 4) an upper filter (bedding) layer of sand; and 5) a layer of riprap for erosion protection.

The radon barrier would limit steady state vertical seepage through the tailings to 10-8 cm/s. This seepage (flux) is most likely within the drainage capacity of the underlying unconsolidated materials and Wasatch Formation bedrock, preventing tailings seepage from perching along low hydraulic conductivity strata of the bedrock. No groundwater mounding in the underlying materials would occur into the disposal cell because the depth to groundwater is greater than 200 feet.

Groundwater protection standards for disposal

Eighteen hazardous constituents (from 40 CFR 192 and Appendix IX of 40 CFR 264) were identified within the tailings at the Rifle processing sites at concentrations exceeding the

MCLs or organic detection limits. These are arsenic, chromium, molybdenum, selenium, uranium, radium-226 and -228 combined, beryllium, vanadium, benzene, diethyl phthalate, benzo [a] anthracene, benzo [a] pyrene, chrysene, fluoranthene, indeno (1,2,3-ed) pyrene, pyrene, acrylonitrile, 2,4-D, and Silvex (2,4,5-TP). The proposed concentration limits for these constituents are the MCLs or background concentrations, whichever are higher.

Performance assessment

Seepage from the disposal cell would not cause concentration limits to be exceeded at the POC. The cell design would comply with the proposed EPA groundwater protection standards because the average linear groundwater velocity in the Wasatch Formation is extremely low. Hydrogeologic characteristics of the Wasatch Formation beneath the Lucas Mesa site are probably very similar to those of the Wasatch Formation at Estes Gulch due to the similarity of the stratigraphy. Hence, the average linear groundwater velocity in the Wasatch Formation at Lucas Mesa is probably less than 0.1 ft/yr (as at Estes Gulch), and contaminated groundwater would probably travel less than 100 feet in 1000 years, the design life of the disposal cell. This is approximately the distance from the perimeter of the tailings to the downgradient edge of the riprap (the POC).

Closure performance assessment

The disposal cell would comply with the closure performance standards of 40 CFR 192.02(a)(4). Active maintenance of the disposal cell would be minimized because it would be constructed with durable, natural materials that would meet the longevity requirements of 40 CFR 192.02. Other safety factors have been incorporated into the disposal cell design so that the cell should operate for longer than the required 1000-year design life. For example, the pile has been designed to accommodate natural forces such as erosion and frost heave.

Groundwater performance monitoring program

An S&M Plan would be developed to address the various monitoring needs of the disposal cell, including groundwater monitoring, biointrusion, soil erosion, and runoff from the pile. The data collected would be used to evaluate the performance of the disposal cell.

The DOE would develop an integrated groundwater monitoring program in the S&M Plan. This program would be conducted after completion of the remedial action to demonstrate that

the performance of the cell complies with the groundwater protection standards and the closure performance standards. The program would include compliance monitoring wells in groundwater at the POC and upgradient of the disposal cell. The compliance monitoring wells would be sampled quarterly during the first year following completion of the remedial action. The wells would then be sampled semiannually or annually through the end of the performance monitoring period. Constituents to be analyzed from monitor well samples would include all the hazardous constituents of concern, major anions and cations, and the standard suite of field parameters (alkalinity, pH, temperature, and specific conduction).

Corrective action plan

In the unlikely event that contaminated groundwater migrates beyond the POC within 1000 years, it would not significantly affect human health or the environment. If groundwater in the Wasatch Formation beneath the Lucas Mesa disposal cell is similar to that in the Wasatch Formation at Estes Gulch, it could be classified as Class III, based on the high concentrations of naturally occurring contaminants and the low yield of the aquifer. Furthermore, there are no downgradient users of groundwater in the immediate vicinity of the proposed disposal site. Because of the probable poor quality of groundwater, the low yield of the Wasatch Formation in other areas, the relatively remote location, and Federal ownership of the site, Wasatch Formation groundwater resources near the disposal cell at Lucas Mesa would probably continue to remain undeveloped.

However, should the proposed concentration limits be exceeded for any hazardous constituent at the POC, the DOE would investigate methods of corrective action to bring the disposal cell into compliance. Any excursion at the POC detected by saturated zone monitoring would require resampling and analysis at least once for verification of the excursion. Details of these procedures would be presented in the S&M Plan.

If corrective action is required, it could require disposal cell cover modifications, application of supplemental standards based on the Class III characteristics of the groundwater, or aquifer restoration. The DOE must demonstrate that the corrective action can be formulated and initiated within 18 months of the finding of exceedance of the groundwater protection standards.

Cleanup and control of existing contamination

The need for and extent of aquifer restoration at the Rifle processing sites would be determined based on the extent

of existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability (from an engineering perspective) of restoring the aquifer.

Preliminary calculations were conducted to estimate the time required for natural flushing (or passive restoration) to remove geochemically conservative contaminants to background concentrations in the alluvium at the Rifle processing sites. These calculations indicate that natural flushing would reduce concentrations of conservative contaminant species to background concentrations in the alluvium at the Old Rifle site within 10 years after the tailings have been removed, and within 50 years at the New Rifle site. However, natural flushing of nonconservative (geochemically reactive) species could require considerably more time, and active aquifer restoration could be required to ensure compliance with the proposed standards. Because of its low hydraulic conductivity, natural flushing in the underlying Wasatch Formation would be negligible within 100 years.

The need for and extent of aquifer restoration will be evaluated when the final groundwater protection standards are promulgated. If it can be demonstrated that natural flushing will reduce concentrations of hazardous constituents in groundwater to background or MCLs within 100 years (as required by Subpart B of 40 CFR 192), then natural flushing with institutional controls will be used to comply with the groundwater standards. However, if natural flushing is not sufficient to reduce concentrations to MCLs or background, then active aquifer restoration, active restoration in combination with natural flushing, or ACLs would be required.

Under UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards, and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

By defining existing and background water quality at the processing and disposal sites, the DOE has demonstrated that the present water quality at these locations is distinguishable from future adverse impacts on groundwater quality, and

that any adverse impacts from the remedial action can be identified. Construction of the disposal cell would not interfere with any future aquifer restoration activities if active restoration is determined to be necessary at some point in the future. Because the period of construction will be relatively short at Rifle, and because there are no users of the groundwater contaminated by tailings seepage at the Rifle sites, there would be little or no risk to human health or the environment by leaving groundwater contamination in place during the interim period between remedial action and evaluation of groundwater cleanup.

Compliance with the proposed EPA groundwater standards

The stabilization alternative at the New Rifle site will not comply with the proposed EPA groundwater protection standards if the radon barrier has a hydraulic conductivity of 10^{-7} or 10^{-8} cm/s. Furthermore, supplementary standards would not apply at the New Rifle site, as groundwater beneath the site is not Class III. In addition, alternate concentration limits (ACLs) are also unlikely to be granted because the New Rifle site is in a relatively populated area.

Impacts to human health

Although the proposed EPA groundwater standards would be exceeded if the average hydraulic conductivity of the radon barrier were 10^{-7} cm/s, there would be no adverse effects to human health because there are presently no users of contaminated groundwater from the Colorado River alluvium downgradient of the New Rifle site. Furthermore, future development of the groundwater in the alluvium is unlikely due to the poor quality of the water (Section E.2.5, Groundwater use, Value, and Alternate Supplies).

E.2.5 GROUNDWATER USE, VALUE, AND ALTERNATE SUPPLIES

The Colorado River is the primary source of domestic water in the Rifle area. The City of Rifle obtains all of its water for municipal use from the Colorado River approximately 0.5 mile upgradient of the Old Rifle tailings site, and all water users within the city are connected to the municipal water system. The city also supplies water to users outside the city limits (Minturn, 1986).

Fifty wells have been identified in the vicinity of the Rifle processing sites and the Estes Gulch disposal site (Figure E.2.30). Thirty-nine wells are within two miles of the Old Rifle site, 26 wells are within two miles of the New Rifle site, and eight wells are within two miles of the Estes Gulch site. Three of the wells near Estes Gulch are screened in the Wasatch Formation approximately 0.75 mile west of the site, and two of these wells are used for domestic purposes.

Although situated at a lower elevation than the Estes Gulch site, these wells are crossgradient to groundwater flow beneath the site. The other wells in the Rifle area are used primarily for irrigation and livestock watering.

The value of groundwater within the two-mile radius discussed above can be estimated by multiplying the quantity presently used by current water rates. The total quantity of groundwater used from 49 wells was estimated to be 2.1 million gallons per month assuming that each well pumps at an average rate of one gpm. Current water supply rates in the area are $10 per month for the first 30,000 gallons and $1.50 for each additional 1000 gallons (Abel, 1986). At these rates, the total value of groundwater use per well would be $30 per month or $360 per year. For the 49 wells, the value of existing groundwater use is estimated to be $17,600 per year.

Groundwater development in the Rifle area should not increase appreciably for the next 50 years because future population growth in Garfield County is expected to be only one to two percent per year (Section J.2.1 of Appendix J, Land Use and Socioeconomics). The use of groundwater for livestock watering is not expected to increase significantly. High TDS concentrations in groundwater in the alluvium and the Wasatch Formation restrict the use of groundwater for irrigation, and background water quality within the two formations is too poor to allow development for a large-scale potable water supply. Readily available water exists in the Colorado River and in colluvium and basalt flows overlying the Wasatch Formation on the Taughenbaugh and Grass Mesas south of Rifle. These aquifers are topographically higher than the contaminated alluvium and Wasatch Formation at the Rifle tailings sites and cannot be affected by the existing groundwater contamination.

E.2.6 AQUIFER RESTORATION

The need for and extent of active aquifer restoration at the Rifle processing sites would be determined based on the extent of existing contamination, the potential for current or future use of the aquifer for drinking water supplies, and the technical practicability (from an engineering perspective) of restoring the aquifer. Studies are currently under way to develop plans, guidance materials, and procedures for aquifer restoration activities.

Under the UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. As a result, remedial action taken with regard to the Rifle sites would not preclude subsequent design enhancements if needed to achieve compliance with the standards, and would not limit the selection of reasonable groundwater restoration methods that may be necessary when the final standards are promulgated. The DOE has characterized conditions at the Rifle uranium mill tailings sites and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater protection standards. When final standards are promulgated, the DOE will evaluate groundwater protection requirements and

undertake such action as necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in accordance with the National Environmental Policy Act.

Aquifer restoration at the Rifle processing sites is not addressed in detail in the FEIS for the Rifle UMTRA sites. Under the Estes Gulch and Lucas Mesa alternatives, construction of the disposal cell would not interfere with any future aquifer restoration activities if active restoration is determined to be necessary at the Old or New Rifle sites in the future. However, under the New Rifle alternative, transient drainage from the tailings could affect natural flushing of contaminants and active aquifer restoration activities. Consequently, additional characterization of the transient tailings drainage at the New Rifle site would be necessary to more accurately predict the effects of the transient drainage on groundwater quality.

Currently, groundwater contaminated by tailings seepage at the Rifle sites is not being used. There will be little or no risk to health or the environment by leaving groundwater contamination in place during the interim period between remedial action and the evaluation of the need for and extent of aquifer restoration has been assessed.

Active restoration methods fall into two general categories: 1) above-ground treatment methods wherein the contaminated water is removed from the aquifer, treated, and either disposed of, used, or reinjected into the aquifer; and 2) in situ methods, such as the addition of chemical (lixiviants) or biological agents to fix contamination in place. An aquifer restoration program at the Old or New Rifle sites could involve one or more of the restoration methods discussed below.

Extraction methods

Contaminated groundwater can be extracted from wells or trenches. The use of trenches is limited to relatively shallow contamination and is particularly useful in materials with low hydraulic conductivity. Wells may be used for groundwater extraction when the hydraulic conductivity of the water-bearing materials is sufficiently high, or when the contamination is relatively deep.

Treatment methods

The need for treatment prior to discharge or reinjection into an aquifer depends upon the concentrations of contaminants in the extracted groundwater and the applicability of regulations on the discharge of effluent to surface water and groundwater. The preferred treatment methods depend on the concentrations and types of contaminants, the desired effluent concentrations, the background water quality, the volumetric requirements of the treatment stream, and the area available for treatment facilities. Chemical treatment methods include chemical precipitation, coagulation, ion exchange, flocculation, neutralization,

sorption, and reverse osmosis. Contaminated groundwater can also be evaporated in evaporation ponds. Biological treatment can be used to transform nitrate to nitrogen gas and oxygen gas.

In addition to above-ground treatment, two in situ treatment methods are possible. These are lixiviant injection and the use of permeable treatment beds or walls. In situ treatment would mobilize contaminants by causing oxidation conditions so that contaminants could be removed expeditiously from the subsurface.

A lixiviant is a solution of complexing species (ions or molecules) that enhances the solubility of the species (metals) to be removed from the aquifer during restoration. For example, injection of lixiviants containing hydrogen peroxide or oxygen to oxidize the system, then sodium bicarbonate to increase the pH, may be useful for removing contaminants that may leach from the solid phase. Lixiviant technology must be tested under site-specific conditions.

Lixiviants would be introduced by injection or infiltration upgradient of the contamination. The lixiviant would move through the contaminated zone, interact with the liquid and solid phases, become impregnated with the contaminants, and then be extracted at the leading edge of the contaminant plume.

Permeable treatment beds are subsurface structures installed below the water table, which provide an artificial reducing zone for contaminants in the groundwater. Following reduction and precipitation of the contaminants onto the reducing beds, the treatment bed materials are removed from the groundwater. Permeable treatment beds or walls cannot be used at Estes Gulch or Lucas Mesa because of the great depth to groundwater in the Wasatch Formation.

In situ chemical reduction, without the use of permeable treatment beds, could temporarily reduce solute concentrations to less than the EPA MCLs, but dissolution or desorption could occur as the geochemical environment equilibrates. Therefore, in situ chemical reduction does not provide long-term assurances that adequate water quality could be maintained.

Discharge of treated water

Following the extraction and treatment of contaminated water, it would be discharged. Options for discharge include:

- Discharge to surface water systems.
- Infiltration to groundwater through ponds or infiltration galleries.
- Injection in shallow wells.
- Injection in deep wells.

Natural flushing

Natural flushing is a passive restoration method whereby dissolved or precipitated contaminants in groundwater are dispersed or removed by the natural flow of groundwater. Under Subpart B of the proposed EPA standards, passive restoration may be permitted if:

1) It can be demonstrated that natural flushing can occur within a period of 100 years or less.

2) Groundwater is not now, nor projected to be, used for a community water supply (or other substantial use) within this period.

3) Institutional controls regulating public use of groundwater can be assured during the entire control period.

4) The institutional controls can effectively protect public health and satisfy beneficial uses of groundwater during the remedial period.

5) The established concentration limits are not projected to be exceeded at the end of the remedial period.

6) Adequate monitoring is established and maintained.

The DOE has determined that the best form of institutional control is outright ownership of the land in question by Federal or State governments. Presently, the state of Colorado does not have a viable means of establishing and enforcing institutional controls.

Natural flushing, with proper institutional controls, may be employed at the processing sites as the sole method for aquifer restoration, or it may be used in conjunction with any of the active restoration methods described above.

At the Old and New Rifle sites, natural flushing is a promising alternative to active restoration because the underlying alluvium is highly transmissive and considerable natural flushing occurs. Preliminary calculations indicate that geochemically conservative (non-reactive) species will be dispersed (flush) to background concentrations within 10 years at the Old Rifle site and within 50 years at the New Rifle site. However, natural flushing of nonconservative species could take considerably longer; additional geochemical characterization (including column leaching tests) would be required to quantify flushing times for nonconservative species. This additional characterization would be conducted when the need for and extent of aquifer restoration (as required by 40 CFR 192, Subparts B and C) is addressed. At this time, the need and means of establishing institutional controls will be resolved.

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APPENDIX F

FLOODPLAIN AND WETLANDS ASSESSMENT

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F.1 INTRODUCTION AND PROJECT DESCRIPTION

In 1979, the U.S. Department of Energy (DOE) established regulations (10 CFR 1022) to comply with floodplain/wetlands environmental review requirements. These regulations provide for compliance with Executive Order 11988 - Floodplain Management and Executive Order 11990 - Protection of Wetlands. These regulations are designed to be coordinated with the environmental review requirements of the National Environmental Policy Act (NEPA). The importance of floodplain and wetlands is acknowledged in the regulations in that part of the purpose of the regulations is to "restore and preserve natural and beneficial values served by floodplains (10 CFR 1022.3 (a)(3)) and to "preserve and enhance the natural and beneficial values of wetlands" (10 CFR 1022.3 (a)(6)).

Title I of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Public Law 95-604 (PL96-604), authorized the DOE to perform remedial action at 24 inactive uranium mill tailings and processing sites to reduce the potential public health impacts from the residual radioactivity remaining at these sites. The inactive processing sites at Rifle, Colorado, are two of the 24 sites authorized for remedial action. To comply with PL95-604, the DOE proposes to clean up the contaminated materials at the Rifle sites and this appendix describes the impacts on the floodplain and wetlands pursuant to 10 CFR 1022.

At Rifle, Colorado, materials contaminated by uranium mill tailings from the Old and New Rifle inactive processing sites are present in the floodplain of the Colorado River and in the wetlands within the floodplain (Davis, 1988; Garrison, 1985; McNure, 1985). There are no floodplains or wetlands associated with the Estes Gulch or Lucas Mesa alternate disposal sites, or the Second Street and Glenwood Springs borrow sites (Garrison, 1985; McNure, 1985). The New Rifle borrow site is in the floodplain; however, there are no wetlands present (Garrison, 1985).

The primary feature of each remedial action alternative is the consolidation and stabilization of the Old and New Rifle tailings and other contaminated materials at either the New Rifle processing site or at one of the two alternate disposal sites. The remedial action would require the following major construction activities regardless of which alternative is selected:

- Removing 0.7 acre of wetlands vegetation at the Old Rifle site and 20.4 acres of wetland vegetation at the New Rifle site.
- Removing the Old Rifle tailings from their present location in the 100-year floodplain.
- Removing material from the 100-year floodplain at the New Rifle borrow site.
- Grading and revegetating the floodplain where necessary, including adding any required soil conditioners to promote regrowth.

- o Upon completion of the remedial action, reducing radioactive contamination in the floodplain to levels that comply with the EPA standards for inactive uranium processing sites (40 CFR 192).

These areas would then be released for any use consistent with local land use controls.

F.2 FLOODPLAIN EFFECTS

The alteration of the floodplain during and after remedial action is of concern due to the potential for changes in river elevations during flood events and the resulting impacts to nearby properties and structures. These impacts are discussed in this assessment.

Other temporary impacts of additional concern are increased sedimentation and erosion, alteration of habitat, and water quality changes. After remedial action, long-term impacts on groundwater quality and flow and surface water quality would result from the removal of the contaminated materials present in the floodplain. Temporary and long-term impacts to soils, water, and ecosystems are discussed in Sections 5.3, 5.5, and 5.6 of the text of this environmental impact statement (EIS). Mitigation measures for these short-term and long-term impacts are discussed in Section F.2.2 of this appendix and in Section 5.20 of the text of this EIS.

Effects of flooding resulting from changes in flood elevations during construction and after completion of the remedial action were calculated. Results of these analyses are summarized in Sections F.2.1 through F.2.3. Additional discussion and documentation of calculations are available in Section E.1.2 of Appendix E, Hydrology.

F.2.1 FLOOD ANALYSIS DURING EXISTING CONDITIONS

The Old Rifle tailings have little impact on the capacity of the 100- and 500-year floodways. However, at the New Rifle site, the presence of the tailings constricts the 100- and 500-year floodways.

During a 100-year flood event, the flow of the Colorado River at the Old and New Rifle sites would be 55,040 cubic feet per second (cfs) resulting in maximum water-surface elevations of 5311 and 5275 feet above mean sea level (MSL), respectively. The mean velocities would be 12 feet per second (fps) at the Old Rifle site and 10 to 17 fps at the New Rifle site. The toe of the Old Rifle tailings pile would be under six feet of water, while the toe of the New Rifle tailings pile would be under four feet of water (Figure F.2.1).

The New Rifle borrow site, 0.5 mile west of the New Rifle site and at a similar elevation, is in the 100-year floodplain. During the 100-year event, the water-surface elevations and flow velocities would be approximately the same as those discussed for the New Rifle site.

During a 500-year event, flow would be 75,200 cfs resulting in water-surface elevations for the Old and New Rifle sites of 5314 and 5278 feet MSL, respectively. The base of the Old Rifle tailings pile would be under nine feet of water and the base of the New Rifle pile would be under six feet of water. Mean velocities would be 12 fps at the Old Rifle site and 10 to 18 fps for the New Rifle site (Figure F.2.2).

