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DOE/EA-0343

United States Department of Energy

Environmental Assessment

Remedial Action at the Green River Uranium Mill Tailings Site Green River, Utah

July, 1988

Uranium Mill Tailings Remedial Action Project UMTRAP

Department of Energy
Albuquerque Operations Office
P.O. Box 5400
Albuquerque, New Mexico 87115

JUL - 6 1988

Dear Friend:

Enclosed is the Department of Energy's Environmental Assessment on the proposed Remedial Action at the Green River Uranium Mill Tailings Site, Green River, Utah (DOE/EA-0343).

In November 1978, Congress enacted Public Law 95-604, the Uranium Mill Tailings Radiation Control Act of 1978. The Act authorizes the Department of Energy to enter into cooperative agreements with the affected states and Indian tribes in order to establish assessment and remedial action programs at inactive uranium mill tailings sites, including the Green River site. The Act stipulates that the department will meet the applicable cleanup and disposal standards promulgated by the Environmental Protection Agency. It further states that the Nuclear Regulatory Commission is to concur in all major decisions, and to license the maintenance and monitoring of the final disposal site.

The Environmental Assessment was prepared in compliance with the National Environmental Policy Act to assess the environmental impacts of the Department's proposal to perform remedial action at the Green River site and its related vicinity properties. The Department's proposed action, as identified in the Environmental Assessment, is to stabilize the residual radioactive material at a new disposal site several hundred feet south of the existing Green River tailings pile.

Also enclosed is a Finding of No Significant Impact, in which the Department has determined, based on the analyses in the Environmental Assessment, that remedial action at the Green River site is not a major Federal action significantly affecting the quality of the human environment. Therefore, preparation of an Environmental Impact Statement is not required.

Sincerely,

W. John Arthur III

W. John Arthur, III
Project Manager
Uranium Mill Tailings Project Office

Enclosures (2)

Billing Code 6450.01

U.S. Department of Energy

Finding of No Significant Impact and Floodplain Statement of Findings for the Remedial Action at the Green River Uranium Mill Tailings Site, Green River, Utah

AGENCY: U.S. Department of Energy

ACTION: Finding of No Significant Impact (FONSI) and Floodplain Statement of Findings.

SUMMARY: The U.S. Department of Energy (DOE) has prepared an environmental assessment (EA) (DOE/EA-0343) on the proposed remedial action at the inactive uranium mill tailings site near Green River, Utah. Based on the analyses in the EA, which is available upon request, the DOE has determined that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.). Therefore, the preparation of an environmental impact statement (EIS) is not required. The DOE has also prepared a Floodplain Assessment as part of the EA. This assessment is prepared pursuant to Executive

Orders 11988 and 11990, and 10 CFR Part 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements.

Under authority granted by the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (Public Law 95-604 dated November 8, 1978), the U.S. Department of Energy (DOE) proposes to clean up the residual radioactive wastes and other contaminated materials at the inactive uranium mill tailings site located at Green River, Utah. The proposed action will move and stabilize the radioactive wastes according to a plan to be concurred in by the U.S. Nuclear Regulatory Commission (NRC) and the State of Utah.

BACKGROUND: On November 8, 1978, the Uranium Mill Tailings Radiation Control Act (UMTRCA), Public Law 95-604 (PL95-604), was enacted in order to address a Congressional finding that uranium mill tailings located at inactive processing sites may pose a potential and significant radiation health hazard to the public. Title I of the UMTRCA authorized the DOE to enter into cooperative agreements with affected states or Indian tribes to clean up those inactive sites contaminated with uranium mill tailings and required the Secretary of the DOE to designate sites to be cleaned up. On November 8, 1979, DOE designated 24 inactive processing sites for remedial action under Title I of the UMTRCA including the inactive uranium mill tailings site near Green River, Utah (44 FR 74892).

The UMTRCA also required the U.S. Environmental Protection Agency (EPA) to promulgate standards for remedial action at all inactive mill sites. The purpose of these standards is to protect the public health and safety and the environment from radiological and nonradiological hazards associated with residual radioactive materials at the sites. The final standards (40 CFR Part 192) were published on January 5, 1983, and became effective on March 7, 1983. However, on September 3, 1985, the U.S. 10th Circuit Court of Appeals remanded groundwater standards 40 CFR 192.2(a)(2)-(3). Proposed standards were issued by EPA on September 23, 1987. 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 Green River site would not preclude subsequent design enhancements if needed to achieve compliance and would not limit the selection of reasonable groundwater restoration methods that may be necessary when final standards are promulgated. When the final EPA standards are promulgated, the DOE will evaluate the groundwater protection requirements and undertake such action as is necessary to ensure that the final standards are met. The need for and extent of aquifer restoration will be evaluated in a separate NEPA process.

Under the UMTRCA, all remedial actions must be selected and performed with the concurrence of the NRC. The NRC has not and does not intend to issue regulations applicable to the Title I remedial actions at the inactive uranium mill tailings sites but will issue a license applicable to the 24 inactive sites for long-term surveillance and maintenance after the remedial actions are complete. On May 15, 1980, the DOE and the State of Utah entered into a cooperative agreement under Title I of the UMTRCA. The cooperative agreement set forth the terms and conditions for the DOE and Utah cooperative remedial action efforts including the DOE's development of a remedial action plan (concurred in by the State of Utah), the DOE's preparation of an appropriate environmental document, real estate responsibilities, and other concerns. The DOE and the State of Utah will provide 90 and 10 percent, respectively, of the engineering and construction costs.

PROJECT DESCRIPTION: The Green River uranium mill tailings site covers 48 acres in Grand County, Utah, 0.5 mile southeast of the town of Green River. The mill was built in 1957 by Union Carbide Corporation and operated from 1958 through 1961, as an upgrader for ores from the Temple Mountain uranium mines approximately 40 miles to the southwest. When the Green River mill was shut down in 1961, the plant equipment was dismantled but the buildings were left intact. Union Carbide (now UMETCO) still owns the site and buildings, which are currently vacant but leased for use to the city of Green River.

The 48-acre designated site consists of the tailings pile (eight acres), the mill yard and ore storage area (21 acres), four main buildings, a water tower, and several small buildings. The total volume of contaminated materials, including the tailings and underlying soils, is estimated to be 185,000 cubic yards (cy). The buildings are structurally sound and are marginally contaminated. Access to the mill yard is restricted by a six-foot-high security fence with locked gates. The tailings pile is also fenced to restrict vehicle and livestock access; pedestrian traffic is not restricted. The remainder of the designated site is not fenced and access is not restricted. Radiation warning signs are posted on the fences at the site. Dispersion of the tailings by wind and water erosion has contaminated approximately 64 acres of which 40 (including the area of the former ore storage and mill yard) and 24 acres are within and outside of the designated site, respectively.

The principal feature of the proposed action is the relocation of the tailings and other contaminated materials to a disposal area 600 feet south of the existing tailings pile. The tailings and other contaminated materials would be consolidated in a below-grade area; the resulting disposal cell would be contoured to have 10 percent (10 horizontal to one vertical) sideslopes and a gently sloping top of five percent. To ensure compliance with the EPA standards, the tailings and contaminated materials would be covered with 1.0 foot of compacted earth (radon/infiltration barrier) to inhibit the emanation of radon and the infiltration of water. The topslope and sideslopes of the disposal cell would be covered with a five-foot-thick layer of sand, gravel, and select fill to protect the radon/infiltration barrier from frost action, and small rock for erosion protection. This layer would also protect against penetration by animals and prevent human intrusion. Various other erosion control measures would be taken to assure the long-term stability of the stabilized disposal cell.

The stabilized disposal cell would cover approximately eight acres, and would be approximately 600 feet along each side. After remedial action the area of the existing tailings pile would be backfilled, graded to promote surface drainage, and revegetated. All other areas disturbed at the site by remedial action would be backfilled and graded to promote surface drainage. All on-site buildings would be decontaminated and left intact for unrestricted use after the remedial action. Forty-five acres of the 48-acre designated tailings site would be released for any use consistent with existing land use controls following completion of remedial action. A fence would be constructed around the disposal site. The final restricted area would cover nine acres; this would require six acres of land outside the designated site boundary. The conceptual design is subject to change during the final design process.

The DOE examined three alternatives for the remedial action in its Environmental Assessment of Remedial Action at the Green River Uranium Mill Tailings Site, Green River, Utah. The DOE's proposed action is to decontaminate the buildings at the mill site and to relocate the radioactive wastes from the existing tailings pile and other contaminated material to an area 600 feet south of the existing tailings pile for permanent stabilization on site. The other alternatives analyzed in the EA included taking no action and stabilizing the wastes on site at the existing tailings site location. Each of the remedial action alternatives involves activity in a floodplain.

FINDING: The DOE has considered the concerns that have been expressed during public meetings and government agency reviews about the environmental and health impacts from the proposed remedial action. In general, these concerns relate to the impacts from radiation released during remedial action, air quality impacts, impacts on the surface water, and impacts from the contaminated groundwater.

The EA discusses the environmental impacts resulting from the proposed remedial action and identifies mitigation measures that would be implemented to assure that the effects are not significant. The FONSI for stabilization on site at the Green River tailings site is based on the following findings which are supported by the information and analyses in the EA.

- Radiation release - The increased radiation exposure above background levels to the general population at and in the vicinity of the Green River site during the remedial action would be extremely low. The total estimated excess health effects for the general population and remedial action workers were projected to be 0.0006 additional cancer deaths due to radiation from the tailings during the remedial action period. The total estimated excess health effects for remedial action workers were projected to be 0.0005 additional cancer deaths due to radiation from the tailings during the remedial action period.

  The no action alternative would result in 0.0001 total estimated excess health effects per year. This number is not directly comparable to the total estimated excess health effects mentioned above for the general population because the excess health effects estimated for the proposed action are for the duration of tailings disturbance and account for increased radon levels due to tailings disturbance. In addition, the total estimated excess health effects for the no action alternative do not consider factors such as dispersion or unauthorized removal and use of the tailings which could lead to greater excess health effects than those calculated.

The DOE would closely monitor the release of radon and airborne radioactive particulates during the remedial action. The release of radon and airborne radioactive particulates would be reduced by dampening contaminated material with water or chemical dust suppressants, by limiting the handling of contaminated material during adverse weather conditions, and by using trucks with tight-fitting tailgates and covers when the materials are to be moved. Drainage controls and waste-water retention ponds would be constructed to prevent contaminated water from leaving the site.

Human exposure to residual radioactive material would be reduced further by restricting access, by providing worker training programs, and by the use of necessary monitoring and protective equipment by the remedial action workers.

The total excess health effects at and in the vicinity of the Green River tailings site after 10 and 1000 years of no action are estimated to be 0.001 and 0.1, respectively. The calculations for the no action alternative do not consider the dispersal of the tailings by natural erosion or by man; thus, the total excess health effects may be greater.

Based on the above, it was determined that the radiation impacts from the proposed action would not be significant.

- Air quality - An inventory of emissions due to remedial action indicated that fugitive dust emissions would be much higher than combustion emissions. Both combustion and fugitive dust emissions would be temporary and endure only for the 14-month period of remedial action. Appropriate air quality permits will be obtained from the State of Utah. No Federal permits will be required.

  The fugitive dust emissions were used in a computer simulation model to determine the total suspended particulates (TSP) concentrations downwind from the various work sites. Results of the modeling indicate that the TSP concentrations at the Green River mill tailings site and the two borrow sites would exceed the Federal secondary and the State of Utah 24-hour TSP standards. However, this impact would be temporary and short-term, lasting only for the length of the remedial action process. The maximum exceedance of the 24-hour TSP standards would occur over a four-month period (months six through nine) during peak remedial action activity. Dust suppression measures, such as water sprays or chemical dust suppressors, will be implemented at the construction site to minimize fugitive particulate emissions.

  For these reasons, it was determined that the air-quality impacts of the proposed action would be temporary and would not be significant.

- Surface-water quality - Surface-water runoff as a result of the cleanup and consolidation of the tailings and contaminated material would be minimal because the remedial action design includes the construction of drainage and erosion controls. This includes waste-water retention ponds constructed during site preparation to prevent the discharge of contaminated water from the site. The contaminated water would be retained for evaporation or use in the compaction of the tailings and contaminated materials, and any sediments from the ponds would be consolidated with the tailings during the final reshaping of the disposal cell.

Surface-water runoff created by excessive precipitation would not cause erosion of the stabilized disposal cell and carry contaminants into local surface waters because erosion control features such as sideslope design and rock barriers were incorporated into the remedial action design.

On this basis, it was determined that the impacts on surface-water resources would not be significant.

o Groundwater quality - Major groundwater aquifers at the Green River site are referred to in the EA as the top, upper-middle, lower-middle, and bottom hydrostratigraphic units. Percolation of tailings seepage into the groundwater system beneath the tailings pile has adversely impacted the water quality in both the top and upper-middle hydrostratigraphic units. Gross alpha activity, molybdenum, nitrate, selenium, and uranium concentrations in the top and upper-middle hydrostratigraphic units exceed background levels, the proposed EPA maximum concentration limits, and state of Utah groundwater standards beneath and downgradient of the existing tailings pile. The vertical extent of contamination is confined to these two shallow units by strong, vertically upward hydraulic gradients between the upper-middle unit and the underlying units. The maximum depth of contamination beneath the surface of the present tailings pile is about 65 feet.

The disposal cell design incorporates many natural, durable components that would minimize infiltration and leachate generation. Compliance with the proposed standards would be aided by the following:

- Below-grade disposal of the tailings that will lessen percolation of precipitation through the tailings by limiting the exposed area of the stabilized pile.

- Emplacement of a cover system consisting of filter layers, erosion protection, and a layer to protect the radon/infiltration barrier from frost action to reduce infiltration and promote surface runoff and evaporation.

- Minimization of tailings seepage by the use of a low hydraulic conductivity radon/infiltration barrier to reduce infiltration.

- Consistent, uniform, vertical fracturing of the foundation bedrock that will prevent ponding ("bathtubbing") in the tailings and promote drainage of runoff water from the toe of the cell.

  - Natural geochemical attenuation of contaminants in the tailings seepage by adsorption and precipitation reactions within the Cedar Mountain Formation fractured bedrock beneath and downgradient of the disposal cell.

  - Strong, upward, vertical hydraulic gradients in the saturated bedrock downgradient of the disposal site that will inhibit downward migration of contamination.

  - Natural dilution (mixing) of the tailings seepage by groundwater underflow in the Cedar Mountain Formation.

  - Limitation of the lateral extent of any future contamination from tailings seepage from the disposal cell due to the prevailing flow of the shallow groundwater toward the existing contaminant plume of the mill site.

  Groundwater protection at the Green River site would be consistent with the proposed EPA standards for inactive sites (40 CFR Part 192) and would be accomplished in accordance with the remedial action plan prepared by the DOE and approved by the NRC. The generic impacts of the EPA standards were addressed in an EIS published by the EPA (EPA 521/1-83-008-1 and 2).

  Based on the above, it was determined that the impacts on groundwater resources would not be significant.

- There are no endangered or threatened species or archaeological resources in the area that would be affected by the remedial action.

- No wetlands would be affected by the remedial action of the Green River tailings site.

In summary, based on the analyses in the EA, the DOE has determined that the proposed action does not constitute a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act (NEPA) of 1969 (423 U.S.C. 4321 et seq.). Therefore, the preparation of an EIS is not required.

FLOODPLAIN STATEMENT OF FINDINGS: This is a Statement of Findings prepared pursuant to Executive Orders 11988 and 11990, and 10 CFR Part 1022, Compliance with Floodplain/Wetlands Environmental Review Requirements. Under authority granted by the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, the DOE proposes to clean up the residual radioactive wastes and other contaminated materials at the inactive uranium mill tailings site in Green River, Utah, and relocate these materials to an area 600 feet south of the existing tailings pile where they would be permanently stabilized. Radioactively contaminated materials are located within the 100-year floodplain of Brown's Wash. On the basis of the floodplain assessment in the Environmental Assessment (EA), Appendix F, the DOE has determined that there is no practicable alternative to the proposed activities and that the proposed action has been designed to minimize potential harm to or within the floodplain of Brown's Wash.