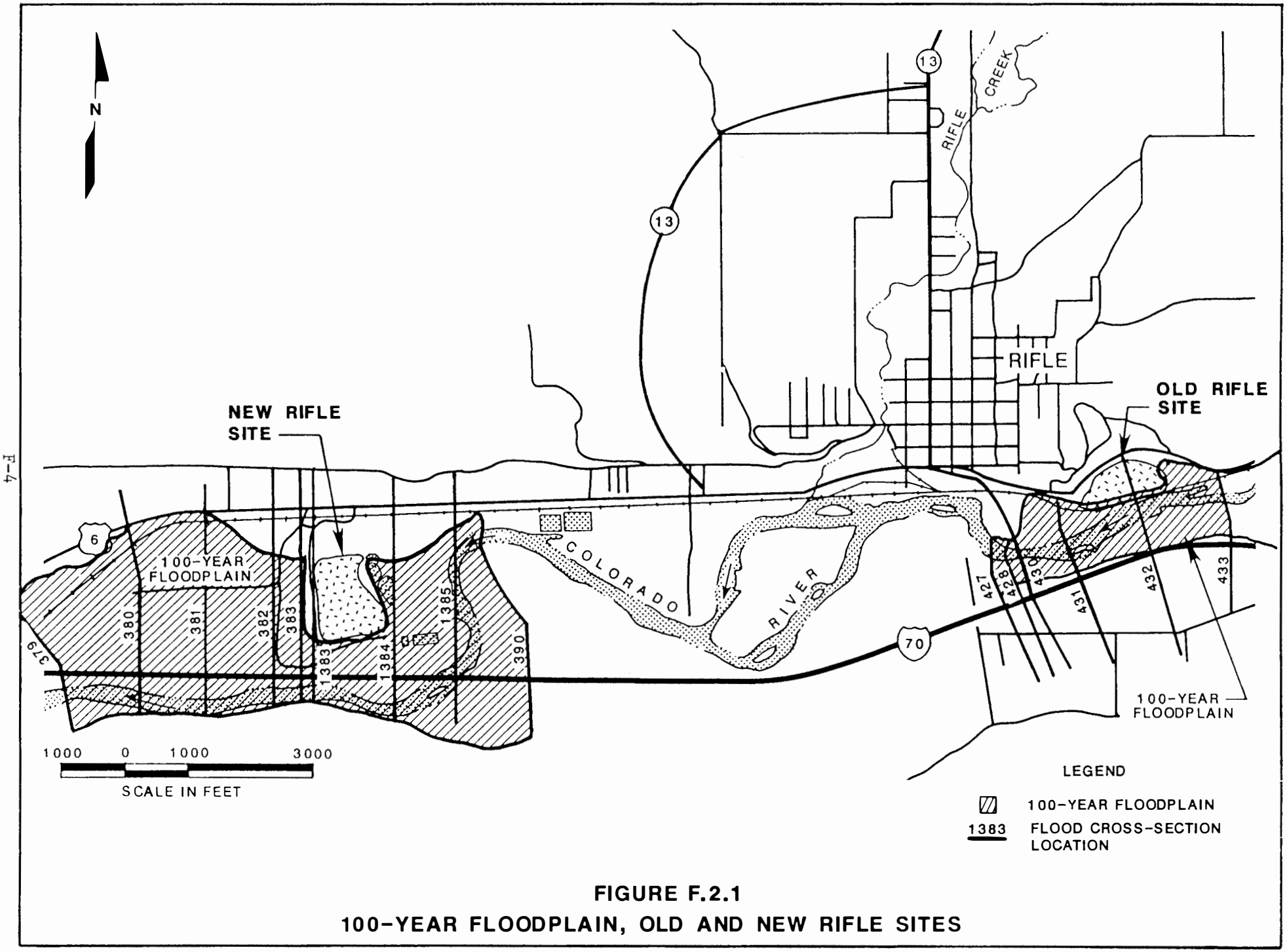


FIGURE F.2.1

100-YEAR FLOODPLAIN, OLD AND NEW RIFLE SITES

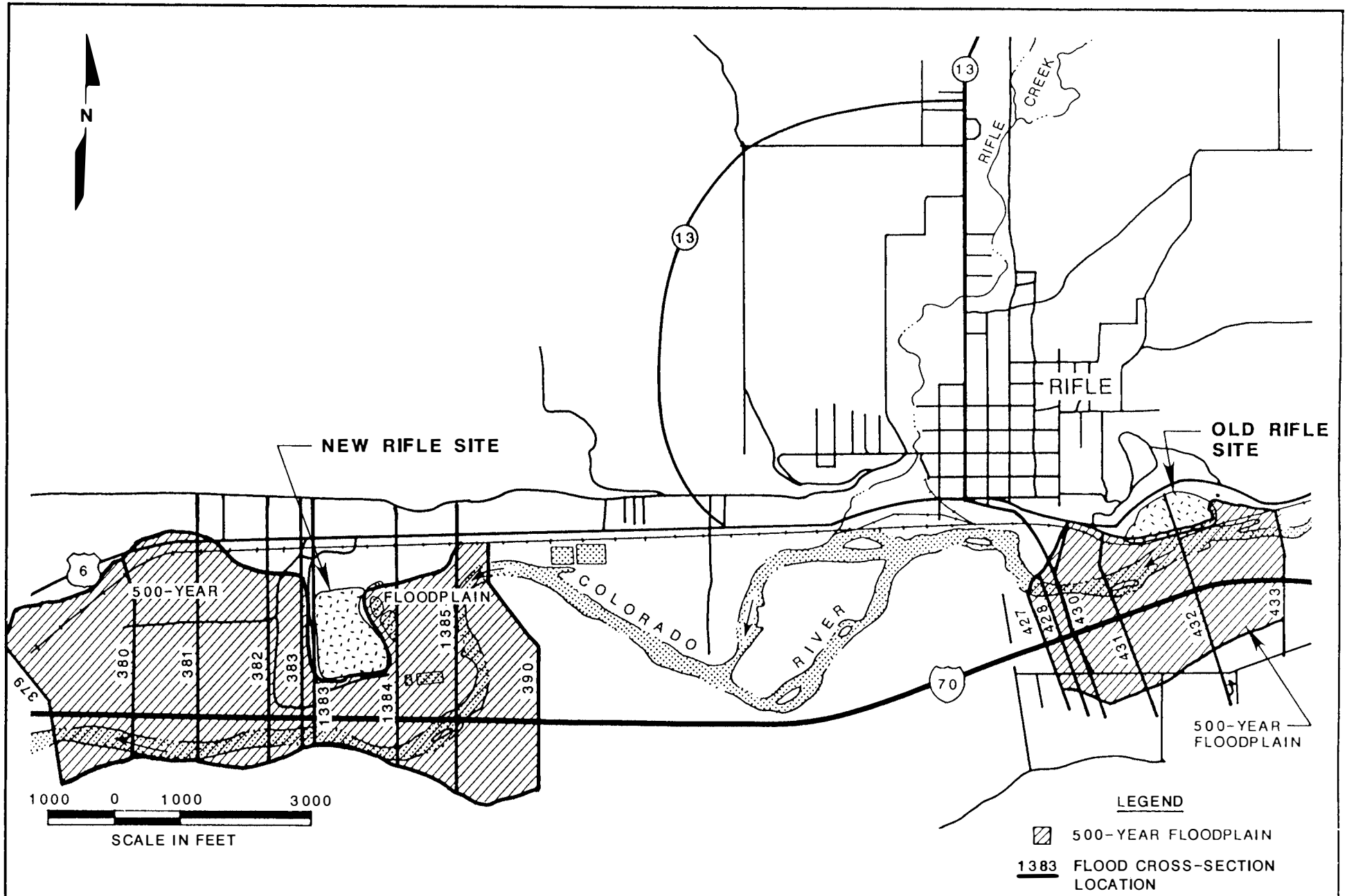


FIGURE F.2.2

500-YEAR FLOODPLAIN, OLD AND NEW RIFLE SITES

Water surface elevations and flow velocities at the New Rifle borrow site during the 500-year flood event would be approximately the same as those for the New Rifle site.

The Probable Maximum Flood (PMF), as described in Section 4.6.1 of the EIS text and Section E.1.2.1 of Appendix E, Hydrology, for the Colorado River at the Old and New Rifle sites would produce a flow of approximately 795,200 cfs and would be 30 and 24 feet, respectively, above baseline. Average channel velocities would range from 13 to 26 fps.

F.2.2 FLOOD CONDITIONS DURING REMEDIAL ACTION

During any of the remedial action alternatives at the Old Rifle site, the tailings (330,000 cubic yards (cy) of tailings and 168,000 cy of contaminated soil beneath the tailings) and approximately 62 acres (160,000 cy) of contaminated soils would be removed from the Colorado River 100-year floodplain. This would slightly deepen the flood channel. During stabilization at the New Rifle site, contaminated materials would be excavated in the 100-year floodplain at the New Rifle site. However, none of these materials would be removed from the 100-year floodplain. During the relocation alternatives, the tailings (2,415,000 cy of tailings and 375,000 cy of contaminated soil beneath the tailings) and approximately 172 acres (684,000 cy) of contaminated soils would be removed from the 100-year floodplain at the New Rifle site. At the New Rifle borrow site, stabilization at the New Rifle tailings site would result in the removal of 163,000 cy of borrow materials from the 100-year floodplain. The Estes Gulch and Lucas Mesa relocation alternatives would result in the removal of 119,900 and 342,000 cy of borrow materials from the 100-year floodplain at the New Rifle borrow site, respectively.

The quantities of material to be removed from the 500-year floodplains at the Old and New Rifle tailings sites and New Rifle borrow sites would be slightly larger than those discussed for the 100-year floodplains because the 500-year floodplains are slightly larger than the 100-year floodplains. The changes in the existing flood levels and velocities attributable to the activities discussed above would be undetectable.

Potential impacts would be mitigated by use of the following measures during remedial action.

- Contaminated materials in the floodplain would be excavated during low flows.
- Riparian vegetation adjacent to areas subject to excavation would be left undisturbed as much as possible to reduce river velocities and associated erosion during flood events.
- Revegetation would begin as soon as practical after removal of contaminated materials.

- o Water bars, mulch, riprap, or other erosion controls would be used to minimize erosion.

F.2.3 FLOOD CONDITIONS FOLLOWING REMEDIAL ACTION

Following remedial action, if the tailings are stabilized at the New Rifle site, the pile would be stabilized within the 100-year and 500-year floodplains. The configuration of the excavated areas within and adjacent to the river would be the same as during the remedial action until the vegetation within the floodplain is reestablished. During a 100-year or 500-year flood event, impacts to nearby property would be similar to flood impacts prior to remedial action. The reestablishment of vegetation would tend to stabilize the floodplain and minimize the impacts during flood flows. Excavated areas of the floodplain would be reclaimed by recontouring the area, adding any necessary soil conditioners, and revegetating the area with native riparian vegetation.

If the tailings are removed from both the Old and New Rifle sites, the 100- and 500-year flood boundaries would change slightly from the existing conditions. The flood elevations at the New Rifle site for the 100-year and 500-year floods would be a few inches to two feet lower, respectively, than for those calculated for stabilization at the New Rifle site. Similar conditions would exist for the New Rifle borrow site. Since the Old Rifle pile does not affect the floodway, removal of the tailings at the site would not change the elevations of the 100- and 500-year flood events.

F.3 WETLANDS EFFECTS

F.3.1 WETLANDS DESCRIPTION

The U.S. Army Corps of Engineers (COE) has determined that there are wetlands adjacent to the New Rifle site within the Colorado River floodplain (Davis, 1988; Opdyke, 1986; Garrison, 1985; McNure, 1985).

Wetland plant communities at the Old Rifle site cover 0.7 acre (Table F.3.1) and they are composed of a cattail-dominated area, or emergent wetlands, and a shrub-dominated wetland where willow (Salix sp.) is common (Figure F.3.1). The wetland vegetation grows in a narrow strip along a drainage ditch on the site.

A total of 20.4 acres of wetlands would be impacted by remedial action at and near the New Rifle site (Table F.3.1); 10.5 acres are in the southeast section of the designated site (Figure F.3.2), while 9.9 acres are in the windblown contaminated area west of the site (Figure F.3.3). The most common species in the emergent wetlands is cattail, along with common reed (Phragmites communis), sedge (Carex sp.), rush (Juncus sp.), and reed canary grass (Phalaris arundinacea). The wet meadow plant community is composed of dense saltgrass growth (Distichlis spicata). The most common plant species in the shrub wetland area are willow and salt cedar (Tamarix parviflora). Other species present include scattered small cottonwood (Populus sp.), skunkbush (Rhus trilobata), and greasewood (Sarcobatus vermiculatus).

The wetlands at the New Rifle site are under the jurisdiction of the COE (Davis, 1988), and a Section 404 permit would be required for any interim or remedial action activity to take place in these wetlands areas. The wetlands at the Old Rifle site are also COE-designated wetlands. However, a separate Section 404 permit is not required for any actions to take place in this area because the flow of water through this wetlands is less than five cubic yards per second and the area is less than one acre in size. Interim or remedial action activities would be allowed in the Old Rifle wetlands area under the Nationwide General Permit Number 26 (Davis, 1988).

Table F.3.1 Wetland plant community acreage

Wetland plant community type area	Old Rifle site	New Rifle site	Windblown contamination (New Rifle)	TOTAL
Emergent	0.4	0.4	5.2	6.0
Wet meadow	0.0	5.5	0.0	5.5
Shrub	0.3	4.6	4.7	9.6
TOTAL	0.7	10.5	9.9	21.1

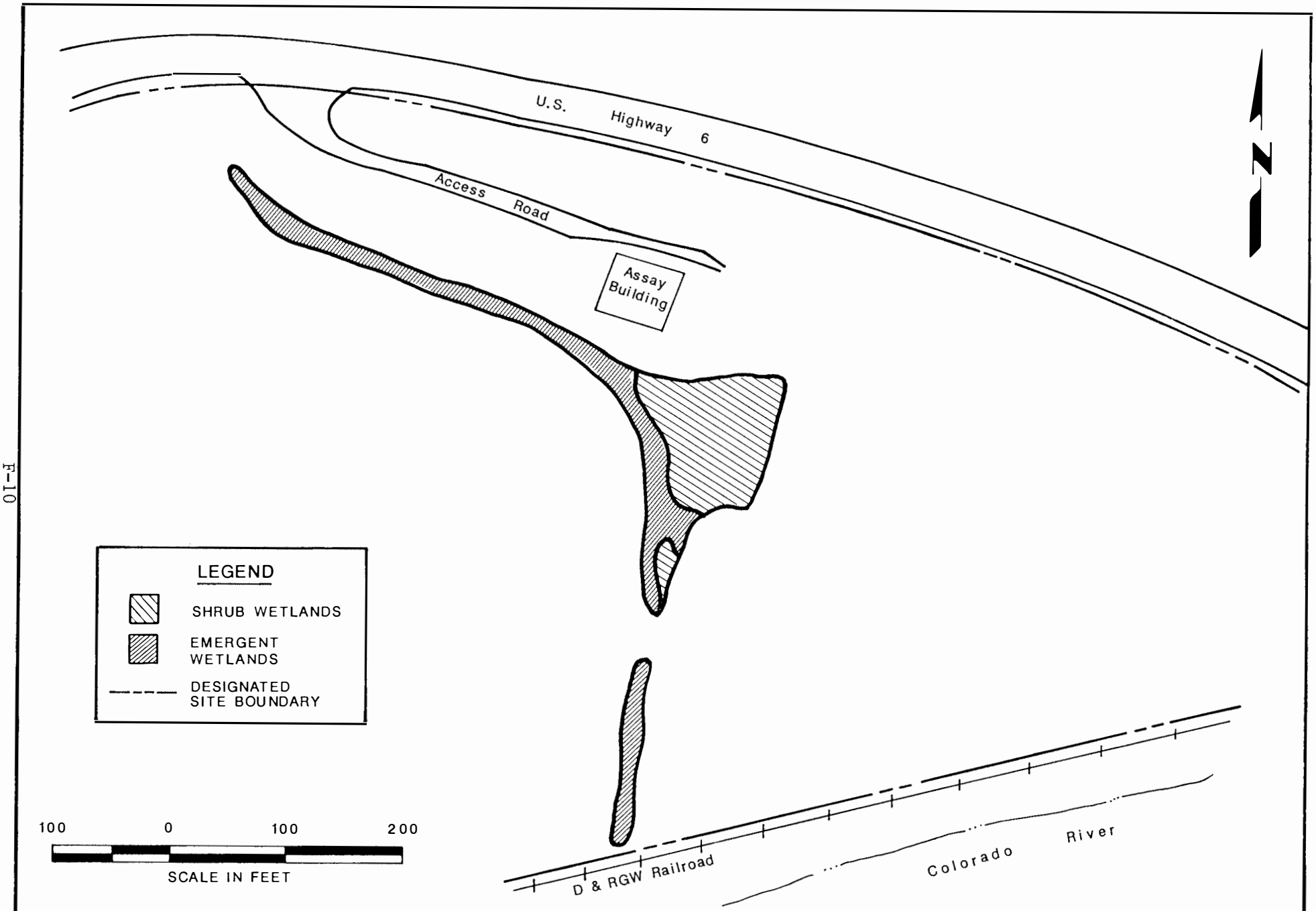


FIGURE F.3.1
WETLAND TYPES, OLD RIFLE SITE

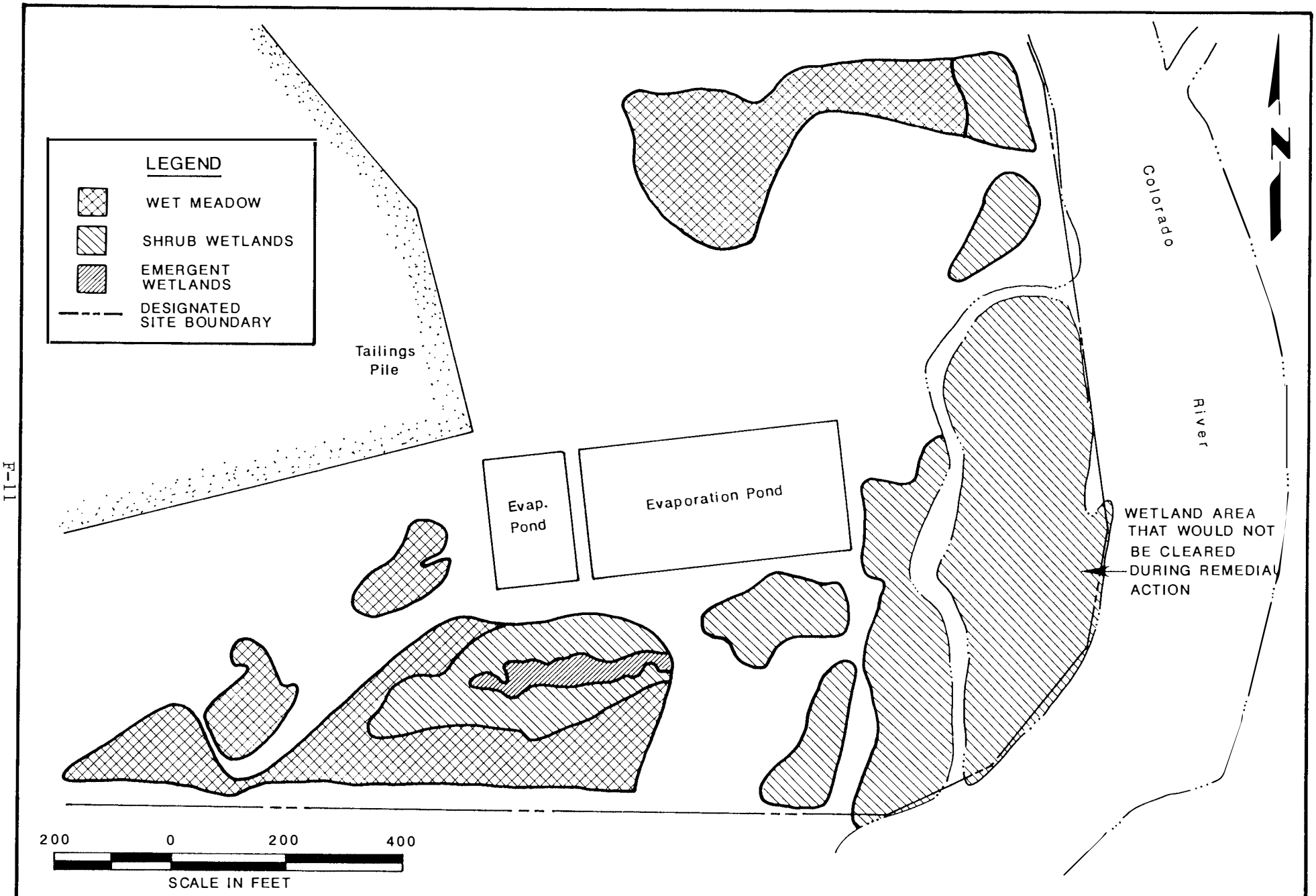


FIGURE F.3.2
WETLAND TYPES, NEW RIFLE SITE

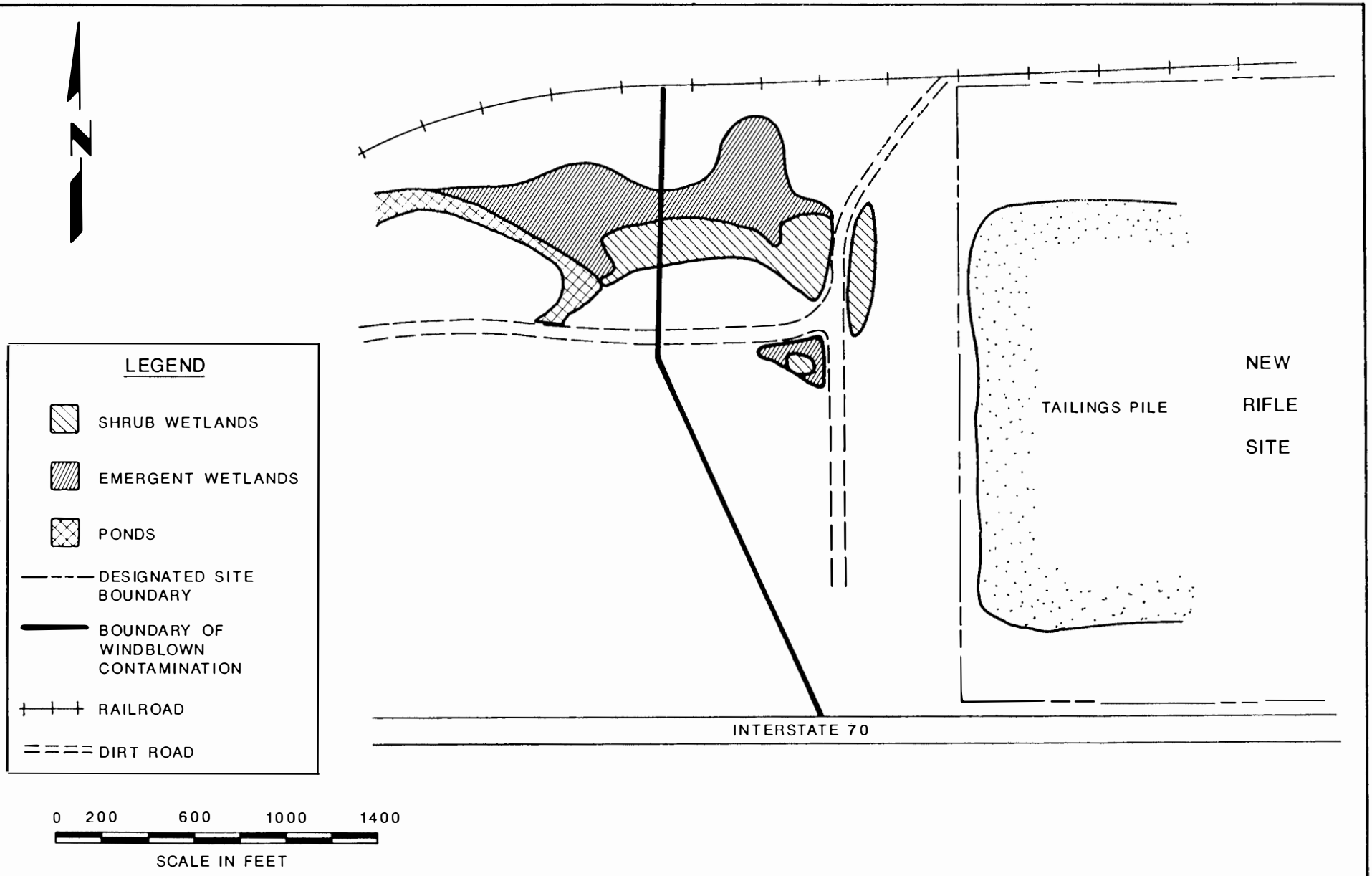


FIGURE F.3.3

WINDBLOWN CONTAMINATION AREA WETLAND TYPES; NEW RIFLE SITE

F.3.2 WETLANDS IMPACTS

During remedial action, 21.1 acres of wetlands at the New Rifle site would be affected by the excavation of contaminated materials. The affected wetlands are fairly typical of wetlands along the Colorado River. Vegetation in the wetlands would be removed prior to excavation. Habitat for birds, small mammals, and other wildlife would be lost during remedial action and until vegetation would become reestablished. Birds and some small mammals would probably relocate upstream or downstream of the site. Small, less mobile mammals utilizing the wetlands could be destroyed during excavation of contaminated soils.

F.3.3 WETLANDS IMPACTS MITIGATION

Revegetation represents the major mitigation measure to be applied to the wetlands areas at the Old and New Rifle sites. Revegetation studies in areas similar to the Rifle sites have shown high rates of success. For example, recent revegetation studies of shrub and tree-dominated wetlands using pole plantings taken from native vegetation have proven to be very successful, with close to 100 percent success when the revegetated areas are protected from grazing and trampling by wildlife and livestock (Swenson and Mullins, 1985; York, 1985). The successful revegetation of wetlands areas at the Old and New Rifle sites would result in plant communities that are similar to ones that presently exist.

The specific details of the mitigation plan will be developed in consultation with the appropriate regulatory agencies, such as the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, and the U.S. Soil Conservation Service. This detailed information, including appropriate seed mixtures, plant species, and revegetation techniques for the area, will be incorporated into the development of the final remedial action design.

General features of the mitigation plan would include:

- Riparian vegetation adjacent to interim and remedial action work areas would be left undisturbed as much as possible.
- Revegetation would occur during an appropriate season to encourage the successful reestablishment of the wetlands areas.
- Fill, grading, and recontouring of disturbed areas to create conditions favorable to the reestablishment of wetland vegetation.
- Using appropriate materials and techniques (e.g., pole-planting, select seed, native vegetation, or soil amendments) that would lead to the reestablishment of wetlands similar to the pre-remedial action conditions.

- Selected use of waterbars, mulches, riprap, or other soil erosion controls to minimize erosion and encourage the establishment and replacement of wetlands areas.