The proposed remedial action for the Green River tailings is stabilization on site. All of the tailings and other contaminated materials would be consolidated in a below-grade area 600 feet south of the existing pile. The tailings pile would be contoured to have 10 percent sideslopes and a gently sloping top. The pile would be covered with 1.0 foot of compacted earth to inhibit radon emanation and water infiltration and to assure compliance with the EPA standards. The top and sides of the pile would be covered with a five foot-thick layer of sand, gravel, select fill and rock for erosion and frost protection. This layer would also protect against penetration by animals and inadvertent human intrusion. A below-grade rock apron would be constructed around the pile to protect the pile against gully intrusion. The top of the stabilized pile would have an average height of 14 feet with a maximum height of 33 feet. The area of the existing tailings pile would be backfilled, graded to promote surface drainage, and revegetated. All other areas at the site disturbed by remedial action would be backfilled and graded to promote surface drainage. All on-site buildings would be decontaminated and left intact. A fence would be constructed around the stabilized tailings pile. A map showing the location of the affected floodplain can be found in the EA, Figure F.2.1.

Specific construction activities related to the floodplain area include (1) the disturbance of approximately 12.5 acres of tailings and other contaminated materials within the 100-year floodplain of Brown's Wash; (2) grading and revegetating the floodplain where excavated, including adding any necessary soil conditioners, and (3) use of water bars, mulch, riprap, or other soil erosion controls, if necessary, to minimize erosion.

The DOE examined three alternatives for the remedial actions in the EA. The DOE's proposed action is to decontaminate the Green River uranium mill tailings site and to relocate the wastes 600 feet south of the existing tailings pile for permanent stabilization on site. The other alternatives analyzed in the EA included taking no action and stabilizing the wastes in-place at the Green River uranium mill tailings site.

During the action alternatives (stabilization on site or stabilization in place) at the Green River tailings site, 12.5 acres within the Brown's Wash 100-year floodplain would be disturbed by removing 20,500 cy of tailings and other contaminated materials. The majority of the disturbance would occur outside the tailings pile boundary, downstream of the tailings pile, and along both banks of the wash. These areas constitute 12 acres of the total disturbed area and contain 16,500 cy of tailings and other contaminated materials. The depths of excavation required in these areas would be one foot or less. Excavation ranging from six to nine feet would be required in an 0.5-acre area of the tailings pile within the 100-year floodplain in order to remove 4,000 cy of contaminated materials.

The no action alternative, which entails leaving the site in its present condition, would not be consistent with the intent of Congress in Public Law 95-604 and would not result in compliance with the EPA standards.

Potential impacts during remedial action would be mitigated by use of the following measures:

o Contaminated materials in the floodplain would be excavated during the period that the wash is dry.

- Berms, riprap or other erosion control measures would be used to minimize erosion along the banks of the wash.

- 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.

The remedial action has been designed to conform to applicable Federal and state regulations. Before construction begins, 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, Utah state agencies, and other agencies having jurisdiction. Initial consultation with the agencies has taken place.

SINGLE COPIES OF THE EA ARE AVAILABLE FROM: W. John Arthur, III, UMTRA Project Manager, U.S. Department of Energy, UMTRA Project Office, 5301 Central Avenue, N.E., Suite 1720, Albuquerque, New Mexico 87108, (505) 844-3941.

FOR FURTHER INFORMATION, CONTACT: Carol Borgstrom, Acting Director, Office of NEPA Project Assistance, Office of the Assistant Secretary for Environment, Safety, and Health, Room 3E-080, Forrestal Building, Washington, D.C. 20585, (202) 586-4600.

Issued at Washington, D.C. May 26, 1988.

E C Baynard
Ernest C. Baynard, III
Assistant Secretary
Environment, Safety, and Health

DOE/EA-0343

ENVIRONMENTAL ASSESSMENT
OF
REMEDIAL ACTION AT THE GREEN RIVER URANIUM MILL TAILINGS SITE
GREEN RIVER, UTAH

JULY, 1988

U.S. DEPARTMENT OF ENERGY
UMTRA PROJECT OFFICE
ALBUQUERQUE, NEW MEXICO

ENVIRONMENTAL ASSESSMENT OF
REMEDIAL ACTION AT THE GREEN RIVER
URANIUM MILL TAILINGS SITE
GREEN RIVER, UTAH

U.S. DEPARTMENT OF ENERGY

ABSTRACT

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Public Law 95-604, authorized the U.S. Department of Energy to clean up inactive processing sites to reduce the potential health impacts associated with the residual radioactive materials remaining at these sites. The EPA has issued proposed revisions (52 FR 36000-36008) to the groundwater protection standards promulgated for the remedial actions at Uranium Mill Tailings Remedial Action (UMTRA) Project sites (40 CFR Part 192). Remedial action at the Green River site must be performed in accordance with these standards and with the concurrence of the U.S. Nuclear Regulatory Commission and the state of Utah.

The inactive (Title I) Green River uranium mill tailings site is one mile southeast of Green River, Utah. The existing tailings pile is within the floodplain boundaries of the 100-year and 500-year flood events. The 48-acre designated site contains eight acres of tailings, the mill yard and ore storage area, four main buildings, a water tower, and several small buildings. Dispersion of the tailings has contaminated an additional 24 acres surrounding the designated site. Elevated concentrations of molybdenum, nitrate, selenium, uranium, and gross alpha activity exceed background levels and the proposed U.S. Environmental Protection Agency (EPA) maximum concentration limits in the groundwater in the unconsolidated alluvium and in the shallow shales and limestones beneath the alluvium at the mill tailings site. The contamination is localized beneath, and slightly downgradient of, the tailings pile.

The proposed action is to relocate the tailings and associated contaminated materials to an area 600 feet south of the existing tailings pile where they would be consolidated into one, below-grade disposal cell. A radon/infiltration barrier would be constructed to cover the stabilized pile and various erosion control measures would be taken to ensure the long-term stability of the stabilized pile.

The environmental impacts presented in this environmental assessment are for the proposed action, no action, and stabilization in place alternatives. The assessment has demonstrated that the proposed action would not significantly affect the quality of the human environment and would be performed in compliance with applicable environmental laws. No action would not be consistent with the intent of Public Law 95-604 and would not result in compliance with the EPA standards. Although the impacts associated with the stabilization in place alternative are similar to those associated with the proposed action, additional construction requirements would be needed to protect the disposal cell from flooding, thereby adding to the costs.

For more information contact:

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1.0 SUMMARY

This environmental assessment (EA) is prepared pursuant to the National Environmental Policy Act (NEPA), which requires Federal agencies to assess the impacts that their actions may have on the environment. This EA examines the short-term and long-term effects of the U.S. Department of Energy's (DOE's) proposed action for the Green River uranium mill tailings site.

The assessment has demonstrated that the proposed action would not significantly alter the quality of the human environment and would be performed in compliance with applicable environmental laws. The no action alternative would not be consistent with the intent of Public Law 95-604 and would result in noncompliance with the U.S. Environmental Protection Agency (EPA) standards.

1.1 PROJECT SUMMARY

The Green River uranium mill tailings site is in Grand County, Utah, one mile southeast of the city of Green River (Figure 1.1). The site is in the floodplain of Brown's Wash, an intermittent tributary of the Green River which flows southward and discharges into the Colorado River 60 air miles south of the city of Green River.

The Green River site area has an arid climate with an average annual precipitation of six inches. Vegetation is sparse and consists primarily of grasses, shrubs, and forbs adapted to the dry desert environment. There is a small riparian zone along the Green River that is characterized by cottonwoods and willows with an understory of shrubs, forbs, and grasses. The closest community to the tailings site is the city of Green River, one mile to the northwest, with an estimated 1986 population of 850. The closest residence is 0.5 mile northwest of the tailings site. Land use is predominantly residential, agricultural, and commercial.

The 48-acre designated site consists of the tailings pile, several buildings, and a water tower. The tailings pile covers eight acres and contains 114,000 cubic yards (cy) of tailings. The total volume of contaminated materials, including the contaminated soils beneath and around the tailings, is 185,200 cy. Elevated concentrations of gross alpha activity, molybdenum, nitrate, selenium, and uranium exceed background levels and the proposed EPA maximum concentration limits in the groundwater in the unconsolidated alluvium and in the shallow shales and limestones beneath the alluvium. This contamination is localized beneath, and slightly downgradient of, the existing tailings pile.

The principal potential hazard associated with the tailings results from the production of radon, a radioactive decay product of the radium contained in the pile. Radon, a radioactive gas, can diffuse through the pile and be released into the atmosphere where it and its radioactive decay products (radon daughters) may be inhaled by humans. Increased exposure to radon and its decay products over a long period of time will increase the probability that health effects (i.e., cancers) may develop in persons living and working near the tailings pile. Exposure to gamma

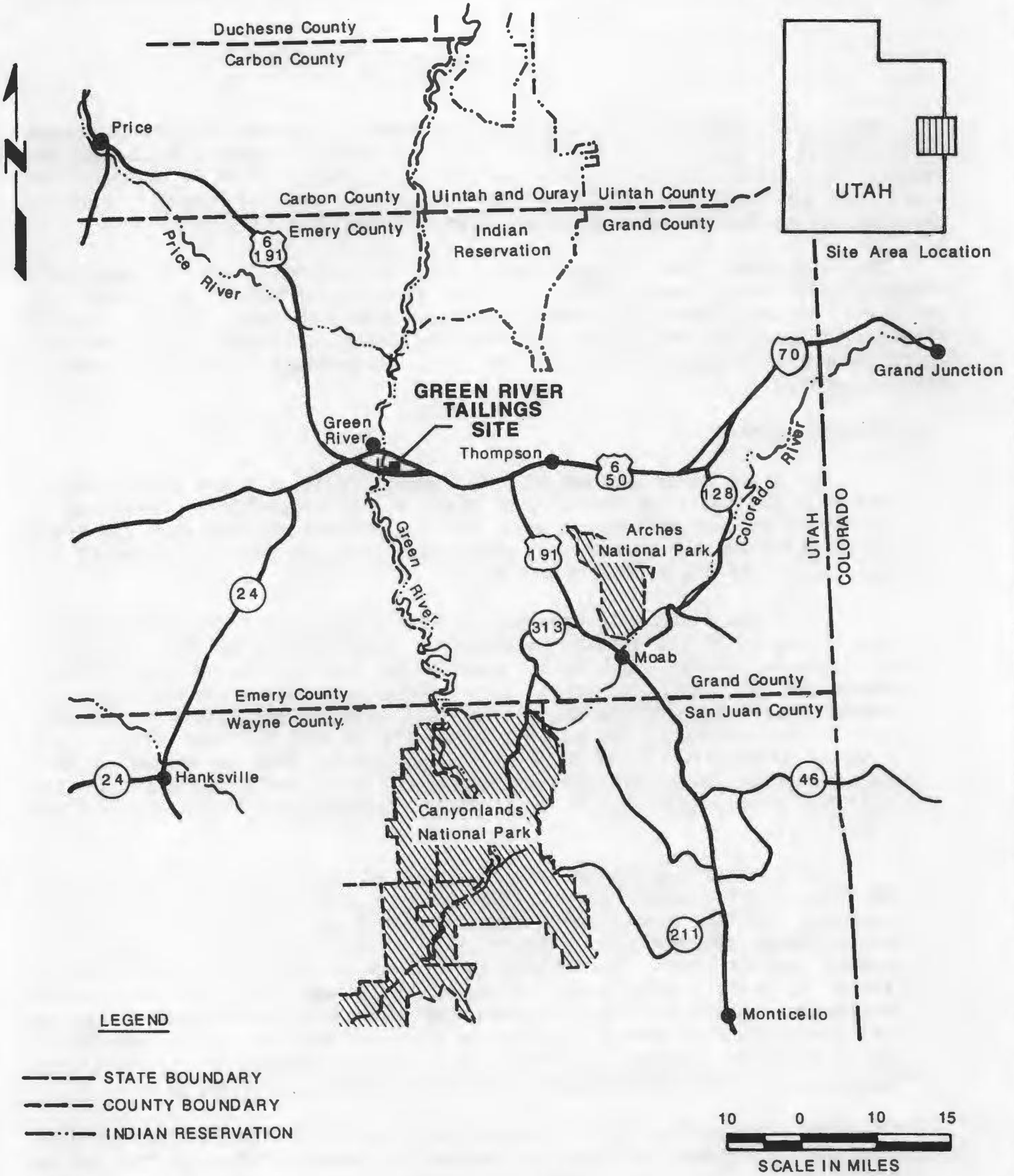


FIGURE 1.1 LOCATION OF THE GREEN RIVER, UTAH, TAILINGS SITE

radiation, the inhalation of airborne radioactive particulates, the ingestion of contaminated foodstuffs produced in the area around the tailings, and the ingestion of surface water and groundwater contaminated by the tailings also pose potential hazards. If the tailings and associated contaminated materials are not properly stabilized, erosion by wind or water or human removal of contaminated materials could spread the contamination over a much wider area and increase the potential for public health hazards.

Title I of the Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, Public Law 95-604 (PL95-604), authorized the U.S. Department of Energy (DOE) to perform remedial action at the Green River tailings site (as well as at many other sites) to reduce the potential public health impacts from the residual radioactivity remaining at the site. The UMTRCA also required the EPA to promulgate standards for remedial action at all inactive mill sites. The purpose of these standards is to protect the public health and safety and the environment from radiological and nonradiological hazards associated with residual radioactive materials at the sites. The final standards (40 CFR Part 192) were published on January 5, 1983, and became effective March 7, 1983. However, on September 3, 1985, the groundwater provisions of the regulations (40 CFR Part 192.20(a)(2)-(3)) were remanded to the EPA by the U.S. Tenth Circuit Court of Appeals. Revised standards were issued by the EPA on September 23, 1987.

Under the UMTRCA, the DOE must comply with the proposed standards until standards are promulgated in final form. Prior to the promulgation of the final standards, the DOE intends to implement the provisions of Subparts A and C to the extent reasonably achieveable within the UMTRA (Uranium Mill Tailings Remedial Action) Project regulatory framework. As a result, remedial action taken with regard to the Green River site 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 Green River uranium mill tailings site and determined that the proposed remedial action would comply with the requirements of Subpart A of the proposed EPA groundwater standards. When the 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 a separate NEPA process.

The proposed remedial action for the Green River tailings is stabilization on site. All of the tailings and other contaminated materials would be consolidated in a below-grade area 600 feet south of the existing tailings pile. The stabilized tailings pile would be contoured to have 10 percent sideslopes and a gently sloping top. The stabilized pile would be covered with one foot of compacted earth to inhibit radon emanation and water infiltration and to assure compliance with the EPA standards. The top and sides of the stabilized pile would then be covered with a five-foot-thick layer of sand, gravel, select fill, and rock for frost and erosion protection. This layer would also protect against penetration by animals and inadvertent human intrusion. A below-grade rock apron would be constructed around the stabilized pile for protection against gully intrusion. The top of the stabilized pile would have an average height of 14 feet with a maximum height of 33 feet. The area of the existing tailings pile would be backfilled, graded to promote surface drainage, and revegetated. All other areas at the site disturbed by remedial action would be backfilled and graded to promote surface drainage. All on-site buildings would be decontaminated and left intact and a fence would be constructed around the disposal site. This conceptual design is subject to change during the final design process; however, the impacts of the final design are expected to be in the range defined in this EA.

The no action alternative would consist of performing no remedial action at the tailings site. The tailings would remain in their present location and condition and would continue to be susceptible to erosion and unauthorized removal and use by man. This alternative would not be consistent with the UMTRCA (PL95-604) and would not result in compliance with the EPA standards (40 CFR Part 192).

The stabilization in place alternative would involve consolidation of all tailings and contaminated materials at the location of the existing tailings pile, which is in the floodplain of Brown's Wash. Riprap would be placed in portions of Brown's Wash to prevent bank erosion toward the stabilized pile. The stabilized pile would be recontoured and covered with compacted earth and rock similar to the proposed action. All disturbed areas at the site would be backfilled and graded to promote surface drainage. All on-site buildings would be decontaminated and left intact and a fence would be constructed around the disposal site.

1.2 IMPACT SUMMARY

This section contains a quantitative listing of the environmental impacts of the proposed action (Table 1.1) and a brief discussion of the major differences between the proposed action and the other alternatives. The impacts are assessed conservatively and represent a realistic upper limit on the severity of the potential environmental impacts of the proposed action. For the purpose of evaluating impacts and for the conceptual design, specific borrow sites were identified; however, other borrow sites may be identified during the final design process and used for the remedial action. The impacts identified for these borrow sites are conservative and represent a realistic upper limit on the severity of impacts that may occur.

All of the remedial action alternatives except no action include remedial action at the 15 vicinity properties associated with the Green River tailings site. The potential impacts of remedial action at the vicinity properties were previously assessed in a programmatic environmental report (DOE, 1985) and are not considered in this environmental assessment.