F.4 ALTERNATIVES

The alternative remedial actions are discussed in Sections 1.2 and 3.2 of the text of this EIS. The impacts of these alternatives are discussed in Sections 5.1 through 5.17. Mitigation measures that are likely to be used are described in Sections 5.20, F.2.2, and F.3.3.

The no action alternative, which entails leaving the tailings and other contaminated materials in their present condition, would not be consistent with the intent of Congress in PL95-604 and would not result in the U.S. Department of Energy's compliance with the U.S. Environmental Protection Agency standards. For the other alternatives, the construction activities and impacts that would occur are discussed in Sections F.2 and F.3.2.

F.5 STATEMENT OF FINDINGS

This Statement of Findings was prepared pursuant to Executive Orders 11988 and 11990, and 10 CFR 1022, Compliance with Floodplains/Wetlands Environmental Review Requirements. Under authority granted by the Uranium Mill Tailings Radiation Control Act of 1978, the DOE and the state of Colorado propose a cooperative remedial action effort to clean up the residual radioactive wastes and other contaminated materials at the mill sites and associated vicinity properties in Rifle, Colorado.

Alternatives under consideration include performing interim actions at the Old and New Rifle sites, but no remedial actions (Alternative 1); stabilizing the tailings and contaminated materials at the New Rifle site (Alternative 2); or relocating the tailings and contaminated materials to either the Estes Gulch (Alternative 3) or the Lucas Mesa (Alternative 4) sites. Alternative 3, relocation to the Estes Gulch site, is the DOE's preferred alternative. Both the Old and New Rifle mill sites, the tailings piles, and the associated windblown radioactively contaminated materials lie within the 100-year floodplain of the Colorado River, as shown in Figures F.2.1 and F.2.2. The Estes Gulch and Lucas Mesa sites are located well outside of the Colorado River floodplain, and there are no floodplains or wetlands associated with either of these sites.

Because the existing tailings piles, mill sites, and associated windblown contaminated areas are located in the floodplain area, some or all of the proposed interim or remedial action activities would occur within the Colorado River floodplains area regardless of which alternative is selected. On the basis of the Floodplain and Wetlands Assessment in the EIS, Appendix F, the DOE has determined that there is no practicable alternative to the proposed activities and that all of the alternatives have been designed to minimize potential harm to or within the floodplain of the Colorado River. Additional and more detailed design information and figures on the four alternatives is presented in Section 3.2 of the text, Description of Alternatives, and Appendix A, Conceptual Designs.

The no action alternative consists of taking no steps toward remedial action at the tailings sites or the vicinity properties. They would remain in their present locations and conditions. However, this alternative considers the completion of interim action activities at the Old and New Rifle sites to remediate existing health and safety hazards to the Rifle community. The interim actions include such activities as removal of asbestos and other chemicals and materials; demolition of unstable and unsafe mill structures; improving site security, and establishment of temporary and construction facilities. Vanadium-contaminated materials would be transferred to a vanadium refining facility for reprocessing; all other chemicals, acids, and materials would be transferred to a licensed disposal site. The selection of this alternative would not be consistent with the intent of Congress in the UMTRCA (PL95-604) and would not result in the site's compliance with the EPA standards (40 CFR 192).

Alternative 2 would involve the stabilization of all the tailings, asbestos, non-hazardous wastes, and contaminated materials from both sites at the

New Rifle site. The Old Rifle materials would be excavated, trucked to the New Rifle site, and consolidated with the New Rifle materials to form one tailings pile. Vanadium-contaminated materials would be transferred to a vanadium refining facility for reprocessing; all other chemicals, acids, and materials would be transferred to a licensed disposal site. The tailings and contaminated materials would then be covered with an earthen radon barrier, a frost protection and drain layer, and a rock erosion protection layer. A below-grade rock apron would be constructed around the base of the entire stabilized tailings pile to protect against the erosional forces of flooding in the Colorado River. Drainage diversion ditches would be constructed on the north, east, and south sides of the pile to divert surface water runoff around and away from the pile. All areas not occupied by the stabilized pile and associated erosion protection features would be restored with clean fill material, graded to promote positive drainage, and revegetated to re-establish vegetation and replace wetlands areas.

Alternatives 3 and 4 would involve relocating the Old and New Rifle tailings, contaminated materials, asbestos, and non-hazardous wastes to either the Estes Gulch or Lucas Mesa sites, respectively. The Estes Gulch site is approximately six miles north of the city of Rifle and the Lucas Mesa site is approximately 35 miles southwest of Rifle. Vanadium-contaminated materials would be transferred to a vanadium refining facility for reprocessing; all other chemicals, acids, and materials would be transferred to a licensed disposal site. A 20-foot-deep disposal area would be excavated at the Estes Gulch site and a 15-foot-deep disposal site would be excavated at Lucas Mesa. The tailings and other materials would be placed in the disposal area, and at either site, they would be covered by an earthen radon barrier, a frost protection and drain layer, and a rock protection barrier. At Estes Gulch site, the disposal pile would be nearly flush with the surrounding terrain, and the adjacent terrain would be graded to promote sheet flow. Rock-filled key trenches along the sides, a rock-lined toe ditch, and an upland drainage area and interceptor ditch would intercept and direct runoff away from the pile. At the Lucas Mesa site, below-grade rock apron and rock-lined diversion ditches would be constructed to divert surface runoff away from the pile. For either alternative, the Old and New Rifle sites would be restored with clean fill material, graded to promote positive drainage, and revegetated to re-establish vegetation and replace wetlands areas after remedial action is completed.

Specific construction activities related to the floodplain, regardless of which alternative is selected, include 1) the disturbance of approximately 40 (interim actions only, no remedial action alternative) to 326 acres (the action alternatives) within the floodplain of the Colorado River; 2) disturbance of 0.7 acre of wetlands vegetation at the Old Rifle site and 20.4 acres of wetlands vegetation at the New Rifle site; 3) grading and revegetating the floodplain where excavated; 4) removal of material from the New Rifle borrow site; and 5) use of soil conditioners, water bars, mulch, riprap or other soil erosion controls, if necessary, to control erosion and promote revegetation.

Potential impacts during interim or remedial action would be mitigated by use of the following measures:

- Wetlands vegetation adjacent to interim and remedial action work areas would be left undisturbed as much as possible to reduce river velocities and associated erosion during flood events.

- Contaminated materials in the floodplain would be excavated during low flows.

- Revegetation would occur during an appropriate season to encourage the successful re-establishment of the wetlands areas.

- Filling, grading, and recontouring of disturbed areas to prevent erosion and create conditions favorable to the re-establishment of wetlands vegetation.

- Revegetation using appropriate materials and techniques (e.g., pole-planting, select seed, native vegetation, or soil amendments or conditioners) that would lead to the re-establishment of wetlands similar to the pre-remedial/interim action conditions.

- Selected use of waterbars, mulches, riprap, or other soil erosion controls to prevent erosion and encourage the establishment of replacement wetlands areas.

The interim and remedial actions have been designed to conform to all applicable Federal and state regulations. Before any activity would begin, all applicable permits and approvals, such as those required under Section 404 of the Clean Water Act, would be obtained from the U.S. Army Corps of Engineers, Colorado state agencies, and other agencies having jurisdiction. Initial consultations with the agencies have taken place.

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APPENDIX G

BIOLOGY

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G.1 INTRODUCTION

This appendix describes the vegetation, fish, and wildlife baseline conditions for the Old and New Rifle tailings sites, Estes Gulch and Lucas Mesa alternate disposal sites, and the borrow sites. It includes a description of threatened, endangered, and sensitive species whose geographic ranges overlap the project area. Information presented here is based on published and unpublished reports on terrestrial and aquatic resources and personal communications with knowledgeable people.

G.2 VEGETATION

The Old and New Rifle sites, alternate disposal sites, and borrow sites lie within the Southern Rocky Mountain physiographic region, which consists of bottomlands, gently to steeply sloping hills, alluvial fans, and mesas. Elevations vary from 5200 feet above mean sea level (MSL) along the Colorado River near the New Rifle site to 6500 feet above MSL at the Lucas Mesa site.

The types of vegetation extant in the region are controlled by local topography. The spruce-fir vegetation zone extends from the higher elevations (11,000 feet above MSL) to 8700 feet above MSL with aspen stands extending to 8100 feet above MSL and to lower elevations in stream valleys. An oak-juniper zone ranges from 8500 to 5000 feet above MSL. Sagebrush, desert grasses, and cottonwood trees occur within the oak-juniper zone to elevations of 5000 feet above MSL. The effects of slope aspect cause lower elevation vegetation zones to extend higher on south-facing slopes (Yeend, 1969). Ponderosa pine is absent in the area although scattered pinon pines occur.

The Old and New Rifle sites, alternate diposal sites, and borrow sites are characterized primarily by pinon-juniper woodland, semi-desert shrub, and riparian vegetation. The pinon-juniper woodland occurs on the hillslopes and generally is interspersed with big sagebrush at its lower elevations. The semi-desert shrub is composed primarily of big sagebrush, saltbush, and greasewood. Big sagebrush occurs on alluvial fans and mesa tops with the saltbush and greasewood occurring in the bottomlands. The riparian vegetation occurs adjacent to the bottomlands along the Colorado River and consists of a narrow zone of trees and shrubs. Dominant vegetation in this riparian zone includes cottonwood, willow, alder, salt cedar, New Mexico locust, squawbush, greasewood, cheatgrass, bluegrass, and wheatgrass. The riverine and palustrine wetlands associated with the Colorado River are included within the riparian zone. Additional information on wetlands is found in Section F.3 of Appendix F, Floodplain and Wetlands Assessment.

G.2.1 Old and New Rifle sites

Vegetation on the disturbed Old Rifle site primarily consists of wheatgrass, other grasses, a few forbs, and Russian olive (DOE, 1983). Greasewood and a few cottonwood trees are found near the abandoned mill area. The western perimeter of the site is occupied by greasewood, salt cedar, cottonwood, alder, rabbitbrush, sagebrush, and New Mexico locust. The site occupies an area which was originally a salt-meadow range site (SCS, 1985). Climax vegetation representative of this range site in an undisturbed state includes alkali sacaton, saltgrass, wheatgrass, sedges, and rabbitbrush. Relative abundance of shrubs and saltgrass increases when range condition deteriorates and eventually undesirable weeds and annual plants dominate.

A small wetland area (0.7 acre) dominated by cattail and willow occurs along a drainage ditch on the site. This wetland is described in greater deal in Section F.3.1 of Appendix F, Floodplain and Wetlands Assessment.

The New Rifle site is highly disturbed with little native vegetation present. The tailings have been seeded with wheatgrass and are currently being irrigated. An area immediately west of the tailings pile appears to be a salt-flat range site in poor condition; it is dominated by greasewood and saltgrass (DOE, 1983). According to the U.S. Soil Conservation Service (SCS) (1985), the tailings site was originally on the salt-meadow and salt-flats range sites. Climax vegetation representative of the salt-flats range site in an undisturbed state consists mainly of saltgrass, alkali sacaton, and greasewood. The relative abundance of forbs and shrubs increases when the range condition deteriorates.

A total of 20.4 acres of wetlands occurs at the New Rifle site. A more detailed description of these wetlands is provided in Section F.3.1 of Appendix F, Floodplain and Wetlands Assessment.

Adjacent to the Old and New Rifle sites along the Colorado River is a riparian zone which consists primarily of wetlands, with some riverine and forested habitat. Cottonwood trees occur in scattered clumps with willow, salt cedar, and grass-dominated areas more common near the Old Rifle site. Small areas of willows and cattails and extensive areas of dense saltgrass with some greasewood border the Colorado River near the New Rifle site.

No threatened and endangered plant species are expected to occur at the Old and New Rifle sites. Section G.4 of this appendix describes the threatened, endangered, and sensitive species in detail.

G.2.2 ESTES GULCH SITE

At the Estes Gulch site and vicinity (elevation 6100 feet above MSL), vegetation is dominated by sagebrush, juniper, and pinon pine; greasewood, a sparse cover of native grasses and forbs, and slopes that are almost devoid of vegetation are also present. Table G.2.1 presents the list of plant species that were observed at the Estes Gulch site. Vegetation around a small stock pond (covering 0.5 acre) located adjacent to the southern portion of the site includes greasewood, cottonwood saplings, and salt cedar saplings.

The vegetation of the pinon-juniper type in the surrounding area consists mainly of pinon pine and Utah juniper trees (SCS, 1985). The common understory shrub layer is typified by big sagebrush, fourwing saltbush, serviceberry, shadscale, and bitterbrush.

The sagebrush type is on the rolling loam range site (SCS, 1985). Climax vegetation consists of big sagebrush, western wheatgrass, needle-and-thread grass, bluebunch wheatgrass, rabbitbrush, and squirreltail. When range condition deteriorates, grass production decreases, and shrub production increases. Annual production for this range site is estimated at 500 pounds per acre during unfavorable years and up to 1000 pounds per acre in favorable years.

Table G.2.1 Plant species observed at the Estes Gulch site

Common name	Scientific name
Trees	
Utah juniper	*Juniperus osteosperma*
Pinon pine	*Pinus edulis*
Shrubs	
Big sagebrush	*Artemisia tridentata*
Fourwing saltbush	*Atriplex canescens*
Shadscale	*A. confertifolia*
Winterfat	*Ceratoides lanata*
Mountain mahogany	*Cercocarpus montanus*
Rubber rabbitbrush	*Chrysothamunus nauseosus*
Hedgehog cactus	*Echinocereus triglochidiatus*
Mormon tea	*Ephedra viridis*
Broom snakeweed	*Gutierrezia sarothrae*
Utah prickly pear cactus	*Opuntia erinacea*
Brittle prickly pear cactus	*O. fragilis*
Antelope bitterbrush	*Purshia tridentata*
Greasewood	*Sarcobatus vermiculatus*
Horsebrush	*Tetradymia canescens*
Horsebrush	*Tetradymia spinosa*
Soapweed	*Yucca glauca*
Forbs	
Sand verbena	*Abronia elliptica*
Wild onion	*Allium accuminatum*
Wild onion	*A. textile*
Alyssum	*Alyssum desertorum*
Pussytoes	*Antennaria rosulata*
Rockcress	*Arabis perennans*
Sandwort	*Arenaria eastwoodae*
Milkweed	*Asclepias cryptoceras*
Aster	*Aster sp.*
Milkweed	*Astragalus amphioxys*
Milkvetch	*A. lonchocarpus*
Milkvetch	*A. oophorus*
Milkvetch	*A. tenellus*
Milkvetch	*A. wetherillii*
Brickelbush	*Brickellia sp.*
Sego lily	*Calochortus nuttallii*
Camelina	*Camelina microcarpa*
Nelson's Indian paintbrush	*Castilleja chromosa*

Table G.2.1 Plant species observed at the Estes Gulch site (Continued)

Common name	Scientific name
Forbs (Continued)	
Chaenactis	Chaenactis stevioides
Chenopodium	Chenopodium fremontii
Chlorispora	Chlorispora tenella
Thistle	Circium bipinnatum
Thistle	Circium undulatum
Hawksbeard	Crepis modocensis
Cryptantha	Cryptantha gracilis
Cryptantha	C. stricta
Cryptantha	Cryptantha sp.
Biscuitroot	Cymopterus bulbosus
Biscuitroot	C. fendleri
Biscuitroot	C. purpureus
Larkspur	Delphinium scaposum
Tansy mustard	Descurainia pinnata
Tansy mustard	D. sophia
Fleabane	Erigeron pumilus
Wild buckwheat	Eriogonum lonchophyllum
Buckwheat	E. microthecum
Wild buckwheat	E. ovalifolium
Filaree	Erodium cicutarium
Erysimum	Erysimum asperum
Spurge	Euphorbia robusta
Gilia	Gilia aggregata
Gilia	G. sinuata
Golden aster	Heterotheca villosa
Hymenopappus	Hymenopappus filifolius
Actinea	Hymenoxys acaulis
Summer cypress	Kochia scoparium
Stickseed	Lappula texana
Peppergrass	Lepidium perfoliatum
Roseheath	Leucelene eriocoides
Lupine	Lupinus brevicaulis
Lomatium	Lomatium sp.
Machaerantha	Machaerantha canescens
Shinners	M. grindeloides
Malcolmia	Malcolmia africans
Alfalfa	Medicago sativa
Stickleaf	Mentzelia albicaulis
Four-o'clock	Mirabilis multiflora
Evening primrose	Oenothera caespitosa
Clustered broomrape	Orobanche fasciculata

Table G.2.1 Plant species observed at the Estes Gulch site (Concluded)

Common name	Scientific name
Forbs (Concluded)	
Penstemon	Penstemon fremontii
Penstemon	P. osterhoutii
Phlox	Phlox austromontana
Phlox	P. longifolia
Mistletoe	Phoradendron juniperinum
Twinpod	Physaria acutifolia
Plantain	Plantago patigonica
Knotweed	Polygonum aviculare
Buttercup	Ranunculus testiculatus
Russian thistle	Salsola kali
Groundsel	Senecio multilobatus
Mustard	Schoencrambe linifolia
Scarlet globemallow	Sphaeralcea coccinea
Twistflower	Streptanthus cordatus
Daisy	Townsendia excapa
Clover	Trifolium longipes
Mullein	Verbascum thapsus
Xylorhiza	Xylorhiza glabriuscula
Grasses	
Crested wheat	Agropyron cristatum
Quackgrass	A. repens
Bluebunch wheatgrass	A. spicatum
Red brome	Bromus rubens
Cheatgrass	B. tectorum
Galleta grass	Hilaria jamesii
Junegrass	Koeleria cristata
Indian ricegrass	Oryzopsis hymenoides
Muttongrass	Poa fendleriana
Bluegrass	Poa secunda
Bottlebrush squirreltail	Sitanion hystrix
Needle-and-thread grass	Stipa comata
Six weeks fescue	Vulpia octoflora

Ref. EES, 1986.

Vegetation on the site is primarily composed of sagebrush. Although quantitative vegetation surveys were not conducted at the Estes Gulch site, vegetation found in the sagebrush type at the Main Elk Creek area, located 11 miles east of the site, is probably similar (Mobil, 1982). On the average, total vegetation cover at the Main Elk Creek area was 32 percent with big sagebrush contributing 17.6 percent of the cover. Understory cover was dominated by cheatgrass (6.6 percent) with annual forbs (2.2 percent), bluegrass (1.0 percent), needle-and-thread grass (0.8 percent), and perennial forbs (0.6 percent) occurring as common species. Bare ground with and without canopy cover comprised 0.4 percent and 27.4 percent, respectively; litter and rock contributed 40.6 percent to the total cover. Total mean shrub density was 2400 plants per acre with big sagebrush and low rabbitbrush contributing over 90 percent.

The Wetherill milkvetch, a state-listed species of special concern, is found near the proposed access road leading into the Estes Gulch site. It may also occur along the portion of Highway 13 that would be widened and improved. Details on this species are contained in Section G.4.13 of this appendix.

G.2.3 LUCAS MESA SITE

The principal vegetation types that occur on the Lucas Mesa site and surrounding area are pinon-juniper woodland and sagebrush. Table G.2.2 presents the list of plant species that are likely to occur at the Lucas Mesa site. Typical climax vegetation of the pinon-juniper type includes the Utah juniper, pinon pine, Indian ricegrass, blue grama, bluebunch wheatgrass, galleta grass, needle-and-thread grass, bluegrass, and various forbs (SCS, 1985). The sagebrush type occurs on the rolling loam range site. Typical climax vegetation of the rolling loam range site was previously described for the Estes Gulch site.

A dense stand of big sagebrush with an understory of forbs and grasses covers the majority of the site. Because of its very high density, sagebrush has almost eliminated the understory grasses in many parts of the site. The site dominance of big sagebrush indicates that the range has deteriorated. Roadsides and other disturbed areas of the site, where sagebrush has been removed, exhibit high densities of low rabbitbrush (DOE, 1983).

The eastern and southern portions of the site are dominated by an open juniper woodland. These areas are occupied by juniper trees with a sparse understory of shrubs, forbs, and grasses, particularly low rabbitbrush, scarlet globemallow, and Indian ricegrass. Juniper trees also occur along several shallow drainages running southeast to northwest across the site (DOE, 1983).

Point-centered quarter measurements to determine shrub and tree density were conducted (DOE, 1983) (Table G.2.3). These measurements, when compared to other studies in the area (Clear Creak and Main Elk Creek areas), indicate a relatively high density of sagebrush and juniper at the Lucas Mesa site (CDM, 1983; Mobil, 1982). The sagebrush densities along Clear Creek (eight miles north of DeBeque) and Main Elk

Table G.2.2 Plant species likely to occur at the Lucas Mesa site

Common name	Scientific name
Trees	
Utah juniper	*Juniperus osteosperma*
Pinon pine	*Pinus edulis*
Shrubs	
Utah serviceberry	*Amelanchier utahensis*
Big sagebrush	*Artemisia tridentata*
Fourwing saltbush	*Atriplex canescens*
Shadscale	*A. confertifolia*
Mountain mahogany	*Cercocarpus montanus*
Rubber rabbitbrush	*Chrysothamunus nauseosus*
Low rabbitbrush	*C. viscidiflorus*
Mormon tea	*Ephedra viridis*
Prickly pear	*Opuntia polyacantha*
Squaw apple	*Peraphyllum sp.*
Bitterbrush	*Purshia tridentata*
Gambel oak	*Quercus gambellii*
Skunkbush sumac	*Rhus trilobata*
Greasewood	*Sarcobatus vermiculatus*
Mountain serviceberry	*Symphoricarpos oreophilus*
Forbs	
Aster	*Aster sp.*
Milkvetch	*Astragalus sp.*
Douglas chaenactis	*Chaenactis douglassi*
Tansy mustard	*Descurainia pinnata*
Buckwheat	*Eriogonum sp.*
Pepperweed	*Lepidium perforiatum*
Hoods phlox	*Phlox hoodii*
Scarlet globemallow	*Sphaeralcea coccinea*
Grasses	
Crested wheatgrass	*Agropyron cristatum*
Western wheatgrass	*A. smithii*
Blue grama	*Bouteloua gracilis*
Cheatgrass	*Bromus tectorum*
Galleta grass	*Hilaria jamesii*
Prairie junegrass	*Koeleria cristata*
Indian ricegrass	*Oryzopsis hymenoides*
Bluegrass	*Poa secunda*
Bottlebrush squirreltail	*Sitanion hystrix*
Needle-and-thread grass	*Stipa comata*

Ref. Jenkins, 1986; DOE, 1983; Mobil, 1982.

Table G.2.3 Shrub and tree density, Lucas Mesa site

Common name	Scientific name	Number of plants per hectare
Big sagebrush	Artemesia tridentata	10,250
Low rabbitbrush	Chrysothamunus viscidiflorus	2410
Utah juniper	Juniperus osteosperma	370

Ref. DOE, 1983.

Creek were 3300 plants per acre (CDM, 1983) and 2000 plants per acre (Mobil, 1982), respectively, as compared to 4100 plants per acre at Lucas Mesa. The juniper densities at Clear Creek and Main Elk Creek were 32 and 26 trees per acre, respectively; at Lucas Mesa, the density was 150 trees per acre.

A Bureau of Land Management (BLM) trend site is also located on the western portion of the Lucas Mesa site. Data collected from 1980 through 1983 at this site indicate that the vegetation cover is decreasing (see Table G.2.4).

No threatened and endangered plant species are expected to occur at the Lucas Mesa site. Section G.4 of this appendix provides details on threatened, endangered, and sensitive species.

G.2.4 BORROW SITES

The Second Street and New Rifle borrow sites, just north and west of the New Rifle site, respectively, are existing borrow operations. Before disturbance, the Second Street borrow site occurred on the salt-flats range site, and the New Rifle borrow site was on the salt-meadow range site and floodplain adjacent to the Colorado River (SCS, 1985). Both the salt-flats and salt-meadow range sites were described previously under the Old and New Rifle sites (Section G.2.1). The native vegetation of the floodplain is characterized by cottonwood, willow, tamarisk, and water-tolerant grasses, sedges, and rushes.

The Glenwood Springs borrow site, located northeast of Glenwood Springs, is also an existing borrow operation. The site area is characterized by pinon-juniper and oak brush vegetation types. It is situated on what was a shallow subalpine range site (SCS, 1985). The climax vegetation of this range site includes needlegrasses, Idaho fescue, mountain brome, wheatgrasses, Utah serviceberry, and big sagebrush. When the range deteriorates, forbs and shrubs become numerous.

Table G.2.4 Vegetation cover of BLM trend site on Lucas Mesa

Common name	Scientific name	1983 cover (percent)	1980-1983 average cover (percent)
Big sagebrush	Artemisia tridentata	23.4	24.9
Galleta	Hilaria jamesii	1.1	1.7
Prickly pear	Opuntia polyacantha	1.8	2.2
Bluegrass	Poa secunda	0.4	0.2
Squirreltail	Sitanion hystrix	0.2	0.1
Aster	Aster sp.	0.1	0.1
Globemallow	Sphaeralcea coccinea	Trace	Trace
Phlox	Phlox sp.	Not found	Trace
Total		27.0	29.2
Litter		21.6	16.4

Ref. Jenkins, 1986.

G.3 FISH AND WILDLIFE RESOURCES

The Old and New Rifle sites, alternate disposal sites, and borrow sites support a diverse assemblage of mammals, birds, reptiles, and amphibians. Major habitat types of the sites are pinon-juniper, sagebrush, and riparian vegetation. In addition, the aquatic or riverine habitat adjacent to the tailings sites supports numerous fish and wildlife species. Tables G.3.1 through G.3.3 list the mammals, nesting birds, amphibians, and reptiles that are expected to occur at the various sites.

G.3.1 OLD AND NEW RIFLE SITES

Wildlife diversity at the Old and New Rifle sites is low due to the disturbed nature of the sites and the close proximity of the city of Rifle. Although birds, small mammals, and reptiles may forage on or inhabit the sites, the sites are not considered significant wildlife habitats; areas adjacent to the Old and New Rifle sites are of greater importance. The riparian and aquatic habitats along the Colorado River, although not unique, serve as important habitats for many species of fish and wildlife including mammals, waterfowl, shorebirds, raptors, amphibians, and reptiles (Tables G.3.1 through G.3.4). The endangered bald eagle occurs in these habitats, and candidate species such as the razorback sucker, western yellow-billed cuckoo, white-faced ibis, long-billed curlew, and western snowy plover may also utilize these habitats. These species are discussed in Section G.4 of this appendix. In addition, the areas along the Colorado River near and north of the Old Rifle site are considered to be a resident population area for mule deer. Areas north of the New Rifle site are considered a critical winter range habitat for mule deer (Schnuur, 1985a). These activity areas are shown on Figure G.3.1.

The Colorado River, one of the most productive fisheries within the Glenwood Springs Resource Area (encompassing the Old and New Rifle sites, Estes Gulch alternate disposal site, and all of the proposed borrow sites), is an important sport fishery (BLM, 1983). A list of fish species that may occur in the Colorado River near the sites is presented in Table G.3.4. Valdez et al. (1982) describe the section of the Colorado River near Rifle as a transition zone between a warm and cool water fishery. The study conducted by Valdez et al. found the bluehead sucker, flannelmouth sucker, common carp, roundtail chub, and speckled dace to be abundant and the white sucker, green sunfish, mottled sculpin, fathead minnow, brown trout, and rainbow trout to be numerous. The rainbow trout is stocked annually in the upper Colorado River above Rifle while the brown trout is stocked sporadically (Sealing, 1986).

G.3.2 ESTES GULCH SITE

The sagebrush and pinon-juniper woodland habitat types support a diverse assemblage of mammal, bird, reptile, and amphibian species.

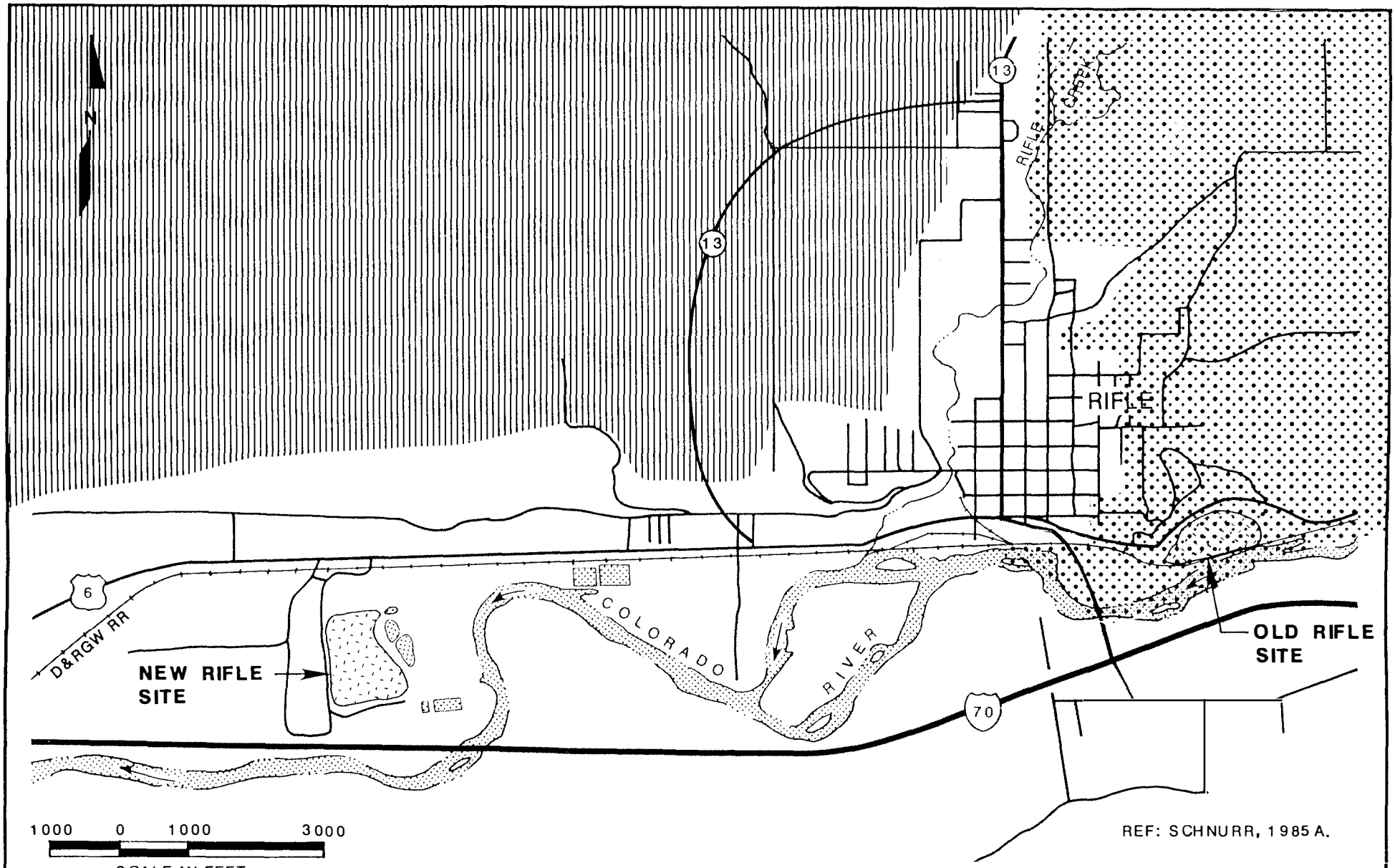


FIGURE G.3.1

MULE DEER ACTIVITY AREAS, OLD AND NEW RIFLE SITES

Table G.3.1 Mammals expected to occur at the Rifle UMTRA Project sites

Species		Habitat preference		
Common name	Scientific name	Valley riparian/ grassy fields	Pinon/ juniper	Sagebrush
Vagrant shrew	Sorex vagrans	X		
Merriam's shrew	Sorex merriami	X		X
Long-eared myotis	Myotis evotis		X	
California myotis	Myotis californicus		X	
Small-footed myotis	Myotis leibii	X		
Silver-haired bat	Lasionycteris noctivagans	X	X	
Western pipistrel	Pipistrellus hesperus		X	
Big brown bat	Eptesicus fuscus	X	X	
Hoary bat	Lasiurus cinereus	X	X	
Pallid bat	Antrozous pallidus		X	
Brazilian free-tailed bat	Tadarida brasiliensis	X	X	
Mountain cottontail	Sylvilagus nuttallii		X	X
Desert cottontail	Sylvilagus audubonii			X
White-tailed jack-rabbit	Lepus townsendii			X
Least chipmunk	Eutamias minimus	X	X	
Colorado chipmunk	Eutamias quadrivittatus	X	X	
White-tailed antelope squirrel	Ammosphermophilus leucurus		X	
Richardson's ground squirrel	Spermophilus richardsonii			X
Rock squirrel	Sphermophilus variegatus		X	
Golden-mantled ground squirrel	Sphermophilus lateralis	X	X	X
Northern pocket gopher	Thomomys talpoides		X	X
Plains pocket mouse	Perognathus flavescens		X	
Deer mouse	Peromyscus maniculatus	X	X	X
Canyon mouse	Peromyscus crinitus		X	
Pinon mouse	Peromyscus truei		X	
Bushy-tailed woodrat	Neotoma cinerea		X	X
Western jumping mouse	Zapus princeps	X		
House mouse	Mus musculus	X		
Coyote	Canis latrans	X	X	X
Red fox	Vulpes vulpes	X		
Gray fox	Urocyon cinereoargenteus		X	X
Raccoon	Procyon lotor	X		
Black bear	Ursus americanus		X	X
Long-tailed weasel	Mustela frenata	X	X	X
Badger	Taxidea taxus	X	X	X

Table G.3.1 Mammals expected to occur at the Rifle UMTRA Project sites (Concluded)

Species		Habitat preference		
Common name	Scientific name	Valley riparian/ grassy fields	Pinon/ juniper	Sagebrush
Spotted skunk	Spilogale putorius	X	X	X
Striped skunk	Mephitis mephitis	X	X	X
Mountain lion	Felis concolor		X	X
Bobcat	Felis rufus	X	X	X
Elk	Cervus elaphus		X	X
Mule deer	Odocoilus hemionus	X	X	X

Ref. CDM, 1983; Mobil, 1982; BLM, no date.

Table G.3.2 Nesting birds expected to occur at the Rifle UMTRA Project sites

Species		Habitat preference		
Common name	Scientific name	Valley riparian/ grassy fields	Pinon/ juniper	Sagebrush
Cooper's hawk	Accipiter cooperii	X		
Red-tailed hawk	Buteo jamaicensis	X	X	
American kestrel	Falco sparverius	X	X	
Chukar	Alectoris chukar			X
Mourning dove	Zenaidura macroura	X	X	X
Common nighthawk	Chordeiles minor	X	X	
Black-chinned hummingbird	Archilochus alexandi			X
Broad-tailed hummingbird	Selasphorus platycercus	X		
Northern flicker	Colaptes auratus	X		
Downy woodpecker	Picoides pubescens	X		
Western kingbird	Tyrannus verticalis	X		
Ash-throated flycatcher	Myiarchus cinerascens		X	
Western wood pewee	Contopus sordidulus	X		
Say's phoebe	Sayornis saya	X		
Dusky flycatcher	Empidonax oberholseri		X	
Western flycatcher	Empidonax difficilis	X		
Horned lark	Eremophila alpestris	X		
Scrub jay	Aphelocoma coerulescens		X	
Pinon jay	Gymnorhinus cyanocephalus		X	
Black-billed magpie	Pica pica	X	X	
Plain titmouse	Parus inornatus		X	
Black-capped chickadee	Parus atricapillus	X		
Bushtit	Psaltriparus minimus	X	X	
Brown creeper	Certhia americana	X		
House wren	Troglodytes aedon	X		
Bewick's wren	Thryomanes bewickii	X		
Rock wren	Salpinctes obsoletus		X	
Blue-gray gnatcatcher	Polioptila coerulea	X	X	
Mountain bluebird	Sialia currucoides		X	
Townsend's solitaire	Myadestes townsendi		X	
American robin	Turdus migratorius	X	X	
Gray vireo	Vireo vicinior		X	
Solitary vireo	Vireo solitarius	X	X	
Warbling vireo	Vireo gilvus	X		
Virginia's warbler	Vermivora virginiae	X	X	X

Table G.3.2 Nesting birds expected to occur at the Rifle UMTRA Project sites (Concluded)

Species		Habitat preference		
Common name	Scientific name	Valley riparian/ grassy fields	Pinon/ juniper	Sagebrush
Yellow-rumped warbler	Dendroica coronata		X	
Black-throated gray warbler	Dendroica nigrescens		X	
Yellow warbler	Dendroica petechia	X		
MacGillivray's warbler	Oporomis tolmiei	X		
Yellow-breasted chat	Icteria virens	X		
Black-headed grosbeak	Pheucticus melanocephalus	X	X	
Lazuli bunting	Passerina amoena	X		X
Green-tailed towhee	Pipilo chloruras	X	X	X
Rufous-sided towhee	Pipilo erythrophthalmus	X	X	X
Vesper sparrow	Pooecetes gramineus			X
Song sparrow	Melospiza melodia	X		
Black-throated sparrow	Amphispiza bilineata			X
Chipping sparrow	Spizella passerina	X	X	X
Brewer's sparrow	Spizella breweri			X
Western meadowlark	Sturnella neglecta	X		X
Red-winged blackbird	Agelaius phoeniceus	X		
Brewer's blackbird	Euphagus cyanocephalus	X		
Brown-headed cowbird	Molothrus ater	X		
Pine siskin	Carduelis pinus	X		

Ref. CDM, 1983; Mobil, 1982.

Table G.3.3 Amphibians and reptiles expected to occur at the Rifle UMTRA Project sites

Species		Habitat preference		
Common name	Scientific name	Valley riparian/ grassy fields	Pinon/ juniper	Sagebrush
Great basin spade-foot	Scaphiopus intermontanus		X	X
Western toad	Bufo boreas	X		
Rocky Mountain toad	Bufo woodhouser	X		
Chorus frog	Pseudacris triseriata	X		
Collared lizard	Crotaphytus colbris		X	X
Northern plateau lizard	Sceloporus virgatus		X	X
Sagebrush lizard	Sceloporus graciosus		X	X
Side-blotched lizard	Uta stansburiana		X	X
Tree lizard	Urosaurus ornatus	X		
Short-horned lizard	Phrynosoma douglassi		X	X
Plateau whiptail	Cnemidophorus velox		X	X
Western whiptail	Cnemidophorus tigris		X	X
Western smooth green snake	Opheodrys vernalis blanchardi	X		
Western yellow-bellied racer	Coluber constrictor mormon		X	X
Corn snake	Elaphe guttata	X		
Gopher snake	Pituophis melanoleucus	X	X	X
Western terrestrial garter snake	Thamnophis elegans	X		
Western rattlesnake	Crotalus viridis		X	X

Ref. CDM, 1983; Mobil, 1982; BLM, no date.

Table G.3.4 Fish species in the Colorado River near the Old and New Rifle sites

Species		Study	
Common name	Scientific name	Mobil (1982)	Valdez et al. (1982)
Bluehead sucker	Catostomus discobolus	X	X
Flannelmouth sucker	Catostomus latipinnis	X	X
White sucker	Catostomus commersoni	X	X
White X bluehead sucker	C. commersoni x c. discobolus		X
White X flannel-mouth sucker	C. commersoni x c. latipinnis		X
Green sunfish	Lepomis cyanellus	X	X
Mountain whitefish	Prosopium williamsoni	X	
Mottled sculpin	Cottus bairdi		
Common carp	Cyprinus carpio	X	X
Roundtail chub	Gila robusta	X	X
Fathead minnow	Pimephales promelas		
Speckled dace	Rhinichthys osculus	X	X
Black bullhead	Ictalurus melas	X	X
Yellow bullhead	Ictalurus natalis	X	
Brown bullhead	Ictalurus nebulosus	X	
Brown trout	Salmo trutta	X	X
Rainbow trout	Salmo gairdneri	X	

Wildlife species expected to occur in the sagebrush and pinon-juniper habitat types are indicated in Tables G.3.1 through G.3.3.

Big game species occurring at the Estes Gulch site are mule deer, elk, and possibly lion and bear. Small game species which may occur within the site area are cottontail rabbits, mourning doves, coyotes, bobcats, and possibly chukar (Gray, 1986).

The Estes Gulch area is considered by the Colorado Division of Wildlife (CDOW) (Schnuur, 1985a) and BLM (Coleman, 1985) as a critical mule deer winter range with an estimated 25 deer per square mile (CDOW and BLM, 1984). Figure G.3.2 shows the mule deer activity areas at the Estes Gulch site and the surrounding area. Heavy mule deer use of the site was observed during field reconnaissance in October and December, 1985. A few elk droppings were also observed during the same reconnaissance (TAC, 1985a, b). An elk winter range is northeast and northwest of the site (Schnuur, 1985a).

The CDOW also reintroduced the Rocky Mountain bighorn sheep onto the Grand Hogback north of the site. Twenty-one bighorn sheep were released in January 1987 to establish a viable population of 100 to 120 animals (Gray, 1986; CDOW and BLM, 1984). At least eight sheep and lambs are still in the area. Additional transplants to supplement this herd are being considered (Coleman 1988). The release site is on BLM land in Section 5, Township 5 South, Range 93 West, three miles northwest of the proposed disposal site. The bighorn sheep habitat as outlined by CDOW and BLM (1984) extends nine miles across the Grand Hogback. The proposed disposal site is less than 0.5 mile south and approximately 200 feet lower in elevation than the bighorn sheep habitat along the west side of the Grand Hogback.

A small stock pond covering 0.5 acre is adjacent to the southern portion of the site. This pond is probably used by a limited number of wildlife such as deer, sparrows, and magpies that occupy nearby habitats.

G.3.3 LUCAS MESA SITE

The sagebrush and pinon-juniper habitat of the Lucas Mesa site supports a variety of mammals, birds, reptiles, and amphibians. Wildlife species expected to occur in the sagebrush and pinon-juniper habitat types are indicated in Tables G.3.1 through G.3.3.

The Lucas Mesa site and surrounding areas are classified as a winter concentration area and critical winter range for mule deer (Lambeth, 1986; Schnuur, 1986). Deer have been observed near the site, and signs of fairly heavy winter use were observed on the site, most often in the pinon-juniper woodland areas (DOE, 1983). Figure G.3.3 shows the mule deer activity areas at the Lucas Mesa site and surrounding area. Mountain lions also occur in the area of the site. Black bears are transients, particularly during the winter months (Lambeth, 1986).

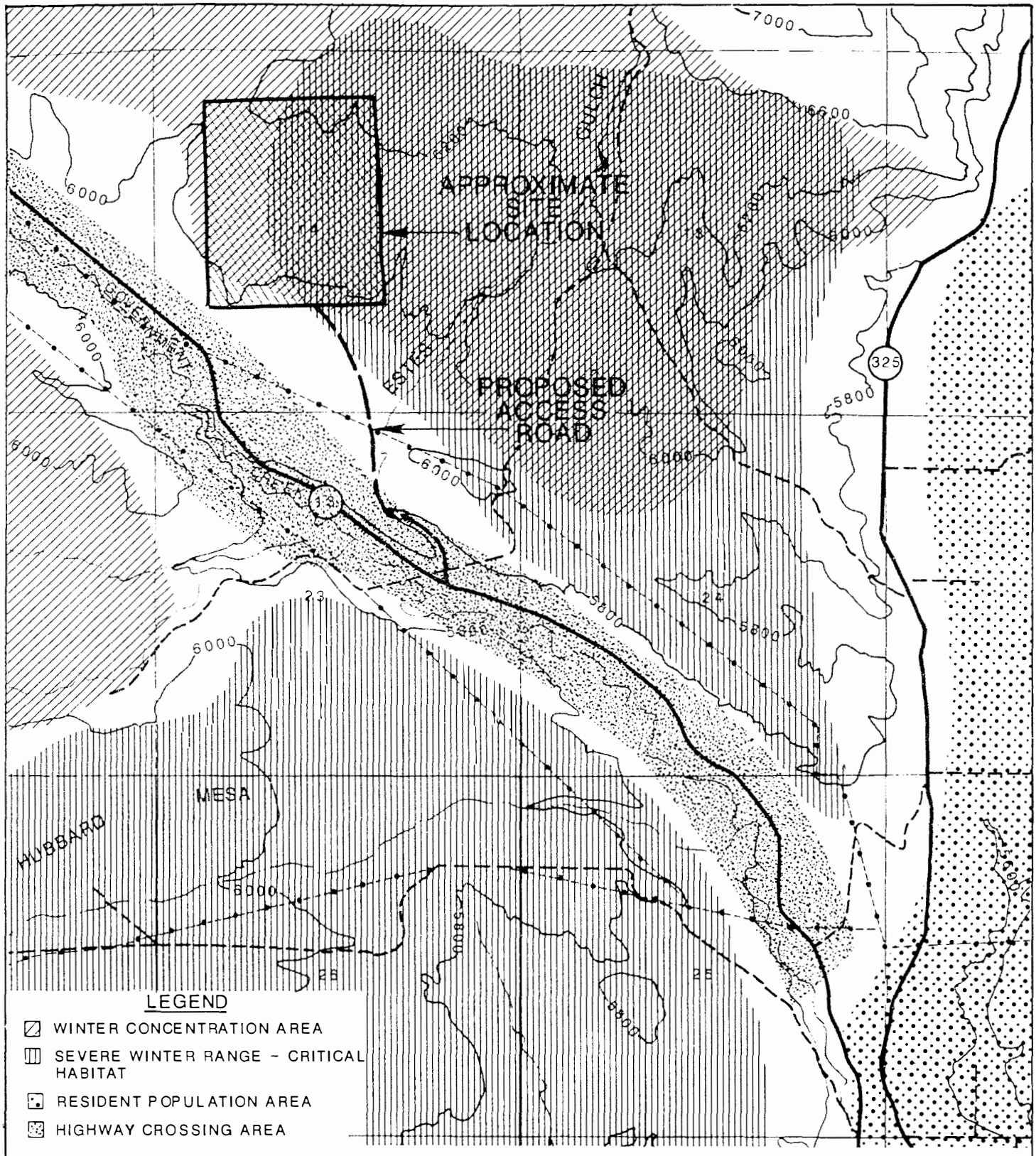


FIGURE G.3.2

MULE DEER ACTIVITY AREAS, ESTES GULCH SITE

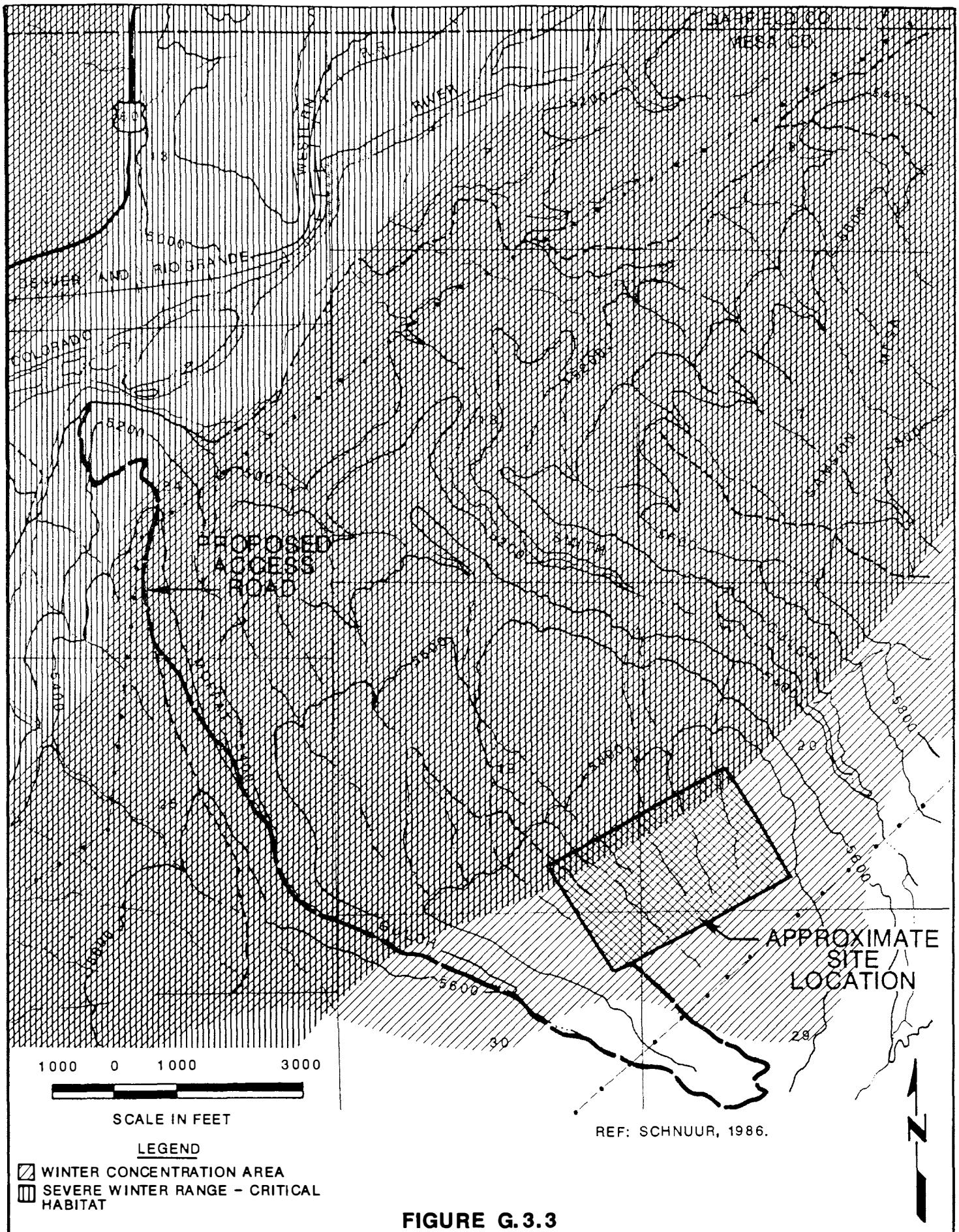


FIGURE G.3.3
MULE DEER ACTIVITY AREAS, LUCAS MESA SITE

Common small game species in the Lucas Mesa area probably include the cottontail rabbit, coyote, and bobcat (Gray, 1986; DOE, 1983). Game birds occurring in the area include the mourning dove and possibly sage grouse, chukar, and turkey (Gray, 1986; Lambeth, 1986).