Table 1.1 Environmental impacts of the proposed action, Green River, Utah, tailings site

Component	Impacts
Remedial action worker health	0.0005 excess health effects (cancers)
Public health	0.0009 excess health effects (cancers) in first 10 years; 0.03 excess health effects in 1000 years
Mineral resources	Consumption of approximately 228,000 cubic yards of borrow materials (earth, sand, gravel, and rock)
Soils	93 acres of soils lost[a]
Water resources	Gradual reduction in existing groundwater contamination; no impacts on surface waters and existing water use
Water consumption	3,800,000 gallons[b]
Air quality (nonradiological, 24-hour maximum)	Small increase in fuel combustion pollutants; 323, 434, and 1110 micrograms per cubic meter increase in total suspended particulates for the tailings site, borrow site 1, and borrow site 2, respectively; activities at the tailings and borrow sites would cause applicable primary and secondary total suspended particulates standards to be exceeded[b]
Wildlife	Permanent loss of 23 acres of habitat
Vegetation	Permanent loss of 23 acres of vegetation
Threatened or endangered species	None anticipated[c]
Aesthetic resources	Pile visible to persons passing by but subordinate to regional view
Cultural resources	None anticipated[d]
Noise	61 dBA at the nearest residence during the day; annoyance but no hearing impacts[b]
Land use	Restricted use of nine acres; no limitation on future use of adjacent lands

Table 1.1 Environmental impacts of the proposed action, Green River, Utah, tailings site (Concluded)

Component	Impacts
Population	Short-term increase of 32 persons; an increase of approximately four percent in the 1986 population of Green River[b]
Employment	Average of 46 persons for 14 months; peak of 69 persons; indirect employment of 20 persons[b]
Social services	None anticipated
Transportation networks	A maximum increase of 13 percent in daily traffic on U.S. Highway 6&50[b]
Non-radiological accidents	An estimated 2.3 equipment-use injuries, 0.024 equipment-use fatal accidents, and 0.64 traffic accidents during the remedial action
Energy resources	Consumption of 170,000 gallons of fuel and 180,000 kilowatt-hours of electricity[b]
Construction costs (1987 dollars)	$2,950,000[e]

[a] Soils that would be permanently lost are contaminated soils (e.g., beneath and adjacent to the tailings pile) that would be consolidated with the tailings and soils that would be used to cover the consolidated tailings and contaminated materials (i.e., radon barrier).

[b] The remedial action is scheduled to last for 15 months; impacts would be greatest during the months of peak activity (months six through nine).

[c] No threatened or endangered species are known to be present at the Green River tailings site or the proposed borrow sites.

[d] A cultural resource survey of the designated Green River tailings site verified the absence of significant cultural resources at the site. No surveys were conducted at the proposed borrow sites. Prior to remedial action, site-specific surveys of the sites to be affected would be conducted to verify the absence of cultural resources at the sites.

[e] This estimate does not include the costs of: (1) property acquisition; (2) engineering design; (3) construction management; (4) overall project management; (5) long-term surveillance and maintenance; and (6) vicinity properties cleanup.

No action

Selection of the no action alternative would not be consistent with the intent of Congress in the UMTRCA (PL95-604) and would not result in compliance with the EPA standards (40 CFR Part 192). This alternative would result in the continued dispersion of the tailings over a wide area by wind and water erosion and the groundwater beneath the tailings would continue to be contaminated. The tailings would not be protected against unauthorized removal by humans, which could cause radiological contamination of other areas and thereby increase public health impacts.

Stabilization in place

Stabilization of the tailings and other contaminated materials at the existing tailings pile would result in environmental impacts similar to the proposed action. The major difference would be the generation of a lesser amount of total suspended particulates for this alternative because the tailings would not have to be moved. Also, the tailings would remain in the floodplain of Brown's Wash.

REFERENCE FOR SECTION 1.0

DOE (U.S. Department of Energy), 1985. Programmatic Environmental Report for Remedial Actions at UMTRA Project Vicinity Properties, UMTRA-DOE/AL150327.0000, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

2.0 REMEDIAL ACTION ALTERNATIVES

2.1 THE NEED FOR REMEDIAL ACTION

2.1.1 Background

In response to public concern over the potential public health hazards related to uranium mill tailings and the associated contaminated materials left abandoned or otherwise uncontrolled at inactive processing sites throughout the United States, Congress passed the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), Public Law 95-604 (PL95-604), which was enacted into law on November 8, 1978. In the UMTRCA, Congress acknowledged the potential health hazards associated with uranium mill tailings and identified 24 sites that were in need of remedial action. The Green River uranium mill tailings site is one of these sites.

Title I of the UMTRCA authorized the U.S. Department of Energy (DOE) to enter into cooperative agreements with affected states or Indian tribes to clean up those inactive sites contaminated with uranium mill tailings and required the Secretary of the DOE to designate sites to be cleaned up. Title I also required the U.S. Environmental Protection Agency (EPA) to promulgate standards for these sites and defined the role of the U.S. Nuclear Regulatory Commission (NRC).

Effective May 15, 1980, the DOE and the state of Utah entered into a cooperative agreement under the UMTRCA. This agreement was modified on March 14, 1983. The cooperative agreement set forth the terms and conditions for the DOE and state of Utah cooperative remedial action efforts including the DOE's development of a remedial action plan (concurred in by the state of Utah), the DOE's preparation of an appropriate environmental document, real estate responsibilities, and other concerns.

The EPA published an environmental impact statement (EIS) (EPA, 1982) on the development and impacts of the standards (40 CFR Part 192) and issued final standards (48 FR 590-604) that became effective on March 7, 1983. In developing the standards, the EPA determined "that the primary objective for control of tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces" and that "a secondary objective should be to reduce the radon emissions from the piles." A third objective should be "the elimination of significant exposure to gamma radiation from tailings piles." The EPA standards are summarized in Table 2.1; more detailed discussions of the EPA standards are provided in Appendix A, EPA Standards, of the Environmental Assessment of Remedial Action at the Shiprock Uranium Mill Tailings Site, Shiprock, New Mexico (DOE, 1984a) and the Plan for Implementing EPA Standards for UMTRA Sites (DOE, 1984b).

PART 192 - HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

SUBPART A - Standards for the Control of Residual Radioactive Materials from Inactive Processing Sites

192.02 Standards

Control shall be designed to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average release rate of 20 picocuries per square meter per second, or
(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

SUBPART B - Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than -

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and
(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building -

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and
(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

SUBPART C - Implementation (condensed)

192.20 Guidance for Implementation

Remedial action will be performed with the "concurrence of the Nuclear Regulatory Commission and the full participation of any state that pays part of the cost" and in consultation as appropriate with other government agencies.

192.21 Criteria for Applying Supplemental Standards

The implementing agencies may apply standards in lieu of the standards of Subparts A or B if certain circumstances exist, as defined in 192.21.

192.22 Supplemental Standards

"Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of 192.21."

(a) ". . .the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standards as is reasonable under the circumstances."

(b) ". . .remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable."

(c) "The implementing agencies may make general determinations concerning remedial actions under this Section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this Section for a specific location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies [and] shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section."

Ref: Federal Register, Volume 48, No. 3, January 5, 1983, 40 CFR Part 192.

TABLE 2.1 EPA STANDARDS

The tailings are the residue of uranium ore processing operations and are finely-ground rock, much like sand. The principal potential hazard associated with the tailings results from the production of radon, a radioactive gas, from the radioactive decay of the radium contained within the tailings. Radon can move through the tailings into the air. Increased exposure to radon and its decay products over a long period of time will increase the probability that health effects (i.e., cancers) may develop in persons living and working near the tailings.

Exposure to gamma radiation, the inhalation and ingestion of airborne radioactive particulates, the ingestion of contaminated food produced in the areas around the tailings, and the ingestion of surface water and groundwater contaminated by the tailings also pose lesser potential hazards. If the tailings and the associated contaminated materials are not properly stabilized, natural processes such as wind and water erosion or removal of the materials by man could spread the contamination and increase the potential public health hazards.

On January 5, 1983, the EPA promulgated final standards for the disposal site and cleanup of the inactive uranium processing sites under the UMTRCA (48 FR 590). However, on September 3, 1985, the groundwater provisions of the regulations (40 CFR Part 192.20 (a)(2)-(3)) were remanded to the EPA by the U.S. Tenth Circuit Court of Appeals. Revised standards were issued by the EPA on September 23, 1987.