No aquatic habitat is present at the Lucas Mesa site. No threatened and endangered wildlife species are expected to occur at the site (see Section G.4).

G.3.4 BORROW SITES

The Second Street and New Rifle borrow sites, north and west of the New Rifle site, respectively, are existing borrow operations. Due to the disturbed nature of the sites, they do not provide important wildlife habitat. However, the nearby Colorado River and riparian zone are important to fish and wildlife species. The description for the Old and New Rifle sites in Section G.3.1 is applicable.

The Glenwood Springs borrow site northeast of Glenwood Springs is also an existing borrow operation. Because of its disturbed nature, the site does not constitute significant wildlife habitat; however, it is within a critical winter range for mule deer and elk. Mule deer winter in the pinon-juniper woodland; elk winter in the pinon-juniper and oak brush zone. The BLM, which regulates borrow activities, prohibits blasting and quarrying from December 15 to April 15 to mitigate adverse impacts on the wintering deer and elk populations. However, truck hauling may continue all year (Coleman, 1986).

G.4 THREATENED, ENDANGERED, AND SENSITIVE SPECIES

This section describes the threatened, endangered, candidate, and state listed species within the areas of potential impact from the interim actions or the remedial action at the Old and New Rifle tailings sites. Correspondence between the U.S. Department of Energy (DOE) and the U.S. Fish and Wildlife Service (USFWS) related to the threatened and endangered species at the New and Old Rifle sites and alternate disposal sites is contained in Attachment G1.

In February 1983, in response to a DOE request, the USFWS provided a list of endangered, threatened, and candidate species that may occur at the Old Rifle, New Rifle, and Lucas Mesa sites. The species listed were the bald eagle at the three sites, the razorback sucker at the Old and New Rifle sites, and the Uinta Basin hookless cactus at the Lucas Mesa site. Subsequently, a biological assessment for these species submitted to the USFWS concluded that remedial action activities at the three sites would not have an adverse impact on these species. The USFWS agreed and, based on this assessment, issued a determination of "no effect" for remedial action in August 1983.

The selection of the Estes Gulch, Hubbard Mesa, and Webster Hill sites for consideration as alternate disposal sites (see Appendix B, Alternatives Analysis) resulted in a renewed DOE request for a list of threatened, endangered, or candidate species that may occur at these new sites. In response, the USFWS indicated that two species listed as endangered (bald eagle, black-footed ferret), one listed as threatened (Uinta Basin hookless cactus), and nine candidate species may be present within the new alternate disposal sites and the Old and New Rifle sites. The nine candidate species are the ferruginous hawk, Swainson's hawk, western yellow-billed cuckoo, long-billed curlew, white-faced ibis, western snowy plover, razorback sucker, DeBeque milkvetch, and DeBeque phacelia (see Attachment G1). In addition, the Wetherill milkvetch is included on the Colorado Natural Areas Program list of plant species of special concern and may occur at the Estes Gulch and Hubbard Mesa sites (O'Kane, 1986).

Threatened, endangered, candidate, or sensitive species which may be present at or near the Lucas Mesa, Hubbard Mesa, Webster Hill, and the borrow sites are not addressed in detail in this document. Remedial action at the Lucas Mesa site has been shown to have no effect on these species (see Attachment G1). The Hubbard Mesa and Webster Hill sites have been eliminated as alternate disposal sites. Consultation with the USFWS on the threatened and endangered species at the Second Street, New Rifle, and Glenwood Springs borrow sites would be conducted as required if these sites are selected in the final design of the remedial action.

In October 1988, the USFWS issued a "no effect" determination for the bald eagle, black-footed ferret, and Uinta Basin hookless cactus. However, as the draft Environmental Impact Statement indicated the use of Upper Colorado River basin surface water resources for either alternative, the USFWS requested additional information on the depletion of this resource and its effect on federally listed fish species (Colorado squawfish, humpback chub, and bonytail chub) and the razorback sucker, a candidate species (see Attachment G1). While only the razorback sucker is thought to occur in the

Rifle area, the USFWS believes that any depletion of water from the Upper Colorado River basin negatively impacts these species (USFWS, 1987).

The DOE re-evaluated project water use for the Old and New Rifle sites and the Estes Gulch site and determined that approximately 280,036,000 gallons (860 acre-feet) of water will be needed over the nearly four-year project life (see Attachment G1). This estimation excludes potable water that would be obtained from the city of Rifle's water treatment and supply system, which is not considered a project-related net depletion. This water use will result in an average annual depletion of approximately 70,009,000 gallons (215 acre-feet).

Because a net depletion was documented, the DOE requested the USFWS's concurrence in a "may effect" determination and the initiation of a formal consultation under the Endangered Species Act (see Attachment G1). This consultation is in progress. However, the Record of Decision cannot be issued until the question of effects on the endangered species has been resolved.

Recently, the DOE agreed to widen and improve portions of State Highway 13 to accommodate increased truck traffic resulting from transport of tailings from the Rifle processing sites to the proposed Estes Gulch disposal site. Widening and improving State Highway 13 is a mitigation measure designed to offset the impacts of tailings transportation. The DOE is beginning consultations with the USFWS and a survey for sensitive plant species will be performed prior to the initiation of any road improvement activities. Site specific mitigation measures will be developed with the appropriate federal agency should any sensitive plant species be encountered.

G.4.1 BALD EAGLE (Haliaeetus leucocephalus)

The bald eagle is listed as endangered by the USFWS and the state of Colorado. No critical habitat has been designated. This species is a locally common winter resident along major rivers and a rare breeder in western Colorado (CDM and Bio/West, 1983).

Wintering bald eagles occur along the Colorado River from November through March with the maximum population observed in early- to mid-March (W-C, 1983). Eagles are generally associated with river habitat where suitable perches and viable fisheries are available. Along the Colorado River, large cottonwood trees growing in the riparian zone provide perching and roosting sites. Bald eagles feed mainly on fish; however, carrion, waterfowl, and rabbits may also be consumed.

The January 1986 winter population counts found 32 eagles along the Colorado River (CDOW, 1986), which is a decline from the January, 1985 winter population survey of 47 eagles (Bryne, 1985). This decline can be attributed to the mild winter experienced in 1985 and 1986, since the population of wintering bald eagles generally fluctuates with the severity of winters along the Colorado River (Coleman, 1986). One of the major concentration areas for the bald eagle occurs along the Colorado River between DeBeque and Parachute; the other is from the Colorado-Utah state line west through Westwater Canyon (CDM and Bio/West, 1983).

Three nest sites have been located along the Colorado River in Garfield County. These nests along the Colorado River were never active; they are considered prenuptial nests because most often a pair of eagles will go through the motions of nesting but will abandon the nest during the first part of April (Bryne, 1986a). The nest near Rifle is located upstream on a cottonwood-dominated island about two miles east of the Old Rifle site. A pair of eagles were observed near the nest site, but they did not nest (Lockhart, 1986a). A survey conducted in March, 1986, found that this nest was apparently destroyed by the wind (Lockhart, 1986b).

The bald eagle has not been observed at the Estes Gulch site but may occasionally fly over the area. Water, a major component of bald eagle habitat, is not available at the site. Government Creek, located less than one mile south of the site, is classified as a perennial stream by the U.S. Geological Survey; however, this stream is known to produce low or no flows during the winter months (Bryne, 1986b). There are no bald eagle nests or roost sites along Government Creek (Schnuur, 1985b). In addition, a field reconnaissance conducted in October, 1985, revealed no bald eagle nests at or near the site (TAC, 1985a).

Therefore, interim actions or remedial action at the Old and New Rifle sites with disposal of the uranium mill tailings at the Estes Gulch site would not impact the bald eagle.

G.4.2 BLACK-FOOTED FERRET (Mustela nigripes)

The black-footed ferret is listed as endangered by the USFWS and the State of Colorado. No critical habitat has been designated. The ferret, primarily nocturnal, preys on prairie dogs and uses their burrows as shelter and den sites. No active prairie dog towns were observed at the Old Rifle, New Rifle, and Estes Gulch sites. Furthermore, the black-footed ferret is not thought to occur within the Glenwood Springs Resource Area which encompasses the Old and New Rifle tailings sites and Estes Gulch alternate disposal site (BLM, n.d.).

Based on these observations, interim actions at both Rifle sites, or stabilization of the uranium mill tailings at the New Rifle or Estes Gulch sites would not impact the black-footed ferret.

6.4.3 UINTA BASIN HOOKLESS CACTUS (Sclerocactus glaucus)

The Uinta Basin hookless cactus is listed as threatened by the USFWS. No critical habitat has been designated. It is a barrel cactus characterized by pink or purplish-pink flowers with stems up to 10 centimeters in length (CDM and Bio/West, 1983). In Colorado, the Uinta Basin hookless cactus occurs in Mesa, Delta, Montrose, and Garfield Counties (Bio/West, 1983; CDM and Bio/West, 1983; W-C, 1983; ERT, 1981). The cactus was not found in the Parachute Shale Oil Project areas located 15 miles west and 18 miles northeast of Rifle (Bio/West, 1983); however, populations were found in the Roan Creek Valley north of DeBeque (ERT, 1982).

The Uinta Basin hookless cactus occurs on alluvial terraces composed primarily of gravels and cobblestones along the upper Colorado River System (W-C, 1983) at elevations above 5000 feet above mean sea level (ERT, 1981). In virtually all known populations, a fine textured, clayey, alkaline, rocky soil is present (Bio/West, 1983; ERT, 1981). A few plants also have been found in draws below terraces that have accumulated a stoney surface litter and are sufficiently undisturbed to have developed some cryptogamic crust (Bio/West, 1983). It is generally found associated with the desert shrub vegetation type represented by big sagebrush, shadscale, saltbush, Mormon tea, Indian ricegrass, and galleta (W-C, 1983; ERT, 1981). Within populations, the cactus plants are generally widely spaced and infrequent.

In the Roan Valley, the cactus was generally found in a gently sloping basin characterized by extensive exposures of the Wasatch Formation, red and gray shales, and mixed shale and sandstone. It was frequently found growing directly under a protective shrub, which may have reduced the vulnerability of the plants to trampling (ERT, 1982).

Because of the disturbed nature of the Old and New Rifle sites and lack of appropriate habitat, it is unlikely that the Uinta Basin hookless cactus occurs at these sites. Therefore, interim actions at both Rifle sites, or the stabilization of uranium mill tailings at the New Rifle site would not impact the Uinta Basin hookless cactus.

Although potential habitat for the Uinta Basin hookless cactus exists in the sagebrush vegetation type at the Estes Gulch site, it was not found during a survey conducted at the site in May, 1986 (EES, 1986). A survey for this species will be conducted during the appropriate season along the segment of Colorado Highway 13 that would be widened prior to the initiation remedial action.

G.4.4 FERRUGINOUS HAWK (Buteo regalis)

The ferruginous hawk generally inhabits the juniper-sagebrush ecotone, utilizing the sagebrush area for hunting and the juniper trees for nesting. Nests are also found in sagebrush and cottonwood and on hillsides, rock outcrops, low cliffs, or river cutbanks. Barren areas and agricultural sites are also used. It feeds mainly on small- to medium-sized mammals consisting of lagomorphs and rodents (USFWS, 1983). The ferruginous hawk has not been observed in the Glenwood Springs Resource Area, but its presence is expected (BLM, no date).

It is unlikely that the ferruginous hawk nests in the Rifle area since foraging areas are not of sufficient size and the relatively common golden eagle and red-tailed hawk would tend to discourage the ferruginous hawk's use of the area (Lockhart, 1986a). Therefore, this species would not be impacted by interim actions or remedial action activities at the Old and New Rifle sites.

The potential for the ferruginous hawk to occur at or near the Estes Gulch site exists. A survey to determine the presence of this

species was conducted at the Estes Gulch site by the USFWS (Kruger, 1986). This survey did not find the ferruginous hawk at the Estes Gulch site.

G.4.5 SWAINSON'S HAWK (Buteo swainsoni)

The Swainson's hawk is found in the pinon-juniper, sagebrush, and agricultural habitat types. It typically nests in junipers or shrubs and rarely on the ground (DOE, 1986). The hawk occurs as an uncommon spring-summer resident and may breed in the Glenwood Springs Resource Area (BLM, no date).

Although the occurrence of the Swainson's hawk is unlikely at the Old and New Rifle sites, it may occur in some agricultural areas near Rifle (Lockhart, 1986a). Thus, interim actions or remedial action activities at the Old and New Rifle sites would not impact this species.

The potential exists for the Swainson's hawk to occur at the Estes Gulch site in the sagebrush and pinon-juniper woodland. A survey to determine the presence of this species at the Estes Gulch site was conducted in conjunction with the ferruginous hawk survey by the USFWS. This survey did not find the Swainson's hawk at the Estes Gulch site (Kruger, 1986).

G.4.6 WESTERN YELLOW-BILLED CUCKOO (Coccyzus americanus)

The western yellow-billed cuckoo is a rare spring-summer resident and a possible breeder in the Glenwood Springs Resource Area. It generally inhabits the cottonwood and willow areas (BLM, no date). This species is not expected to occur at the Estes Gulch site because of a lack of this habitat, but it may occur near the Old and New Rifle sites in the riparian and aquatic habitats. The interim actions or the remedial action activities at the Old and New Rifle sites are not expected to impact the yellow-billed cuckoo due to the limited amount of riparian area to be disturbed; it is expected that this species, if disrupted, would relocate to other nearby riparian habitats which are fairly typical along the Colorado River.

G.4.7 LONG-BILLED CURLEW (Numenius americanus)

The long-billed curlew is a rare transient on rivers and lakes in the Glenwood Springs Resource Area during the spring (BLM, no date). The curlew feeds on a variety of insects (USFWS, 1983). It is not expected to occur at the Estes Gulch site, but it may occur near the Old and New Rifle sites in the riparian and aquatic habitats. Only a limited amount of the fairly typical riparian habitat would be disturbed during remedial action, and this species could relocate to other nearby riparian habitat; therefore, there would be no impact on the long-billed curlew.

G.4.8 WHITE-FACED IBIS (Plegadis chihi)

The white-faced ibis breeds in colonies in freshwater marshes from eastern Oregon sporadically across to North Dakota and south into parts of Kansas and Colorado. The ibis winters in the southwestern United States and Mexico (USFWS, 1983). This species is only known as an uncommon transient during the spring and summer in the Glenwood Springs Resource Area (BLM, no date). It is not expected to occur at the Estes Gulch site; however, it may occur near the Old and New Rifle sites in the riparian and aquatic habitats. Only a limited amount of the fairly typical riparian habitat would be disturbed by the interim action or the remedial action activities at the Old and New Rifle sites, and the white-face ibis, if disrupted, would relocate to other nearby riparian habitats. Thus, the project would have no impact on this species.

G.4.9 WESTERN SNOWY PLOVER (Charadrius alexandrinus nivosus)

The western snowy plover is generally found on sand flats and alkali ponds (Robbins et al., 1966). This species has not been observed in the Glenwood Springs Resource Area, and is not expected; however, it may be present (BLM, no date). It is not expected to occur at the Estes Gulch site, but it may be present near the Old and New Rifle sites in the riparian and aquatic habitats. The interim action or remedial action activities at the Old and New Rifle sites are expected to have no impact on the snowy plover due to the limited amount of the fairly typical riparian habitat to be disturbed; if affected, this species would relocate to other nearby riparian habitats.

G.4.10 DEBEQUE PHACELIA (Phacelia submutica)

The DeBeque phacelia is an annual forb that occurs on soils of the Wasatch Formation (Colorado Native Plant Society, 1982). It is sometimes associated with other species of phacelia, eriogonum, or shadscale. It also has been found associated with cheatgrass and chenopodium near sagebrush and pinon-juniper vegetation types. The DeBeque phacelia is not expected to occur at the Old and New Rifle sites because of their disturbed condition. This species was not found at the Estes Gulch site during a survey conducted in May, 1986 (EES, 1986). A survey for this species will be conducted during the appropriate season along the segment of Colorado Highway 13 that would be widened prior to the initiation of remedial action.

G.4.11 DEBEQUE MILKVETCH (Astragalus debequasus)

The DeBeque milkvetch is a perennial plant that occurs on soils of the Wasatch Formation. This species is characterized by white flowers and grows in small to large clumps (Welsh, 1985). It was found 7.5 miles south of the town of DeBeque in pinon-juniper and mixed shrub vegetation types at an elevation of approximately 5400 feet above MSL. The DeBeque milkvetch is not expected to occur at the

Old and New Rifle sites because of their disturbed condition, and it was not found during a survey conducted in May 1986 at the Estes Gulch site (EES, 1986). A survey for this species will be conducted during the appropriate season along the segment of Colorado Highway 13 that would be widened prior to the initiation of remedial action.

G.4.12 WETHERILL MILKVETCH (Astragalus wetherillii)

The Wetherill milkvetch is on the Colorado Natural Areas Program list of plant species of special concern (O'Kane, 1986). In Colorado, this species is found in Garfield, Mesa, Montrose, and San Miguel Counties. The Wetherill milkvetch, a perennial forb, is characterized by small, white, or whitish flowers. It occurs on steep slopes, canyon benches, and talus cliffs, in sandy clay soils derived from shale or sandstone, and with sagebrush and junipers at elevations of 4700 to 5850 feet above MSL (Barneby, 1964). A survey conducted in May 1986 found the Wetherill milkvetch near the proposed access road leading into the Estes Gulch site (Figure G.4.1) (EES, 1986). There were approximately 600 plants scattered along the pinon-juniper hillsides adjacent to the proposed access road. A few plants were also found at the base of the hills. It may also occur along the portion of State Highway 13 that would be widened and improved for disposal at the Estes Gulch site. This area would be surveyed during the appropriate season prior to the initiation of any road improvement activities. All populations of the Wetherill milk-vetch would be avoided during the remedial action to prevent impacts on this plant species.

G.4.13 FISH SPECIES: COLORADO SQUAWFISH (Ptychocheilus lucius), HUMPBACK CHUB (Gila cypha), BONYTAIL CHUB (Gila elegans), AND RAZORBACK SUCKER (Xyrauchen texanus)

The Colorado squawfish is listed as endangered by the USFWS and by the state of Colorado. It occurs in the Colorado River upstream to Palisade, Colorado, and occurs in the Grand Junction, Colorado, area. It is not known to be in the Rifle area. Adult fish prefer deep, moving water, while juveniles prefer shallow, protected backwaters with silt and sand substrates, and little current. Spawning occurs over large gravel bars in the main channels (USFWS, 1987; DOE, 1983).

The humpback chub is listed as endangered by the USFWS and the state of Colorado. It occurs in the Colorado River in the Black Rocks -- Westwater Canyon area downstream of Grand Junction, Colorado. The humpback chub prefers fast currents, deep water and sand, silt, boulder and bedrock substrates. Spawning probably takes place in or near the resident canyon (USFWS, 1987; DOE, 1983).

The bonytail chub is listed as endangered by the USFWS and the State of Colorado. It is "the rarest of the Colorado River native fishes...." (DOE, 1986), and there are no known reproducing populations. It is on the verge of extinction on a state-wide basis. Almost extinct in the Colorado River, a few specimens have been

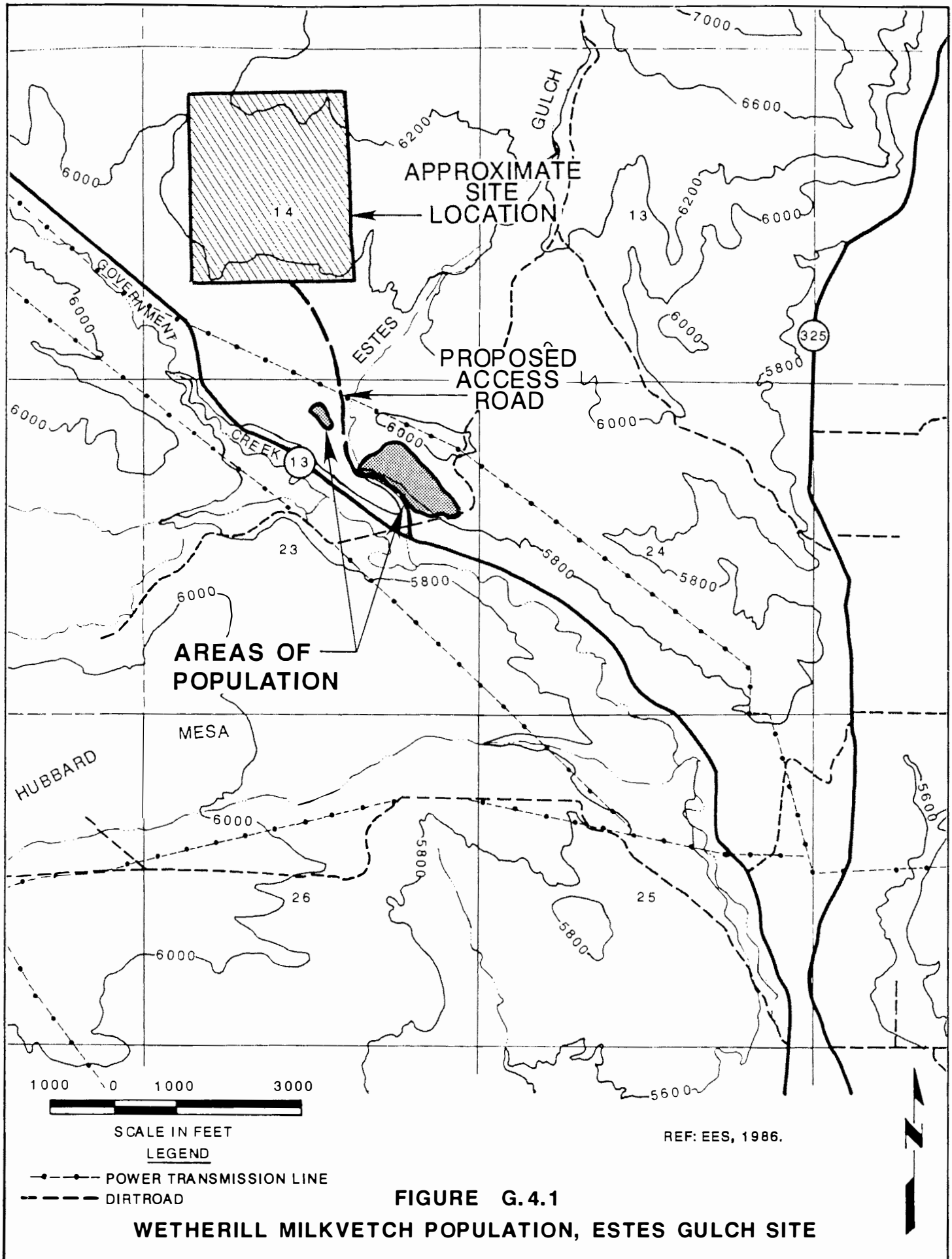


FIGURE G.4.1

WETHERILL MILKVETCH POPULATION, ESTES GULCH SITE

captured only in the Black Rocks area near the Colorado-Utah border. Its preferred habitat is quiet eddys and pools (DOE, 1983; USFWS, 1987).

The razorback sucker is currently a USFWS candidate species and is listed as endangered by the state of Colorado. It is found sporadically in major upper Colorado River basin tributaries and has been found in the Colorado River between DeBeque and Rifle. All specimens collected were adults, suggesting a low reproductive rate. Its habitat preferences are not clearly understood, but it appears to prefer backwater areas and gravel pits with little or no flow and silty bottoms (Valez et al., 1982; DOE, 1983; USFWS, 1987).

Of the four fish species discussed above, only the razorback sucker may actually be present in the Colorado River near the Old and New Rifle sites. However, because of habitat loss and other factors, the USFWS has determined that a Upper Colorado Basin-wide jeopardy situation has existed for the three endangered species since 1978. The USFWS has determined that any depletion of water has a negative effect on the listed fish species; therefore, a documented project-related net water depletion results in a "may effect" determination and requires the initiation of a formal consultation under Section 7 of the Endangered Species Act (see Attachment G1).

Under the Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (USFWS, 1987), a recovery program and cooperative agreement developed between the USFWS, the states of Colorado, Utah, and Wyoming, water development interests, and environmental organizations, all Section 7 consultations will result in a one-time contribution to the USFWS. This contribution amounts to $10 per acre-foot of water used, based on the average annual project depletion. These funds are earmarked for managing the Recovery Program and protecting necessary instream flows, thereby providing the mechanism for a non-jeopardy conclusion by the USFWS.

The DOE re-evaluated project water use for the Old and New Rifle sites and the Estes Gulch site and determined that a total of approximately 280,036,000 gallons (860 acre-feet) of water will be needed from the Colorado River and the Rifle Gap Reservoir. This estimation excludes the potable water that would be obtained through the city of Rifle's water treatment and supply system. These waters are not considered part of a project-related net depletion. The UMTRA Project water use will result in an average annual depletion of approximately 70,009,000 gallons (215 acre-feet) over the nearly four-year project life. Because a net depletion has been documented, the DOE requested the USFWS's concurrence in a "may effect" determination and the initiation of a formal consultation under Section 7 of the Endangered Species Act (see Attachment G1). The consultation process is in progress. The DOE will comply with all mitigation and conservation specified by the USFWS. However, the Record of Decision cannot be issued until the question of effects on the endangered species has been resolved.

The only potential direct impact to the razorback sucker would be increased, though limited, siltation of the Colorado River as a result of interim actions or remedial action activities at the Old and New Rifle sites. Because no excavation would occur in the Colorado River, any additional siltation is expected to be minimal and short-term; therefore, there would be negligible direct impacts to the razorback sucker.

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ATTACHMENT G1

Correspondence with the U.S. Fish and Wildlife Service

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3) 337-0924

DEC-83-01-15

Client No. 4762
January 19, 1983

Mr. Fred Bolwahnn, Project Leader
Endangered Species Office
U.S. Fish and Wildlife Service
Room 1406 Federal Building
125 South State Street
Salt Lake City, Utah 84138

Dear Mr. Bolwahnn:

Under contract to Sandia National Laboratories for the Department of Energy, NUS Corporation is preparing two Environmental Impact Statements as part of the Uranium Mill Tailings Remedial Action (UMTRA) Program. One document will cover the tailings site at Grand Junction, Colorado and one will involve two tailings sites at Rifle, Colorado. We are hereby requesting information concerning the presences of federally listed or proposed endangered or threatened species with the areas of potential impact for these projects, as described below.

The existing Grand Junction uranium mill tailings pile is located in parts of sections 23 and 24, T1S R1W, in Grand Junction, Colorado. Alternatives for disposal of these tailings include stabilization of the pile in place, and removal (by truck or rail) to one of two alternate remote locations. These remote locations are the Cheney Reservoir site, parts of sections 11, 12, 13 and 14, T3S R2E south of Whitewater, Colorado, and the 6+50 Reservoir site, parts of sections 36 and 35, T9S R104W, west of Mack, Colorado. Maps of all sites involved are attached.

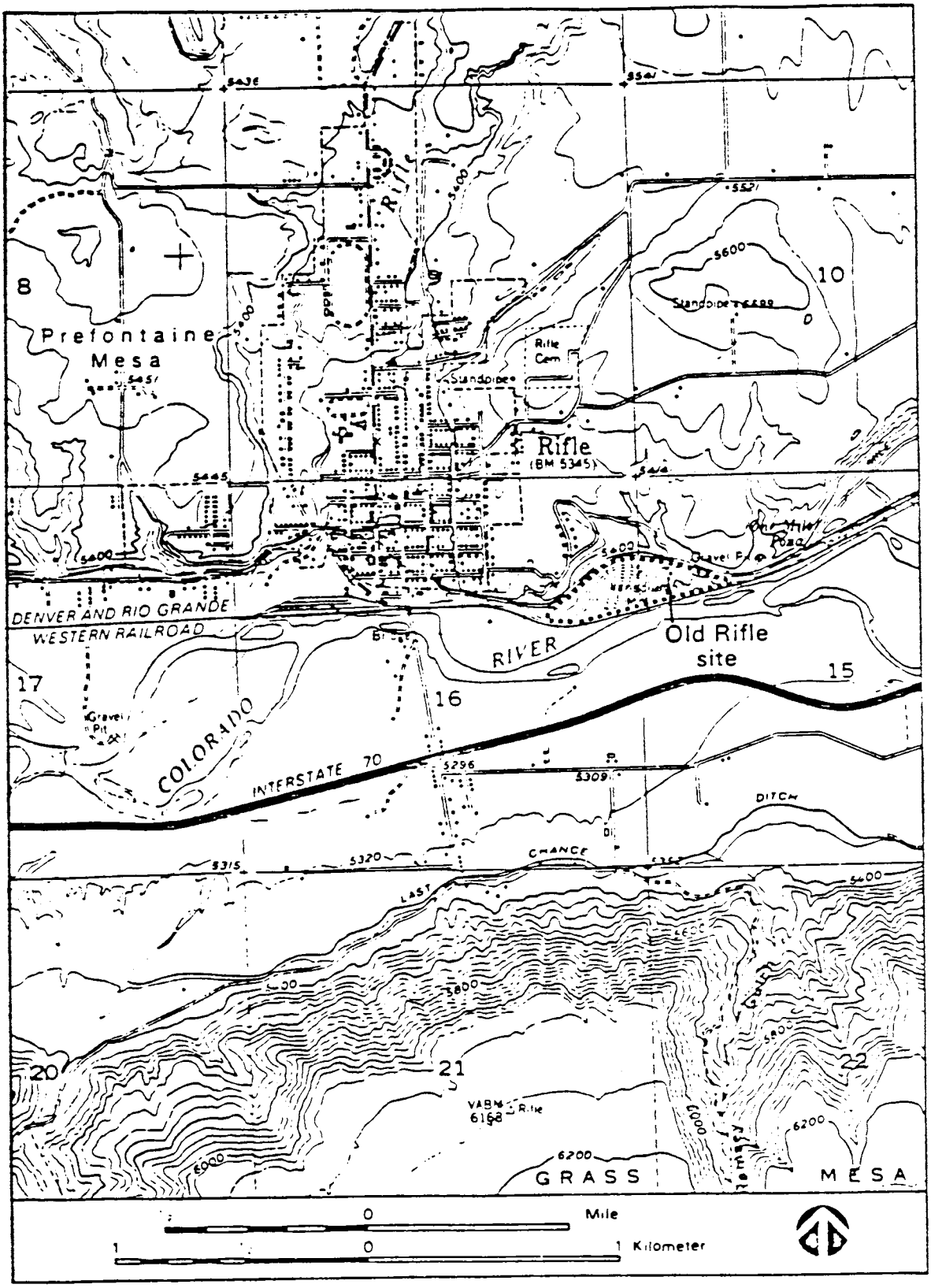
The existing Rifle uranium mill tailings piles are located in section 18, T6S R93W near Rifle, Colorado (the Old Rifle site) and inparts of sections 15 and 16, T6S R93W near Rifle, Colorado (the New Rifle site). Alternatives for disposal of these tailings include stabilization of the piles in place, consolidation of the two piles at one of the existing locations, or removal (by truck, rail or conveyor system) to a remote location. The remote location is the Lucas Mesa site, parts of sections 19, 20, 29 and 30, T8S R96W, south of DeBeque, Colorado. Maps of all sites involved are attached.

If you require further information concerning this project or the potential impact areas, please contact me at 303/337-0924.

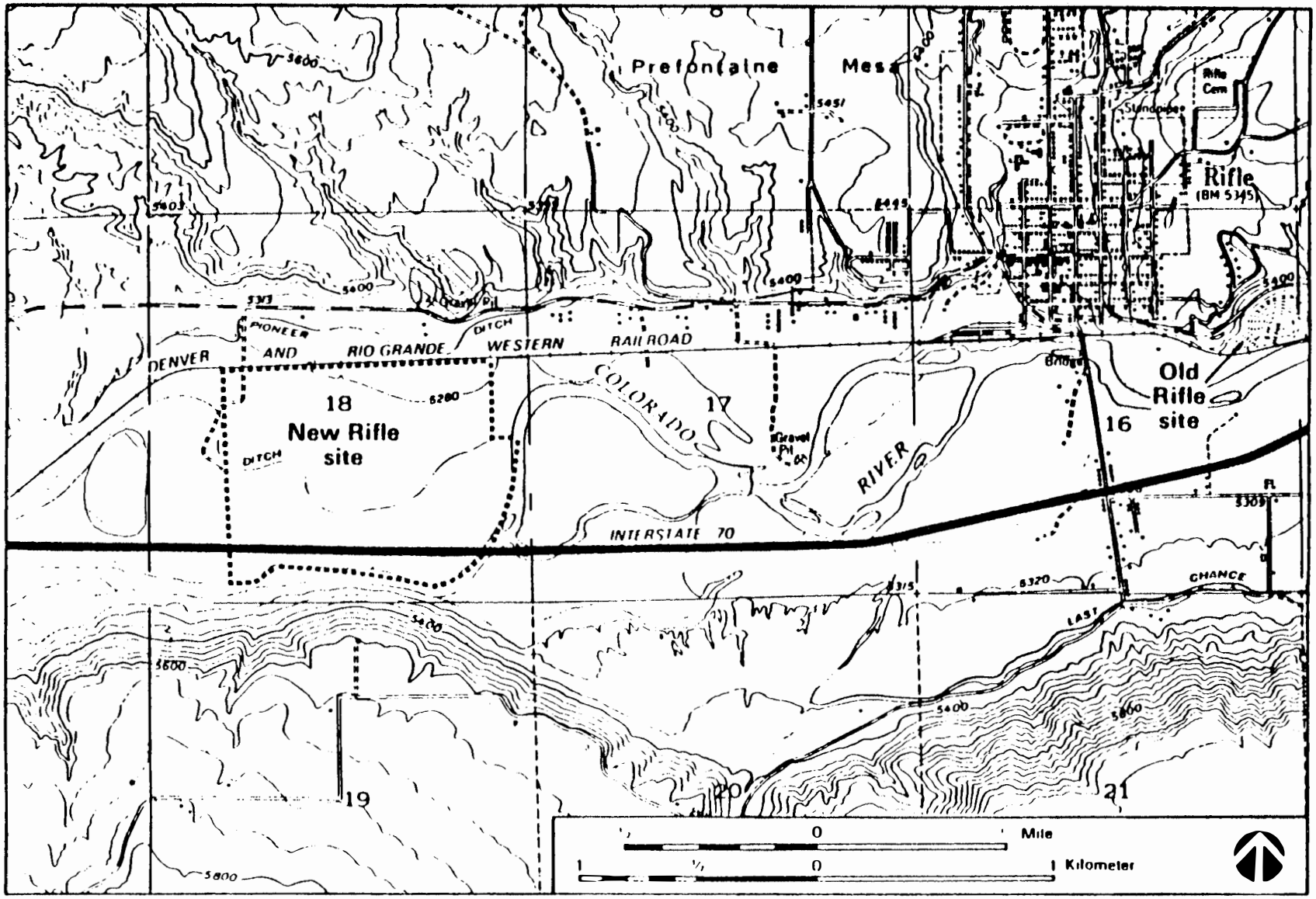
Sincerely,

Andrew R. Grainger
Associate Ecologist

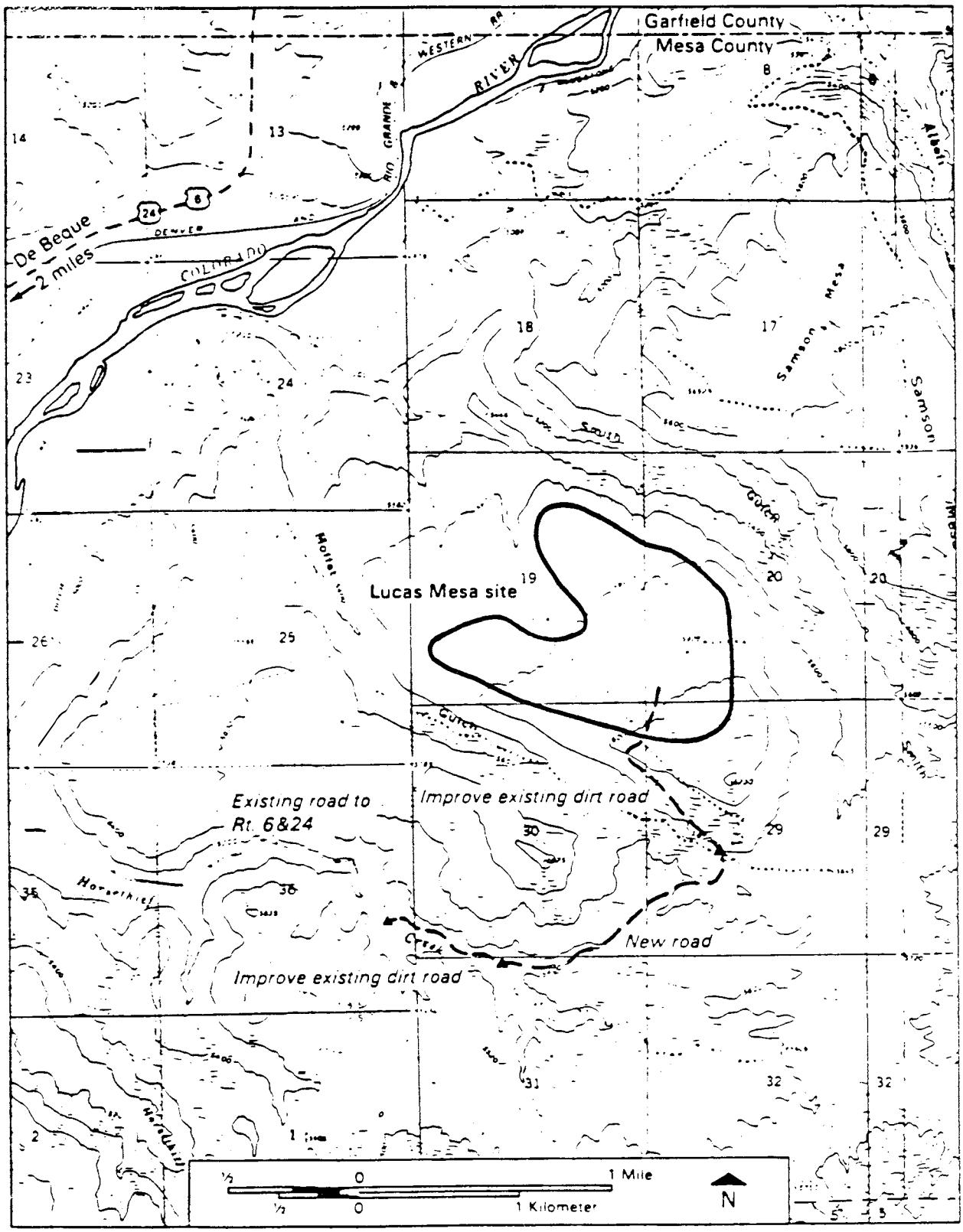
ARG/io



The Old Rifle site and its vicinity.



The New Rifle site and its vicinity. This map is based on a map prepared by the U.S. Geological Survey before Highway 6/24 was rerouted south to its present position just north of the railroad tracks and the New Rifle site.



The Lucas Mesa site and its vicinity.

United States Department of the Interior
FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES OFFICE
1406 Federal Building
125 South State Street
Salt Lake City, Utah 84138

IN REPLY REFER TO:

24 February 1983

Mr. Andrew R. Grainger
Associate Ecologist
NUS Corporation
3000 S. Jamaica Court
Suite 150
Aurora, Colorado 80014

Dear Mr. Grainger:

We have reviewed your letter dated 19 January 1983 requesting information concerning federally listed threatened and endangered species that may be within the area of impact for projects you describe. We understand that all project sites listed in your letter are being studied as potential areas for permanent disposal of uranium mill tailings. Below are locations of these six areas, with listed species that may occur in each area following the site location description.

Grand Junction area uranium mill tailings:

1. Existing Grand Junction tailings pile, located in parts of Sections 23 and 24, T1S, R1W, in Grand Junction, Colorado.

Listed Species	
bald eagle	*Haliaeetus leucocephalus*
Colorado squawfish	*Ptychocheilus lucius*
humpback chub	*Gila cypha*
Candidate Species	
razorback sucker	*Xyrauchen texanus*

2. Cheney Reservoir site, located in parts of Section 11, 12, 13 and 14, T3S, R2E, south of Whitewater, Colorado.

Listed Species	
whooping crane	*Grus americana*
black-footed ferret	*Mustela nigripes*
spineless hedgehog cactus	*Echinocereus triglochidiatus* var. *inermis*
Uinta Basin hookless cactus	*Sclerocactus glaucus*

3. U. S. Hwy. 6 & 50 Reservoir site, located in parts of Sections 36 and 35, T9S, R104W, west of Mack, Colorado.

Listed Species

black-footed ferret	Mustela nigripes

Rifle area uranium mill tailings:

1. Old Rifle site, located in Section 18, T6S, R93S, near Rifle, Colorado.

Listed Species

bald eagle	Haliaeetus leucocephalus

Candidate Species

razorback sucker	Xyrauchen texanus

2. New Rifle site, located in parts of Sections 15 and 16, T6S, R93W, near Rifle, Colorado.

Listed Species

bald eagle	Haliaeetus leucocephalus

Candidate Species

razorback sucker	Xyrauchen texanus

3. Lucas Mesa site, located in parts of Sections 19, 20, 29, and 30, T8S, R96W, south of DeBeque, Colorado.

Listed Species

bald eagle	Haliaeetus leucocephalus
Uinta Basin hookless cactus	Sclerocactus glaucus

Section 7 (c) also requires the Federal agency proposing a major Federal action significantly affecting the quality of the human environment to conduct and submit to the FWS a biological assessment to determine the effects of the proposal on listed and proposed species. The biological assessment shall be completed within 180 days after the date on which initiated or a time mutually agreed upon between the agency and the FWS. Before physical modification/alternation of a major Federal action is begun the assessment must be completed. If the biological assessment is not begun within 90 days, this list should be verified with us prior to initiation of the assessment. We do not feel that we can adequately assess the affects of the proposed action on listed and proposed species or critical habitat and proposed critical habitat without a complete assessment. When conducting a biological assessment, the following shall be done at a minimum:

1. conduct a scientifically sound on-site inspection of the area affected by the action, which must, unless otherwise directed by the FWS, include a detailed survey of the area to determine if listed or proposed species are present or occur seasonally and whether suitable habitat exists within the area for either expanding the existing population or potential reintroduction of populations;

2. interview recognized experts on the species at issue, including those within the Fish and Wildlife Service, state conservation agencies, universities, and others who may have data not yet found in scientific literature;

3. review literature and other scientific data to determine the species' distribution, habitat needs, and other biological requirements;

4. review and analyze the affects of the action on the species, in terms of individuals and populations, including consideration of the cumulative effects of the action on the species and habitat;

5. analyze alternative actions that may provide conservation measures;

6. conduct any studies necessary to fulfill the requirements of (1) through (5) above;

7. review any other relevant information.

Candidate species are listed so that they may receive your attention in your environmental planning. While they do not have the protection of the Endangered Species Act they are being considered for listing by the FWS. Should they become listed prior to the completion of Federal action on this project Section 7 Consultation would have to be reinitiated to consider the newly listed species.

The FWS can enter into formal Section 7 consultation only with another Federal agency or its designee. State, county or any other governmental or private organizations can participate in the consultation process, help prepare information such as the biological assessment, participate in meetings, etc.

After the relevant Federal agency has reviewed the assessment, it is that agency's responsibility to determine if the proposed action "may affect" any of the listed species or critical habitats. The agency should also determine if the action is likely to jeopardize the continued existence of proposed species or result in the destruction or an adverse modification of any critical habitat proposed for such species. If the determination is "may affect" for listed species the agency must request in writing formal consultation from the Field Supervisor, Endangered Species Office, U.S. Fish and Wildlife Service at the address given above. In addition, if the agency determines that the proposed action is likely to jeopardize the continued existence of proposed species or result in the destruction or adverse modification of proposed critical habitat, it must confer with the FWS. At this time the agency should provide this office a copy of the biological assessment and any other relevant information that assisted it in reaching its conclusion.

Your attention is also directed to Section 7(d) of the Endangered Species Act, as amended, which underscores the requirement that the Federal agency or the applicant shall not make any irreversible or irretrievable commitment of resources during the consultation period which, in effect, would deny the formulation or implementation of reasonable and prudent alternatives regarding their actions on any endangered or threatened species.

We are prepared to assist you whenever you have questions which we may be able to answer. If we can be of further assistance, please advise us.