In response to the Court's remand, the newly proposed EPA groundwater standards involve:

- Protection of human health, safety, and the environment.
- Consideration of radiological and nonradiological hazards.
- Consistency with the requirements of the Resource Conservation and Recovery Act (RCRA), as amended.
- General standards applicable to all UMTRA Project sites (i.e., not site-specific as was the case for the remanded standards).

These items are discussed below.

Subpart A, (40 CFR Part 192.01-192.02) consists of the requirements for control of potential contaminant releases to the groundwater at disposal sites. It incorporates the following:

- RCRA list of hazardous constituents (40 CFR Part 264.93).
- RCRA maximum concentration limits (MCLs) (40 CFR Part 264.94), background limits, or alternate concentration limits (ACLs). The establishment of ACLs must be concurred

in by the NRC, be as low as reasonably achievable (ALARA), and satisfy the water-quality protection considerations stipulated in 40 CFR 264.94(b).

- RCRA point of compliance (40 CFR Part 264.95).
- Four hazardous constituents and associated MCLs (molybdenum, radium, uranium, and nitrate) are added to those taken from the drinking water standards. (Note: an MCL for an additional constituent, gross alpha, is included separately and without discussion in Subpart A.)
- A liner or equivalent beneath the disposal site if tailings contain excess water (40 CFR Part 192.20).
- Monitoring during a post-remedial-action period to verify design performance.
- Corrective action to be initiated within 18 months after monitoring indicates or projects an exceedance of the applicable concentration limits.

Subpart B, (40 CFR Part 192.11-192.12) lists the standards applicable for remediating contaminated groundwater. It incorporates:

- Cleanup of the listed groundwater constituents to levels specified in Subpart A.
- Extension of the remedial period to allow for natural flushing if:
    - The groundwater is not, and is not projected to be, a public drinking water source.
    - Institutional controls will effectively protect health and satisfy other beneficial uses.
    - Concentration limits (40 CFR Part 264.94) will be met in less than 100 years.

Subpart C, (40 CFR Part 192.20-192.22) addresses supplemental standards applicable to Subparts A and B. The supplemental standards provide for alternative actions which come as close to the standards "as reasonable under the circumstances." NRC concurrence in the application of supplemental standards is required. The supplemental standards may be applied if protection of human health and the environment is assured (40 CFR Part 192.22(d)) and:

- The proposed action would cause more environmental harm than it would prevent (40 CFR Part 192.21(b)), or
- Restoration is technically impracticable from an engineering perspective (40 CFR Part 192.21(f)), or

o The groundwater is Class III (40 CFR Part 192.21(g)).

All remedial actions performed under the UMTRCA must be performed in accordance with the EPA standards and with the concurrence of the NRC. The NRC has not and does not intend to issue regulations applicable to the remedial actions at the inactive uranium processing sites but will issue a general license for all sites and will concur in site-specific surveillance and maintenance plans. The NRC concurrence in a site-specific surveillance and maintenance plan will render a site licensed. The final plan will contain the site-specific surveillance and maintenance program, legal description of the site, site ownership, subsurface mineral ownership, and reporting and record keeping requirements.

2.1.2 The remedial action process

The remedial action process for the Green River uranium mill tailings site began with site characterization and will conclude with long-term surveillance and maintenance. Preliminary radiological investigations and engineering assessments have been completed and published. Currently, related studies that address the site-specific engineering concepts, surveillance and maintenance requirements, and licensing are under preparation.

2.1.3 The Green River tailings site

The Green River uranium mill tailings site is in Grand County, Utah, one mile southeast of the city of Green River and 0.5 mile south of U.S. Highway 6&50 (U.S. 6&50). The site is in the Gunnison Valley; this valley is bordered on the north by the Book Cliffs and on the south by the San Rafael Valley. The area contains cliffs, mesas, and the Gray Canyon of the Green River. The climate of the area is arid with average annual precipitation of six inches. Vegetation in the immediate site area consists of species common to the arid desert environment (e.g., greasewood, saltbush, rabbitbrush, Indian ricegrass, and galleta grass).

A portion of the tailings site is in the 100-year and 500-year floodplains of Brown's Wash, an intermittent tributary of the Green River which flows southward and discharges into the Colorado River 60 air miles south of the city of Green River. The tailings site is bordered by a mainline track of the Denver and Rio Grande Western (D&RGW) Railroad on the north and Interstate Highway 70 (I-70) on the south (Figure 2.1). The elevation above mean sea level at the site varies from 4064 feet along Brown's Wash to 4144 feet in the ore storage area southeast of the mill yard.

The mill at the Green River site was built in 1957 by Union Carbide Corporation, which operated the mill from 1958 until 1961. During the three years of milling operations, 183,000 tons of ore averaging 0.29 percent uranium oxide (U_3O_8) were

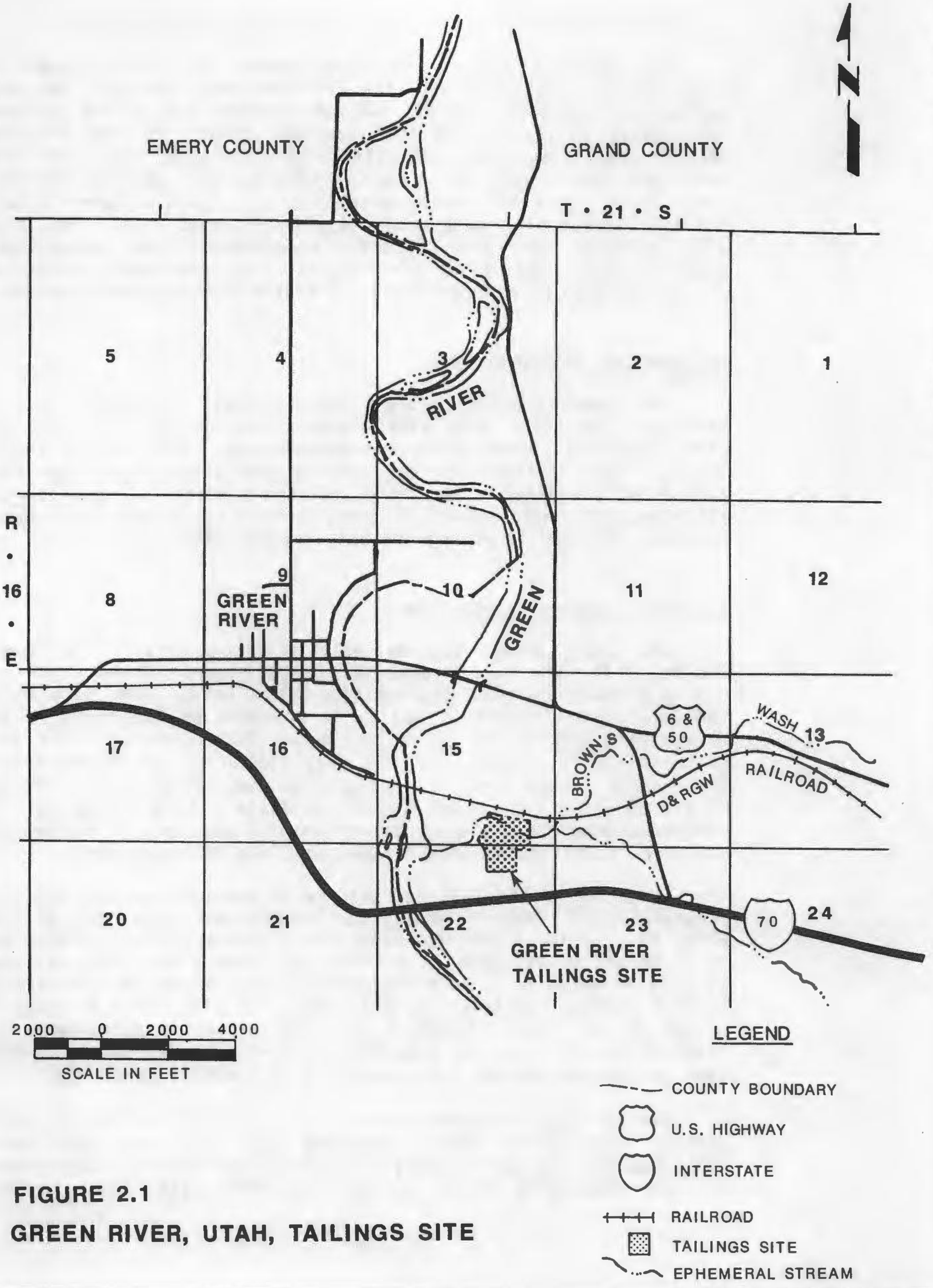


FIGURE 2.1

GREEN RIVER, UTAH, TAILINGS SITE

processed. Remaining at the site are the tailings pile, several buildings, and a water tower (Figure 2.2). The tailings pile occupies eight acres of the 48-acre designated site and contains 114,000 cubic yards (cy) of tailings. The total volume of contaminated materials, including the tailings and soils beneath and around the tailings, is estimated to be 185,200 cy. Elevated concentrations of gross alpha activity, molybdenum, nitrate, selenium, and uranium exceed background levels and the proposed EPA MCLs in groundwater in the unconsolidated alluvium and in the shallow shales and limestones beneath the alluvium. This contamination is localized beneath, and slightly downgradient of, the existing tailings pile.

2.1.4 The purpose of this document

This environmental assessment (EA) is prepared pursuant to the NEPA, which requires Federal agencies to assess the impacts that their actions may have on the environment. The EA examines the short-term and long-term effects of the DOE's proposed remedial action for the Green River tailings site. The no action and stabilization in place alternatives are also examined.

The DOE will use the information and analyses presented here to determine whether the proposed action would have a significant impact on the environment. If the impacts are determined to be significant, an EIS will be prepared. If the impacts are not judged to be significant, the DOE will issue a Finding of No Significant Impact (FONSI) and implement the proposed action. The procedures and documents are defined in regulations issued by the Council on Environmental Quality (CEQ) in 40 CFR Parts 1500 through 1508.

The proposed action and stabilization in place alternatives would include remedial action at the vicinity properties associated with the tailings site. Vicinity properties are properties that are outside a designated tailings site boundary and that may have been contaminated by tailings dispersed by wind or water erosion or by removal by man before the potential hazards of the tailings were known. There are 15 vicinity properties associated with the Green River tailings site. The potential environmental impacts of remedial actions at these vicinity properties were previously assessed in a programmatic environmental report (DOE, 1985) and are therefore not considered in this environmental assessment.

Section 2.0 of this document describes the proposed action and the alternatives to it. Section 3.0 discusses the present condition of the environment. Section 4.0 assesses the environmental impacts of the proposed action and the alternatives. Further details of the studies on which this document is based are contained in the appendices at the end of this document and in the referenced supporting documents.

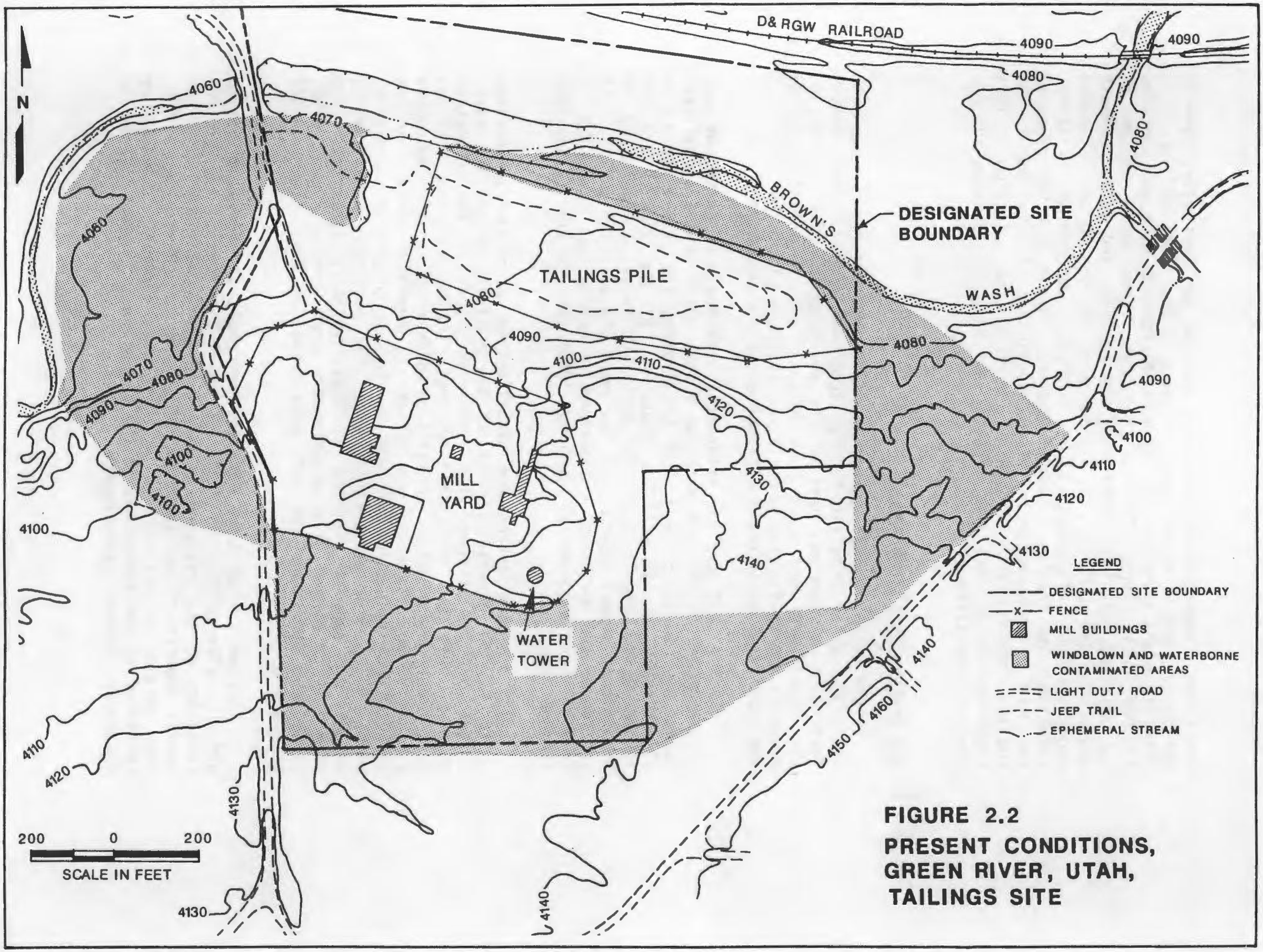


FIGURE 2.2
PRESENT CONDITIONS, GREEN RIVER, UTAH, TAILINGS SITE

2.2 THE PROPOSED ACTION--STABILIZATION ON SITE

The proposed action for the Green River tailings site is stabilization on site, which would involve relocation of the tailings to an area south of the present location. The tailings and other contaminated materials from beneath and around the existing tailings pile would be consolidated in a below-grade area. The stabilized pile would be covered with a layer of compacted earth (radon/infiltration barrier) to inhibit radon emanation and water infiltration. A layer of select fill would be placed over this layer to protect it from frost action. A rock erosion protection barrier would be placed over the stabilized pile to inhibit wind and water erosion, penetration by plants and burrowing animals, and human intrusion. Various other erosion control measures would be taken to assure the long-term stability of the stabilized tailings pile.

The conceptual design for stabilization on site will comply with the EPA standards. The remedial action would be performed using conventional construction practices and techniques that would comply with applicable regulations (Appendix E, Permits, Licenses, and Approvals) and that would assure the safe and environmentally sound stabilization of the tailings and other contaminated materials. The objectives and details of the conceptual design are provided in Appendix A, Conceptual Designs, and in the draft Remedial Action Plan (DOE, 1988). The major design features are summarized in the following sections.

2.2.1 Description of final conditions

The proposed action for the Green River tailings is stabilization on the site. All tailings and contaminated materials would be removed from the floodplain of Brown's Wash and placed in an excavated area 600 feet south of the existing tailings pile (Figure 2.3). The below-grade excavation would average 14 feet deep, extending to a maximum of 20 feet below the existing surface (Figure 2.4). The base of the excavation would be 50 feet above the streambed of Brown's Wash.