The FWS representative who will provide you with technical assistance is Robert Smith of our Grand Junction Field Office ([303] 243-2778).

Sincerely,

Terry J. Hickman

for Fred L. Bolwahnn
Field Supervisor

cc: Mr. James A. Morley
Uranium Mill Tailings
Project Office
Department of Energy
P. O. Box 5400
Albuquerque, New Mexico 87115

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

JUL 01 1983

Mr. Fred Bolwahan
U.S. Fish and Wildlife Service
1406 Federal Building
125 S. State Street
Salt Lake City, Utah 84138

Dear Mr. Bolwahan:

Pursuant to Section 7 of the Endangered Species Act, enclosed is a biological assessment which was conducted regarding the potential impacts on threatened, endangered, and candidate floral and faunal species as a result of remedial actions on inactive uranium mill tailings sites at Grand Junction and Rifle, Colorado. Overall, the assessment concludes that no adverse impacts to any threatened, endangered, or candidate species would occur as a result of the remedial action project alternatives.

Since we are initiating the review process on the Preliminary Draft Environmental Impact Statement (PDEIS) for the Grand Junction and Rifle mill tailings sites, we request your review of the biological assessment. Please contact John Arthur of my staff at (505) 844-3941 with any questions regarding the assessment.

Thank you for your agency's cooperation in this matter.

Sincerely,

James A. Morley

James A. Morley, Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/o enclosure:
D. Lechel, JEG

BIOLOGICAL ASSESSMENT
Related to Remedial Action at the
Grand Junction and Rifle sites

This biological assessment concerns the potential impact on threatened, endangered or candidate species resulting from UMTRA Program remedial-action alternatives for the Grand Junction and New Rifle and Old Rifle sites. Two environmental impact statements are being prepared, one concerning the Grand Junction site and one concerning the Rifle site.

The Grand Junction site is located in parts of Sections 23 and 24, T1S R1W, adjacent to Grand Junction, Colorado. Alternatives for disposal of these tailings include stabilization of the pile at the Grand Junction site, and removal (by truck or rail) to one of two alternative remote locations. These remote locations are the Cheney Reservoir site, south of Whitewater, Colorado (parts of Sections 11, 12, 13 and 14, T3S R2E), and the 6&50 Reservoir site, west of Mack, Colorado (parts of Sections 36 and 35, T9S R104W). These sites are shown in Figures 1, 2, and 3.

The existing Rifle sites are located in Section 18, T6S R93W near Rifle, Colorado (the Old Rifle site) and in parts of Sections 15 and 16, T6S R93W near Rifle, Colorado (the New Rifle site). Alternatives for disposal of these tailings include stabilization at the sites, consolidation of the two piles at one of the existing locations, or removal (by truck, rail or conveyor system) to a remote location. The remote location is the Lucas Mesa site, parts of Sections 19, 20, 29 and 30, T8S R96W, south of DeBeque, Colorado. These sites are shown in Figures 4, 5, 6 and 7.

Species considered in this assessment are those listed by the U.S. Fish and Wildlife Service, Endangered Species Office, Salt Lake City, in a letter to NUS Corporation dated 24 February 1983 (USF&WS, 1983). This letter also outlines procedures to be taken in conducting a biological assessment. These steps have been followed to the extent consistent with the scope and potential impacts of the project.

As part of the preparation of the environmental impact statements, each site has been visited between 20 and 22 September and 14 and 17 October, 1982 by a biologist to assess the potential of the sites to support threatened or endangered species. In addition, the 6&50 Reservoir and Cheney Reservoir sites were visited on April 11, 1983 with Mr. Steve High, BLM biologist from Grand Junction, to search for endangered cacti and to assess the potential of these sites to support these species.

This assessment relies primarily on literature sources and contacts with knowledgeable individuals to determine the potential presence of threatened or endangered species on the sites. Potential impacts are evaluated using project plans developed during preparation of the environmental impact statements.

Each endangered, threatened or candidate species listed by the U.S. Fish and Wildlife Service is discussed below, along with a discussion of the potential impact of the various alternatives on the species and its habitat.

1. Spineless Hedgehog Cactus Echinocereus triglochidiatus var. inermis

This species is listed as endangered by the U.S. Fish and Wildlife Service (1982). No critical habitat has been designated. The spineless hedgehog cactus is listed as potentially occuring on the Cheney Reservoir site (USF&WS 1983).

This species is known to occur in Mesa and Montrose Counties, Colorado (USF&WS 1978, Colorado National Areas Program 1982). High (1983) has located populations of this species several miles east and west of the Cheney Reservoir site, and feels the species is restricted to the pinyon-juniper zone.

The Cheney Reservoir site has been searched by an NUS Corporation biologist and a brief search was conducted with Steve High of BLM. Only Opuntia sp. cacti were observed. The site supports a salt desert shrub community, as does the access corridor. The nearest pinyon-juniper habitat is approximately ½ mile east of the site.

Because the Cheney Reservoir site does not support appropriate habitat for the spineless hedgehog cactus, it is extremely unlikely the species occurs on the site or the planned access route. Therefore, because no known populations or preferred habitat exist on the site, this alternative will not adversely affect the spineless hedgehog cactus. Other alternatives not involving the Cheney Reservoir site will also not affect this species.

2. Uinta Basin Hookless Cactus Schlerocactus glaucus

This species is listed as threatened by the U.S. Fish and Wildlife Service (1982). No critical habitat has been designated. The Uinta Basin hookless cactus is listed as potentially occuring on the Cheney Reservoir and Lucas Mesa sites (USF&WS 1983).

This species is known to occur in Mesa, Delta, Montrose and Garfield Counties (USF&WS 1978, Colorado Natural Areas Program 1982). It is found in a variety of habitats, although habitat descriptions agree that soils supporting this species are gravelly or rocky (USF&WS 1978, Colorado Natural Areas Program 1982). Associated plants are shadscale (Atriplex confertifolia), galleta (Hilaria jamesii) and Mormon tea (Ephedra spp.) (USF&WS 1978). High (1983) feels this species may be found in a variety of habitats.

Populations of the Uinta Basin hookless cactus are known to exist west of the Cheney Reservoir site on rims above the Gunnison River, but none are

known near the Cheney Reservoir site (High 1983). Similarly, the species occurs near Roan Creek north of DeBeque, but is not known to occur south of the Colorado River (near Lucas Mesa) in this area.

The only cacti observed on the Cheney Reservoir, 6&50 Reservoir, and Lucas Mesa sites during site reconnaisance visits by NUS Corporation were Opuntia sp. Steve High visited the Cheney Reservoir and 6&50 Reservoir sites in April 1983 and also found only Opuntia sp. cacti.

The Lucas Mesa site is at the upper elevational limits of the range of this species (USF&WS 1978, Colorado National Areas Progam 1982). For this reason, and because it is dominated by sagebrush and pinyon-juniper vegetation, the site does not provide typical habitat. In addition, soils over much of site are deep and not very rocky. The occurence of the Uinta Basin hookless cactus on this site is unlikely. Access to Lucas Mesa would not involve additional road building.

The Cheney Reservoir site appears to provide adequate habitat for this species. However, this or similar species (e.g., Schlerocactus whipplei) have not been located on or near the site. Because of the apparent absence of the species, no impact is anticipated.

Similarly, the 6&50 Reservoir site appears to provide adequate habitat for the Uinta Basin hookless cactus, and populations of S. whipplei occur to the west within 2 miles of the site. However, searches of the site by an NUS Corporation biologist, and in conjunction with Steve High, have revealed only Opuntia sp. cacti. S. glaucus is not known to occur in the area (High, 1983). Because of the apparent absence of the species, no impact is anticipated.

Stabilization at either the Grand Junction or Rifle sites would avoid any potential impacts on the Uinta Basin hookless cactus. No cacti were observed on these sites, and they do not provide adequate habitat for this species or for the spineless hedgehog cactus.

Colorado Squawfish Ptychocheilus lucius

This species is listed as endangered by the U.S. Fish and Wildlife Service (1982) and by the State of Colorado (Colorado Division of Wildlife 1983). No critical habitat has been designated. The Colorado squawfish has been listed as potentially inhabiting the Colorado River near the Grand Junction site.

The Colorado squawfish occurs in the Colorado River upstream to Palisade, Colorado. Adult fish appear to prefer areas of deep water and large volume. Spawning probably occurs on large gravel bars in the main channel, and spawning is believed to occur near Clifton, upstream from the Grand Junction site. Young squawfish are found in protected areas such as side channels,

and adults are often found in large backwater areas (Benkhe and Benson 1980, Bureau of Reclamation 1982).

Squawfish are found both upstream and downstream of the Grand Junction site, and have been taken near the mouth of the Gunnison River. Gravel pits and backwater areas (off the main Colorado River) are occupied by adults and young at certain times of the year; these areas also occur upstream and downstream from the site, but none are documented in the immediate area (Miller et al. 1983a, Miller et al. 1983b). The Colorado River near the Grand Junction site does not provide preferred habitat, which is usually characterized by either high flow, deep water areas, off-channel backwaters, or gravel bars. Thus, the area is not likely to be particularly important to squawfish.

None of the alternative actions considered in the environmental impact statement will alter Colorado River flow regimes in terms of volume of water flow or seasonal flow. Because all alternatives involve construction on the Grand Junction site, the various alternatives would not be different from each other. Colorado squawfish, if present near the area, will not be affected by any of the alternatives.

Presently the Grand Junction site is not discharging detectable quantities of radioactivity to the Colorado River. Concentrations of radioactivity in the river are about the same up and downstream of the pile. Future discharges of radioactivity would be minimized by the remedial action. Therefore, no radiation impacts on fish in the river are expected.

4. Humpback Chub Gila cypha

This species is listed as endangered by the U.S. Fish and Wildlife Service (1982) and the State of Colorado (Colorado Division of Wildlife 1983). No critical habitat has been designated. The humpback chub has been listed as potentially inhabiting the Colorado River near the Grand Junction site.

The humpback chub appears to have specific habitat preferences for deepwater canyon areas such as Ruby Canyon and Westwater Canyon downstream from the Grand Junction site. A few specimens have been taken upstream from Grand Junction in the Colorado River, but deep water areas seem to be required for population maintainence. Young humpback chubs are found in backwater areas (Benkhe and Benson 1980, Bureau of Reclamation 1982).

The Colorado River near the Grand Junction site does not provide good habitat for humpback chubs, and specimens have not been observed near the area. Because this project will not affect Colorado River flows, none of the alternatives will adversely impact the humpback chub.

As described above, no detectable radiation is escaping into the Colorado River from the existing Grand Junction site, and none of the alternatives being considered would alter this situation.

5. Razorback Sucker Xyrauchen texanus

This species is listed as endangered by the State of Colorado (Colorado Division of Wildlife 1983) and is a candidate for listing by the U.S. Fish and Wildlife Service. No critical habitat has been designated. The razorback sucker has been listed as potentially inhabiting the Colorado River near the Grand Junction site and the Old and New Rifle sites (U.S. Fish and Wildlife Service 1983).

Less is known about the habitat preferences and occurence of the razorback sucker than about the fish species previously discussed. Spawning has been reported to occur in rocky shore areas and on gravel bars (McAda and Wydowski 1980). The species appears in off-channel ponds created by gravel operations, and this type of habitat may be preferred for spawning and as rearing habitat for young.

This species is known to occur upstream from Palisade in the Colorado River. Adults have been observed as far upstream as River mile 224.5, between Rifle and DeBeque, but spawning and young have not been reported (Smith 1983). Apparently, no records for as far upstream as Rifle exist. Bennett (1983) feels that the species would not be found that far upstream, although he points out that no barriers exist between DeBeque and Rifle.

From what little is known about this species, it appears that the Colorado River near the existing Grand Junction site does not provide adequate habitat for the razorback sucker. Because the River would in no way be altered by project activities, no impact on the species at Grand Junction is anticipated.

The Colorado River near Rifle provides some riffle and gravel bar habitat, as well as water-filled gravel pits, which may be attractive to razorback suckers. However, because the species is not known to occur in the area and no alterations to Colorado River habitats will be made, adverse impacts as a result of project activities are extremely unlikely.

As previously described, radiation releases from the existing sites are undetectable, and project activities would not change the situation.

6. Whooping Crane Grus americana

This species is listed as endangered by the U.S. Fish and Wildlife Service (1982) and the State of Colorado (Colorado Division of Wildlife 1983). Critical

habitat has been designated at several areas, including Monte Vista and Alamosa National Wildlife Refuges in southern Colorado, but none is designated in the Grand Valley area. The whooping crane may potentially occur near the Cheney Reservoir site (U.S. Fish and Wildlife Service 1983).

Whooping cranes belonging to the Aransas-Wood Buffalo flock are occasionally observed as migrants in eastern Colorado. Historically no nesting has occurred in Colorado (Bailey and Niedrach 1965). Chase et al. (1983) list the whooping crane as a rare to uncommon migrant, based mainly on the experimental population which migrates through western Colorado.

In 1975 an experimental program was begun to establish a second whooping crane population by cross-fostering "surplus" whooping crane eggs from Wood Buffalo National Park, Northwest Territories, to sandhill cranes (Grus canadensis) at Gray's Lake National Wildlife Refuge, Idaho (Drewien and Bizeau 1978). Whooping cranes raised by sandhills at Gray's Lake winter at Bosque del Apache National Wildlife Refuge in New Mexico and migrate through western Colorado with a major stopover point at Monte Vista National Wildlife Refuge (Colorado Division of Wildlife 1978). Some whooping cranes have been observed in the Grand Junction vicinity. An individual whooping crane was sighted in the Piceance Basin in May, 1976, and one was killed by a golden eagle (Aquila chrysaetos) on 13 October 1979 southwest of Rangely, Colorado (Wingingstad et al. 1981). In the fall of 1981 one radiotagged, immature whooping crane spent a night during its southward migration on the Grand Junction Mesa at an elevation of approximately 8,500 feet (Drewien 1982). In the spring of 1983 individual whooping cranes were observed in flocks of sandhill cranes near Highline Reservoir in the Grand Valley. Whooping cranes have also been observed at Fruitgrower's Reservoir near Paonia (Smith 1983).

Cheney Reservoir, as well as numerous other reservoirs in the Grand Valley, is a known migratory stopover point for sandhill cranes during migration (Smith 1983). As such, whooping cranes may also utilize the reservoir as a stopover point. Cheney Reservoir is approximately one mile south, and not within line-of-sight, of the proposed Cheney Reservoir alternative storage site. During the construction phase of the project, it is possible that activity on the Cheney Reservoir site could deter sandhill and whooping cranes from landing at Cheney Reservoir. Cheney Reservoir itself will not be disturbed, and no disturbance (such as noise) will remain after construction is completed. Therefore, it is unlikely that whooping cranes, if they do stop at Cheney Reservoir, would be adversely impacted by use of the Cheney Reservoir alternative. The other alternatives, disposal at the Grand Junction site and relocation to 6&50 Reservoir, would not impact whooping cranes.

7. Bald Eagle Haliaeetus leucocephalus

This species is listed as endangered by the U.S. Fish and Wildlife Service (1982) and the State of Colorado (1983). No critical habitat has been designated. The bald eagle is listed as potentially occurring on the Grand Junction, Lucas Mesa, Old Rifle and New Rifle sites (U.S. Fish and Wildlife Service 1983).

There are five rather poorly documented historical records of bald eagles nesting in Colorado in scattered locations (Bailey and Niedrach 1965). At present there are four known active bald eagle nest sites in Colorado, none of which are in or near the area of interest (Lytle 1982, CDOW 1978). Fisher et al. (1981) have documented nesting activity at three other sites along the Colorado River between Parachute Creek and Glenwood Springs, and at one other site on the Roaring Fork River. Documented nesting activity included carrying nesting material and rebuilding nests. The three nest sites on the Colorado River are all located in large cottonwood trees, while the Roaring Fork nest is in a large ponderosa pine (Fisher et al. 1981). However, all eagles had left these areas by late March 1981, presumably to migrate north to traditional nesting areas. There is no evidence of eggs or young at any of these sites.

A cooperative study of wintering bald eagles along the Colorado River has been conducted by CDOW, BLM and Bureau of Reclamation personnel since 1978. (Lytle 1982). Bald eagles are present in the Colorado River Valley from November through March each year (Lytle 1982, Lambeth 1982) although Green (1982) observed an eagle at DeBeque on 5 October 1979. Green (1982) states that use areas and numbers of eagles present have been fairly consistent in each year of the study.

Fisher et al. (1981) identify two areas as "high use areas" for bald eagles. One area is located along the Colorado River between DeBeque and Parachute Creek to the north, and the other is from the Colorado-Utah state line downstream through Westwater Canyon. Lytle (1982) and Lambeth (1982) state that concentrations of eagles are related to food supply (particularly waterfowl), good perches, and open water.

None of the project areas are within areas heavily used by wintering bald eagles. Very few bald eagles are found in the vicinity of Grand Junction, and the Colorado River around Rifle supported a maximum of three bald eagles during the 1980/1981 winters (Fisher et al. 1981). Impacts to bald eagles as a result of disposal at the Grand Junction, New Rifle and Old Rifle sites would be limited to increased noise and activity as a result of construction. Because these sites occur in areas already heavily populated by humans, increased disturbance as a result of construction activities is not expected to adversely impact bald eagles.

Relocation of the Old and New Rifle tailings to the Lucas Mesa alternative site would involve transport of tailings between Rifle and DeBeque by existing road (I-70) or rail routes, and up to the disposal area by improved existing road or a conveyor system. The site itself does not support bald eagles. Impacts would be limited to the increased truck or rail traffic between Rifle and DeBeque, which includes a high use area for wintering bald eagles. Because these routes are already heavily travelled, additional impact on wintering bald eagles from use of the Lucas Mesa alternative is expected to be negligible.

8. Black-footed ferret Mustela nigripes

This species is listed as endangered by the U.S. Fish and Wildlife Service (1982) and the State of Colorado (Colorado Division of Wildlife 1983). No critical habitat has been designated. This species is listed as potentially occurring on the 6&50 Reservoir site and the Cheney Reservoir site (U.S. Fish and Wildlife Service 1983).

There are no recent specimen records of the black-footed ferret for Colorado (Armstrong 1972), although occasional sight records are reported from several areas of the state. Recently, 2 possible sightings of ferrets have occurred near the 6&50 Reservoir site. On 24 April 1982 Mrs. Gordon Peterson sighted what she believes were 2 black-footed ferrets along I-70 between mile posts 13 and 14 between Mack and Loma, approximately 7 airline miles from the 6&50 Reservoir site. Smith (1983) believes this to be good sighting, because Mrs. Peterson is a trained biologist. David Cameron of URS, Inc., Denver, Colorado, believes he may have seen a black-footed ferret in T9S R104W Section 28, approximately 2 miles from the 6&50 Reservoir site. Cameron got only a very brief glimpse of the animal and believes the sighting is possible at best (Cameron 1983). In addition, no prairie dog towns were observed by Cameron in the area.

The black-footed ferret is closely associated with prairie dogs (Cynomys spp.) throughout its range. The ferret preys on prairie dogs and uses prairie dog burrows for shelter and as den sites. Ferrets are primarily nocturnal and spend most of the time underground, except for dispersal of young in September and October (Hillman and Clark 1980).

No prairie dog towns or individual burrows have been observed on the 6&50 Reservoir site. The closest towns, consisting of 40, 40, 50,50 and 80 burrows, are located approximately 2 miles southeast of the site (Bureau of Land Management, 1983). In addition, numerous prairie dog towns occur along I-70 near Mack and Loma.

No active prairie dog towns have been observed on the Cheney Reservoir site. Inactive burrows are present in the SE1/4 of SE1/4, Section 11 on the site. The nearest active prairie dog towns are at least a mile to the north of the site (Bureau of Land Management 1983), which is away from the planned access route to the site.

Because of the lack of black-footed ferret habitat (prairie dog towns) on the 6&50 Reservoir and Cheney Reservoir sites and the planned access road to each site, the species, if it occurs in either area, will not be affected by on site activites. If a black-footed ferret population does exist in the Mack-Loma area along I-70, individual ferrets could possibly be killed by trucks transporting uranium tailings to the 6&50 Reservoir. However, because the tailings will be transported only during daylight hours, and because above-ground ferret activity is almost exclusively nocturnal, the chances of a ferret being killed, if a population exists, seem extremely slim.

Disposal at the Grand Junction site would eliminate the potential for conflict with black-footed ferret populations.

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE COLORADO—UTAH
1406 FEDERAL BUILDING
125 SOUTH STATE STREET
SALT LAKE CITY, UTAH 84138-1197

IN REPLY REFER TO:

August 8, 1983

Mr. James A. Morley, Project Manager
Uranium Tailings Project Office
Department of Energy
Albuquerque Operations Office
P. O. Box 5400
Albuquerque, NM 87115

Dear Mr. Morley:

We have reviewed your biological assessment regarding the potential impacts to federally listed species as a result of remedial actions on inactive uranium mill tailings sites at Grand Junction and Rifle, Colorado. We agree with your "no effects" determinations for the species in question.

Please stay in contact with us as the project progresses. Should any of the project alternatives change significantly, we will have to reinitiate Section 7 consultation.

Thank you for your interest in conserving endangered species.

Sincerely,

Fred L. Bolwahnn
Field Supervisor

FLB:jh

AUG 11 3 05 PM '83

JACOBS ENGINEERING GROUP INC.
ADVANCED SYSTEMS DIVISION, ALBUQUERQUE OPERATIONS

5301 CENTRAL AVENUE N.E — SUITE 1700. ALBUQUERQUE. NEW MEXICO 87108
TELEPHONE (505) 846-4030

October 14, 1985

Robert G. Ruesink, Field Supervisor
U. S. Fish and Wildlife Service
2078 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

Dear Mr. Ruesink:

Jacobs Engineering Group Inc. is the Technical Assistance Contractor to the U.S. Department of Energy (DOE) for the Uranium Mill Tailings Remedial Action (UMTRA) Project. DOE is currently developing remedial action plans for two inactive uranium mill tailings sites near Rifle, Colorado. These plans include the consideration of three recently selected alternate disposal sites. A map showing the location of these three sites is attached.

Please provide me with your findings regarding threatened or endangered species that may occur at or near these sites. Your office has previously sent us a letter listing T and E species of concern near the tailings sites, and Lucas Mesa alternate disposal site (a copy is attached). A Biological Assessment which addressed T and E species at these sites was submitted. I would also appreciate receiving your comments regarding wetlands that may occur at the new alternate disposal sites.

If you have any questions, please feel free to contact Chuck Burt or me at (505) 846-1250. Thank you for your assistance.

Very truly yours,
JACOBS ENGINEERING GROUP INC.

Robert C Peel for D. Lechel

Dave Lechel
Manager, Environmental Services

DL:CB:jw
Attachments

cc: CBurt
LStepp
WTaber

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ENDANGERED SPECIES OFFICE
529 25½ ROAD
INDEPENDENCE PLAZA
SUITE B-113
GRAND JUNCTION, COLORADO 81505
TELEPHONE: 303-241-0563

IN REPLY REFER TO:

November 15, 1985

Mr. Dave Lechel
Manager, Environmental Services
Jacobs Engineering Group, Inc.
5301 Central Avenue N.E., Suite 1700
Albuquerque, N.M. 87108

Dear Mr. Lechel:

We have received your letter of October 14, 1985, regarding Uranium Mill Tailings Remedial Action (UMTRA) Project plans for two inactive uranium mill tailing sites near Rifle, Garfield County, Colorado. The species lists provided in this letter pertain not only to the newly identified alternate disposal areas (Webster Hill, Estes Gulch, and Hubbard Mesa sites) but also the actual source site of the tailings near Rifle, Colorado.

The following list of species which may be present within the area of influence of your project.

Federally Listed Species

Bald eagle	Haliaeetus leucocephalus
Black-footed ferret	Mustela nigripes
Uinta Basin hookless cactus	Sclerocactus glaucus

Historically, the endangered black-footed ferret (Mustela nigripes) may have occurred in portions of northeastern Colorado. Although unconfirmed sightings of this mammal have occurred in portions of Garfield County, Colorado, the only known population is in Meeteetse, Wyoming. Literature documents a close association between prairie dogs and black-footed ferrets. The standard that is used for determining possible project effects to black-footed ferrets is the disturbance of currently occupied prairie dog habitat. Should any of the activities that are part of the above-referenced project result in an impact to prairie dogs, black-footed ferret surveys may be necessary.

The Federal agency should review their proposed action and determine if the action would affect any listed species. If the determination is "may affect" for listed species you must request in writing formal consultation from the Field Supervisor, U.S. Fish and Wildlife Service, Endangered Species Office, 2078 Administration Building, 1745 West 1700 South, Salt Lake City, Utah 84104. At this time you should provide this office a biological assessment and/or any other relevant information that assisted you in reaching your conclusion.

We would like to bring to your attention species which are candidates for official listing as threatened or endangered species (Federal Register, Vol. 45, No. 242, December 15, 1980, Vol. 47, No. 251, December 30, 1982, Vol. 48, No. 229, November 28, 1983, and Vol. 50, No. 188, September 27, 1985). While these species have no legal protection at present under the Endangered Species Act, they are quite rare and restricted. We would ask that you take care to avoid them if they are found in the area. We believe that it is within the spirit of the ESA to consider project impacts to candidate species at this time. Additionally, we wish to make you aware of the presence of Federal candidates should any be proposed or listed prior to the time that all Federal actions related to the project are complete.

Federal Candidate Species

Ferruginous hawk	Buteo regalis
Long-billed curlew	Numenius americanus
Swainson's hawk	Buteo swainsoni
Western snowy plover	Charadrius alexandrinus nivosus
Western yellow-billed cuckoo	Coccyzus americanus occidentalis
White-faced ibis	Plegadis chihi
Razorback sucker	Xyrauchen texanus
DeBeque milk-vetch	Astragalus debegquaeus
DeBeque phacelia	Phacelia submutica

Thank you for your interest in conserving endangered species.

Sincerely,

Robert P. Smith

Robert P. Smith
Project Leader

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

JUN 3 1987

Mr. Jeffrey Opoycke
Acting State Supervisor
U.S. Fish And Wildlife Service
529 25 1/2 Road
Suite B-113
Grand Junction, Colorado 81505

Dear Mr. Smith:

Enclosed is a copy of the "Draft Environmental Impact Statement, Remedial Actions at the former Union Carbide Corporation Uranium Mill Sites, Rifle, Garfield County, Colorado", DOE/EIS-0132-D. Pursuant to Section 7 of the Endangered Species Act, the U.S. Department of Energy requests that Section 4.7 and 5.6 and Appendix G of the Environmental Impact Statement (EIS) be considered as a biological assessment of the potential impacts on threatened, endangered, and candidate floral and faunal species due to remedial actions on the inactive uranium mill tailings sites at Rifle, Colorado. We have concluded that no adverse impacts to any threatened, endangered, or candidate species would occur as a result of the remedial action alternatives.

We are now initiating the review process for the draft EIS for the Rifle mill tailings sites and request your review of the EIS and your concurrence in our determination of no effects. The comment period for this document terminates on July 13, 1987.

Please contact Donald Leske of my staff at (FTS) 846-1236 if you have any questions regarding the EIS. Thank you for your agency's cooperation in this matter.

Sincerely,

Mark L Matthews for

James R. Anderson
Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/o Enclosure:
W. Taber, TAC
D. Lechel, TAC

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

SEP 1 2 1988

Mr. Robert Leachman
U.S. Fish and Wildlife Service
529 25 1/2 Road
Suite B-113
Grand Junction, CO 81505

Dear Mr. Leachman:

It has recently come to the Department of Energy's attention that the U.S. Fish and Wildlife Service did not receive the DOE's letter of June 3, 1987 requesting a review and comment on the "Draft Environmental Impact Statement, Remedial Actions at the former Union Carbide Corporation Uranium Mill Sites, Rifle, Garfield County, Colorado", DOE/EIS-0132-D.

In addition, pursuant to Section 7 of the Endangered Species Act, the DOE is resubmitting its request that Section 4.7 and 5.6 and Appendix G of the enclosed DEIS be considered as a biological assessment of the potential impacts on threatened, endangered, and candidate floral and faunal species due to remedial actions on the inactive uranium mill tailings sites at Rifle, Colorado. We have concluded that no adverse impacts to any threatened, endangered, or candidate species would occur as a result of the remedial action alternatives, and we request your concurrence in our determination of no effects.

Technically, the review process for the DEIS has ended and preparation of the preliminary FEIS has begun. While it is regretable that the U.S. Fish and Wildlife Service did not have the opportunity to comment during the formal review period, it is important that the U.S. Fish and Wildlife Service review the DEIS and the biological assessment, and then make a determination on effect or no effect by September 21, 1988.

Please contact Donald Leske of my staff at (FTS) 846-1207 if you have any questions regarding the EIS. Thank you for your agency's cooperation in this matter.

Sincerely,

W. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/o enclosure:
W. Taber, TAC
W. Glover, TAC

DOI/UMTRA/1088-0012

United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:
(FWE)

October 4, 1988

W. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office
Department of Energy
Albuquerque, New Mexico 87115

Dear Mr. Arthur:

This responds to your September 12, 1988, letter requesting our review and comment on the Draft Environmental Impact Statement for the Uranium Mill Sites at Rifle, Colorado. Specifically, we were requested to review sections regarding potential impacts to federally listed species and concur with the Department of Energy's (Department) "no affect" determination.

We concur with your "no affect" determination for bald eagle, black-footed ferret and Uinta Basin hookless cactus. However, the draft environmental statement discloses the need for approximately 175 acre-feet of water for the Estes Gulch Alternative (Table 5.7, page 167). The Service believes that any depletion of water from the upper Colorado River basin has a negative impact to federally listed fish species. Therefore, if completion of the project, as proposed, will result in a net water depletion from the upper Colorado River basin, we would expect a may affect determination for the Colorado squawfish, humpback chub, and bonytail chub. Consequently, we are requesting the Department to evaluate the total water requirements of the Rifle uranium tailings remedial action project, and determine whether the water use will result in a net depletion of water from the upper Colorado River basin. The depletion should be quantified as an average annual depletion expressed in acre-feet for the life of the project. If a net depletion is documented, formal consultation under the Endangered Species Act should be initiated by the Department with this office.

If we may be of any assistance, please contact me or Bob Leachman in our Grand Junction office at (303) 243-2778 or FTS 322-0351.

Sincerely,

Lawrence R. Dewease
for

LeRoy W. Carlson
Acting State Supervisor

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

DEC 0 1 1988

LeRoy Carlson
Acting State Supervisor
U.S. Fish and Wildlife Service
Colorado Field Office
730 Simms Street Room 292
Golden, CO 80401

Dear Mr. Carlson:

This transmittal is provided in response to your letter of October 4, 1988 regarding the Uranium Mill Tailings Remedial Action (UMTRA) Project activities at Rifle, Colorado and removal of the contaminated materials to the proposed Estes Gulch disposal site. The purpose of this letter is to supplement the biological assessment contained in Sections 4.7, 5.6, and Appendix G of the UMTRA Project's Rifle Draft Environmental Impact Statement. This letter also serves to address the issue of project-related net depletion of the upper Colorado River basin water resources and subsequent potential impacts to fish species covered under the Endangered Species Act.

The DOE has re-evaluated the Rifle UMTRA Project's total water requirements. It has been determined the Project will utilize approximately 860 acre-feet of water over the nearly four year project life (an average of approximately 215 acre-feet per year). A total of approximately 387 acre-feet over two years will be needed for the remedial action work at the Old and New Rifle sites. It is proposed this water be taken from the Colorado River utilizing existing water rights held by UMETCO. The remaining 473 acre-feet of water needed for nearly four years of remedial action activities at the Estes Gulch site will be supplied by the City of Rifle utilizing their existing water rights at the Rifle Gap Reservoir. Seasonal and daily water use quantities for both areas are provided in the enclosed table.

This consumption of water resources, as part of the completion of the proposed project, could result in a net depletion of water from the upper Colorado River basin and may affect the Colorado squawfish, the humpback chub, and the bonytail chub. Therefore, the DOE requests the U.S. Fish and Wildlife Service's concurrence in a "may affect" determination and a formal consultation under Section 7 of the Endangered Species Act.

If you have any questions or require any additional information, please contact Chuck Cormier of my staff at FTS 844-3941.

Sincerely,

W. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/enclosure:
F. Bosiljevac, UMTRA
C. Cormier, UMTRA
D. Leske, UMTRA
B. Taber, JEG
B. Glover, JEG
MB. Leaf, JEG
C. Burt, JEG

November 29, 1988

APPROXIMATE WATER CONSUMPTION AT THE RIFLE UMTRA PROJECT SITES

ASSUMPTIONS: 6 day work week X 4.3 work weeks per month = 25.8 work days per month

OLD & NEW RIFLE SITES:
Source: Colorado River; UMETCO water rights.

TIME OF USE	ACRE-FEET PER DAY	ACRE-FEET PER MONTH	NUMBER OF MONTHS	TOTAL ACRE-FEET CONSUMED
4-9/90	0.60	15.51	6	93.06
9-11/90	0.51	13.37	3	40.12
3-6/91	0.49	12.82	4	51.28
7-9/91	0.79	20.57	3	61.73
10-12/91	0.79	20.49	3	61.49
3-12/91	0.30	7.91	10	79.14
		Subtotal		386.82

ESTES GULCH SITE:
Source: Rifle Gap Reservoir; City of Rifle water rights.

TIME OF USE	ACRE-FEET PER DAY	ACRE-FEET PER MONTH	NUMBER OF MONTHS	TOTAL ACRE-FEET CONSUMED
9-11/89	0.82	21.17	3	63.51
3-9/90	1.33	34.42	7	240.98
9-11/90	1.41	36.39	3	109.17
3-11/91	0.02	0.63	9	5.67
3-11/92	0.10	2.76	9	24.85
3-7/93	0.21	5.61	5	28.05
		Subtotal		472.23
		Total		895.05

DOI-UMT-0379-G

United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

FWE/CO

FWE/GJ 6-CO-89-F-06

W. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office
Department of Energy
Albuquerque, New Mexico 87115

Dear Mr. Arthur:

Enclosed for your review and comment is our draft biological opinion for the Uranium Mill Tailings Remedial Action Project at Rifle, Colorado.

Due to the depletion of water associated with operation of the mine, the Department of Energy must contribute $2,150.00 to the conservation fund to offset anticipated impacts to federally listed endangered fishes. Once payment to the conservation fund has been made, and your comments received, we shall finalize the biological opinion within two weeks. Unless the process is completed by April 14, 1989, we must mutually agree to an extension of time to comply with Endangered Species Act Regulations (50 CFR 402.14(e)).

Sincerely,

LeRoy W. Carlson
Colorado State Supervisor

cc: FWS/FWE, Salt Lake City, UT
FWS/FWE, Denver, CO
FWS/FWE, Grand Junction, CO
FWS/FWE, Washington, D.C.
Official File
Reading File

MAR 27 11 30 AM '89

DRAFT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

FWE/GJ 6-CO-89-F-06

W. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office
Department of Energy
Albuquerque, New Mexico 87115

Dear Mr. Arthur:

This responds to your letter of December 1, 1988, regarding the Uranium Mill Tailings Remedial Action Project at Rifle, Colorado, and your determination that the project will result in a net annual water depletion of 215 acre-feet from the upper Colorado River basin. As we believe small depletions, cumulatively, may have negative impacts to federally listed fishes, we concur with your determination that the proposed project "may affect" the Colorado squawfish, humpback chub, and bonytail chub. Therefore, we are providing this biological opinion as prescribed by Section 7 of the Endangered Species Act, 16 U.S.C. 1531 et seq., and the Interagency Cooperation Regulations 50 CFR 402.

Biological Opinion

Cleanup of the contaminated materials at the Rifle uranium tailings site, with the inclusion of conservation measures outlined below, is not likely to jeopardize the continued existence of the Colorado squawfish (Ptychocheilus lucius), humpback chub (Gila cypha), and bonytail chub (Gila elegans). We concur with your finding of "no effect" for the black-footed ferret, bald eagle, and Uinta Basin hookless cactus.

Project Description

The Rifle Uranium Mill Tailings Remedial Action Project site consists of two separate tailings sites adjacent to the city of Rifle in Garfield County, Colorado (Figure 1). The eastern site is known as Old Rifle and is approximately 0.3 mile from the center of Rifle. The western site, known as New Rifle, is approximately two miles from the center of Rifle. The Colorado River is immediately south of both sites.

The uranium mill at the Old Rifle site was owned and operated by the Union Carbide Corporation (Union Carbide) from 1924 to 1932 and from 1942 to 1958. From 1932 to 1942, the mill was idle for economic reasons. The mill produced vanadium during both operating periods and uranium during the latter period. After 1958, most of the Old Rifle tailings were reprocessed at the New Rifle site.

DRAFT

The new Rifle mill replaced the Old Rifle mill in 1958 and is also owned and operated by Union Carbide. From 1958 to 1973, the mill produced uranium and vanadium. From 1973 to 1984, a portion of the mill was used to produce vanadium; this operation involved processing vanadium solutions and did not yield tailings.

The New Rifle tailings site occupies 142 acres. The tailings pile covers 33 acres, and the mill area covers 59 acres. The entire New Rifle site is contaminated, and a 63-acre area adjacent to the tailings site has been contaminated with windblown tailings. The total amount of contaminated materials at the New Rifle site, including contaminated soils beneath the tailings, is estimated to be approximately 2,930,000 cubic yards. Seepage from the tailings pile has contaminated ground water in the alluvium and Wasatch Formation beneath the pile.

The Department of Energy's (Department) preferred alternative is the removal of all contaminated materials to the Estes Gulch disposal site approximately six miles north of Rifle. An access road would be constructed to the Estes Gulch site, and a disposal area averaging 15 feet in depth would be excavated at the site. All of the tailings and contaminated materials would be trucked to the Estes Gulch site and placed in the disposal area. The tailings and contaminated materials would then be covered with an earthen radon barrier and a rock erosion protection barrier. The Department has determined that the proposed remedial action will result in an average annual depletion of 215 acre-feet from the upper Colorado River basin.

Basis for Opinion

Water depletions in the Upper Colorado River Basin have been recognized as a major source of impact to endangered fish species. Continued water withdrawal has restricted the ability of the Colorado River system to produce flow conditions required by various life stages of the fish. Impoundments and diversions have reduced peak discharges by 50 percent since 1942 while increasing low flows by 21 percent in some reaches. These depletions along with a number of other factors have resulted in such drastic reductions in the populations of Colorado squawfish, humpback chub and bonytail chub that the Service has listed these species as endangered and has implemented programs to prevent them from becoming extinct.

COLORADO SQUAWFISH

The Colorado squawfish evolved as the main predator in the Colorado River system. The diet of Colorado squawfish longer than three or four inches consists almost entirely of other fishes (Vanicek and Kramer 1969). The Colorado squawfish is the largest cyprinid fish (minnow family) native to North America and, during pre-development times, may have grown as large as six feet in length and weighed nearly 100 pounds (Behnke and Benson 1983). These large fish may have been 25-50 years of age.

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Based on early fish collection records, archaeological finds and other observations, the Colorado squawfish was once found throughout warm water reaches of the entire Colorado River Basin, including reaches of the upper Colorado River and its major tributaries, the Green River and its major tributaries, and the Gila River system in Arizona (Seethaler 1978). Colorado squawfish were apparently never found in colder, headwater areas. Seethaler (1978) indicates that the species was abundant in suitable habitat throughout the entire Colorado River basin prior to the 1850's. The San Juan River historically supported populations of the endangered fishes (Evermann and Rutter 1895, and Jordan 1891). In 1959, the presence of Colorado squawfish in the New Mexico portion of the San Juan River was confirmed when two specimens were collected near Rosa in Rio Arriba County (Koster 1960).

A marked decline in Colorado squawfish populations can be closely correlated with the construction of dams and reservoirs during the 1960's, the introduction of nonnative fishes, and the removal of water from the Colorado River system. Behnke and Benson (1983) summarized the decline of the natural ecosystem. They pointed out that dams, impoundments, and water use practices are probably the major reasons for drastically modified natural river flows and channel characteristics in the Colorado River Basin. Dams on the mainstem have essentially segmented the river system, blocking Colorado squawfish spawning migrations and drastically changing river characteristics, especially flows and temperatures. In addition, major changes in species composition have occurred due to the introduction of nonnative fishes, many of which have thrived as a result of changes in the natural riverine system (i.e., flow and temperature regimes). The decline of endemic Colorado River fishes seems to be at least partially related to competition or other behavioral interactions with nonnative species, which have perhaps been exacerbated by alterations in the natural fluvial environment.

The Colorado squawfish currently occupies about 1,030 river miles in the Colorado River system (29 percent of its original range) and is presently found only in the upper Colorado River Basin above Glen Canyon Dam. It inhabits about 350 miles of the mainstem Green River from its mouth to the mouth of the Yampa River. Its range also extends 140 miles up the Yampa River and 104 miles up the White River, the two major tributaries of the Green River. In the mainstem Colorado River, it is currently found from Lake Powell extending about 201 miles upstream to Palisade, Colorado, and in the lower 33 miles of the Gunnison River, a tributary to the mainstem Colorado River (Tyus et al. 1982). Recent investigations found adult Colorado squawfish inhabit the San Juan River as far upstream as 151.5 miles above Lake Powell. These studies indicate successful Colorado squawfish spawning by the capture of young-of-the-year Colorado squawfish. These young-of-the-year fish were captured from backwaters between 6 and 143 miles above Lake Powell (Meyer and Moretti 1988, Platania and Bestgen 1987).

DRAFT

The life stages that appear to be most critical are from egg fertilization through its first year of life. It has been demonstrated that these phases of Colorado squawfish development are also closely tied to some specific habitat requirements. It is imperative that proper flows and temperatures are provided during these essential life stages. The conservation measures outlined below will help further investigate and meet the habitat requirements of the Colorado squawfish, thus offsetting project-related impacts and the likelihood of jeopardy for the species.

Conservation Measures

On January 21-22, 1988, the Secretary of the Interior, the governors of Wyoming, Colorado, and Utah, and the Administrator of the Western Area Power Administration were cosigners of a Cooperative Agreement to implement the "Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin" (Recovery Program). An objective of the Recovery Program was to identify reasonable and prudent alternatives that would ensure the survival and recovery of the listed species while providing for new water development in the Upper Colorado River Basin.

The following excerpts are pertinent to the consultation because they summarize portions of the Recovery Program that address depletion impacts, Section 7 consultation, and project proponent responsibilities:

> "All future Section 7 consultations completed after approval and implementation of this program (establishment of the Implementation Committee, provision of congressional funding, and initiation of the elements) will result in a one-time contribution to be paid to the Service by water project proponents in the amount of $10 per acre-foot based on the average annual depletion of the project.... This figure will be adjusted annually for inflation.... Concurrently with the completion of the Federal action which initiated the consultation, e.g., ...issuance of a 404 permit, 10 percent of the total contribution will be provided. The balance...will be...due at the time the construction commences.... Funds from these contributions will be applied equally to flow acquisition and to other recovery activities...."

It is important to note that these provisions of the Recovery Program were based on appropriate legal protection of the instream flow needs of the endangered Colorado River fishes. The Recovery Program further states:

DRAFT

> "...it is necessary to protect and manage sufficient habitat to support self-sustaining populations of these species. One way to accomplish this is to provide long term protection of the habitat by acquiring or appropriating water rights to ensure instream flows.... Since this program sets in place a mechanism and a commitment to assure that the instream flows are protected under State law, the Service will consider these elements under Section 7 consultation as offsetting project depletion impacts."

Thus, the Service has determined that the project depletion impacts, which the Service has consistently maintained are likely to jeopardize the listed fishes, can be offset by (a) the water project proponents one-time contribution to the Recovery Program in the amount of $10 per acre-foot of the project's average annual depletion, and (b) appropriate legal protection of instream flows pursuant to State law. The Service believes it is essential that protection of instream flows proceed expeditiously, before significant water depletions occur.

The Department will make a one-time payment of $10 per acre-foot of average annual depletion, or a total payment of $2,150.00. Fifty percent of the funds will be used for acquisition of water rights to meet the instream flow needs of the endangered fishes (unless otherwise directed by the Implementation Committee); the balance will be used to support other recovery activities for the Colorado River endangered fishes. Payment should be made to the Regional Director, U.S. Fish and Wildlife Service, P.O. Box 25486, Denver Federal Center, Denver, Colorado 80225, or its designated agent.

Should there be any changes in the amount of water depletion (215 acre-foot on an average, annual basis) or any other project change from that which was proposed which may affect any endangered or threatened species, or if there is failure to comply with the conservation measures outlined above, then the Service should be contacted to determine if further consultation is required. The Service has determined the incidental take associated with this project to be zero.

Thank you for your interest in conserving endangered species.

Sincerely

LeRoy W. Carlson
Colorado State Supervisor

cc: FWS/FWE: Grand Junction
FWS/FWE: SLC
FWS/FWE: Washington, D.C.
Official File
Reading File

REFERENCES

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

APR 28 1989

FWE/CO

Mr. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office
Department of Energy
Albuquerque, New Mexico 87115

Dear Mr. Arthur:

This follows an April 12, 1989, telephone call between Mary Beth Leaf of Jacobs Engineering and Bob Leachman of our Grand Junction staff regarding the Uranium Mill Tailings Remedial Action Project at Rifle, Colorado.

Ms. Leaf has indicated that payment to the conservation fund is being delayed. In accordance with Endangered Species Act Regulation 50 CFR 402.14(e), we have mutually agreed to extend the consultation period. Once payment is received, we will finalize the biological opinion within two weeks.

Sincerely,

LeRoy W. Carlson

LeRoy W. Carlson
Colorado State Supervisor

cc: FWS/FWE, SLC
FWS/FWE, GJ

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

Mr. LeRoy W. Carlson
Colorado State Supervisor
United States Department
of the Interior
Fish and Wildlife Service
730 Simms Street, Room 292
Golden, CO 80401

Dear Mr. Carlson:

The U.S. Department of Energy (DOE) has reviewed the draft biological opinion for the Uranium Mill Tailings Remedial Action (UMTRA) Project received from the Fish and Wildlife Service on March 27, 1989. The DOE is in agreement with the draft opinion and will comply with the Endangered Species Act by making payment to the U.S. Fish and Wildlife Service Conservation Fund in the amount of $2,150.

We would appreciate your expediting the final biological opinion for the Rifle project. Should you have any further questions, please call Frank Bosiljevac of my staff.

Sincerely,

Frank D. Bosiljevac

Mark L. Matthews
Acting Project Manager
Uranium Mill Tailings Project Office

Enclosure

cc w/o enclosure:
Bob Leachman,
U.S. Fish & Wildlife, GJ
B. Taber, JEG
M. Leaf, JEG

DOI/UMT/0884-0026

United States Department of the Interior
FISH AND WILDLIFE SERVICE

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228

IN REPLY REFER TO:

FWE
MAIL STOP 60120

AUG 08 1989

Mark L. Matthews, Acting Project Leader
Uranium Mill Tailings Project Office
Department of Energy
P.O. Box 5400
Albuquerque, New Mexico 87115

Dear Mr. Matthews:

This acknowledges receipt of your check number 3533 in the amount of $2,150.00 dated April 12, 1989. This check satisfies the Endangered Species commitment identified in our Biological Opinion 6-CO-89-F-05.

Sincerely,

Galen L Buterbaugh

GALEN L. BUTERBAUGH

Regional Director

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