The relocated pile would have sideslopes of 10 percent (10 horizontal to one vertical) and a topslope of five percent. The cover system (Figure 2.5) would be comprised of five components: (1) a rock cover (riprap) to prevent surface erosion, penetration by animals, and inadvertent human intrusion; (2) a sand bedding layer to prevent piping of fine-grained material through the rock cover and promote runoff of precipitation; (3) a layer of select fill to protect the radon/infiltration barrier from frost action; (4) a filter layer to promote drainage of infiltration through the overlying layers; and (5) a radon/infiltration barrier. The radon/infiltration barrier would be constructed of silty clay taken from a local alluvial borrow source, amended with sodium bentonite (three percent), and then compacted to assure that the hydraulic conductivity (K) of the barrier is 10^{-7} cm/s to inhibit the infiltration of precipitation through the barrier and diminish the rate of seepage through the bottom of the stabilized

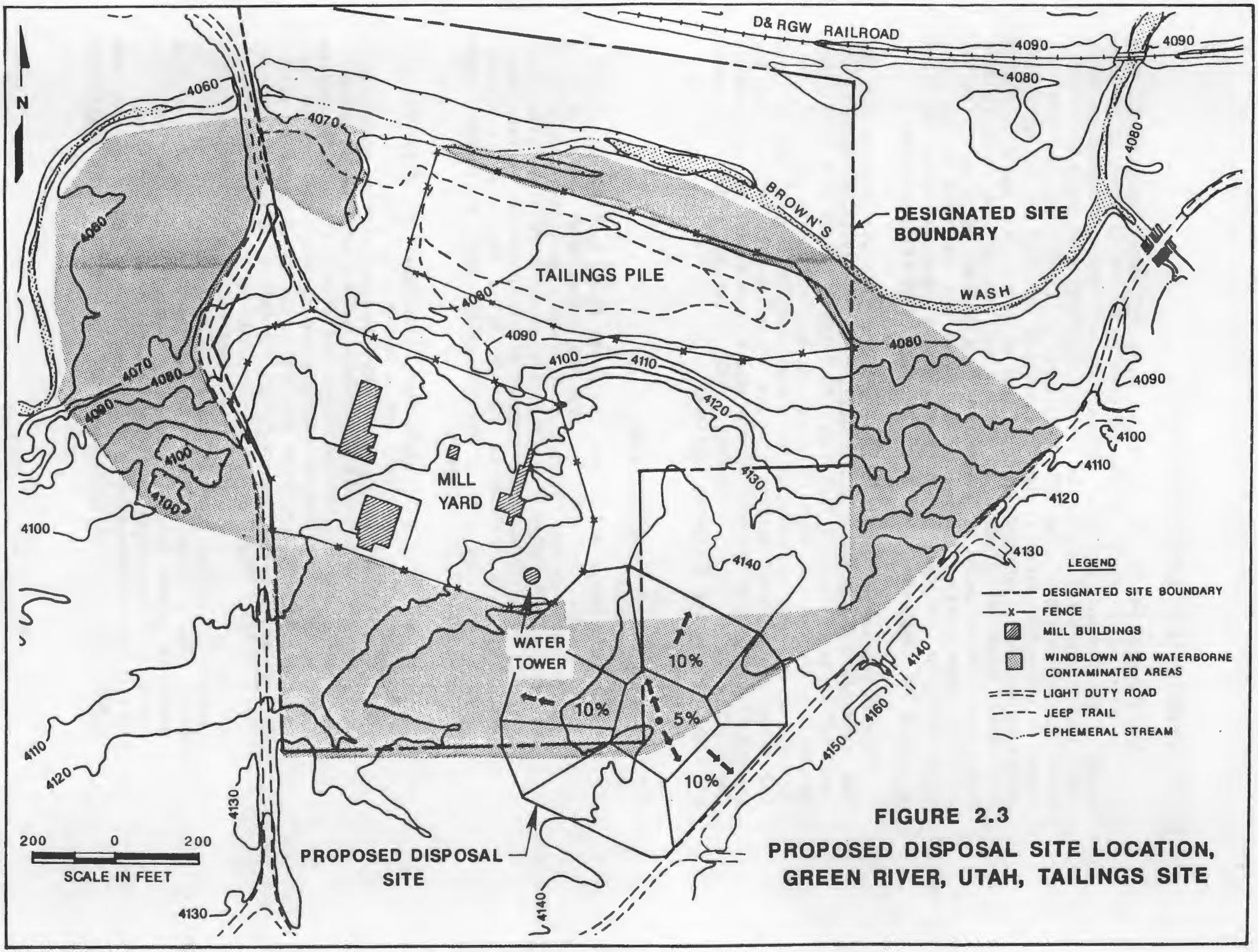
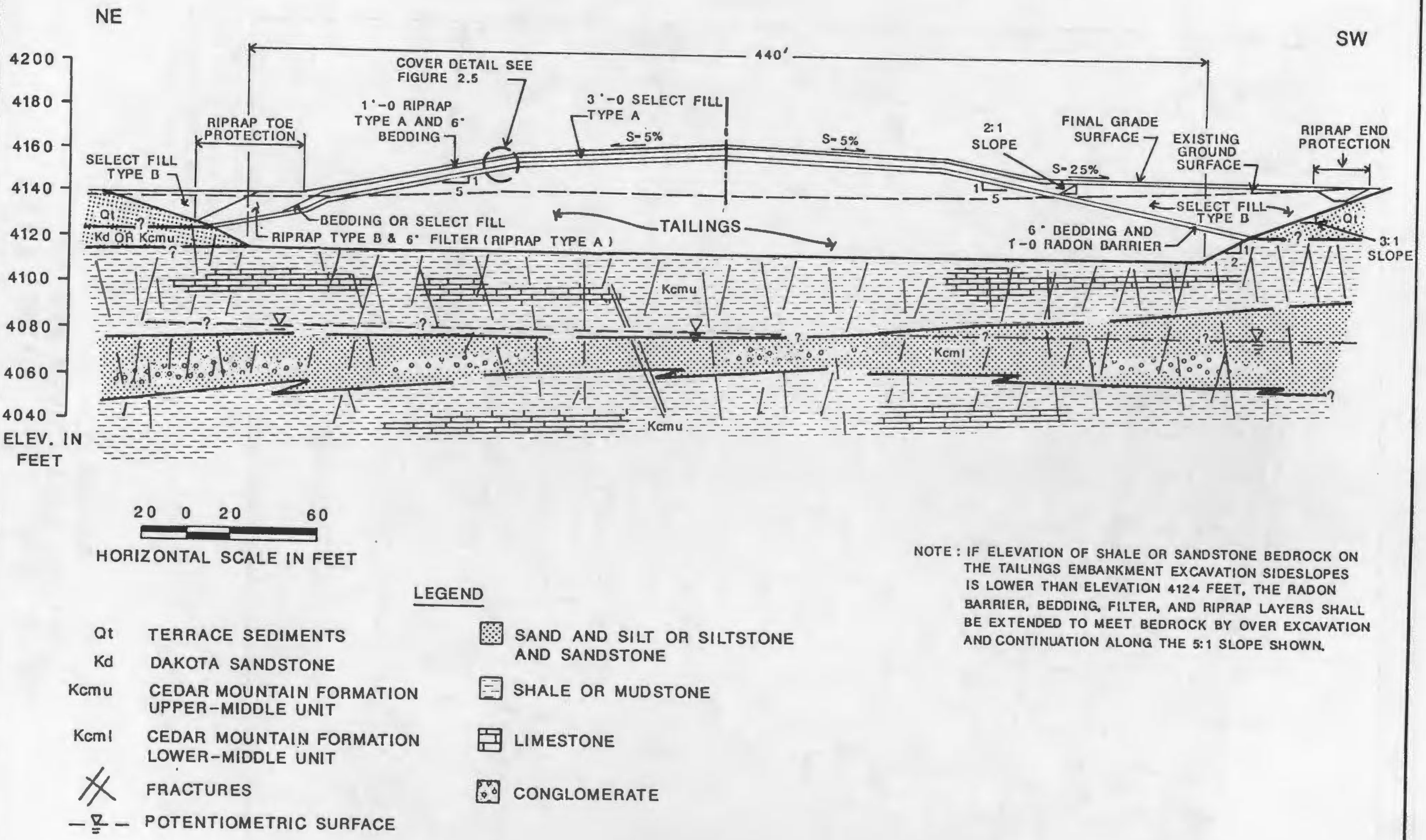


FIGURE 2.3

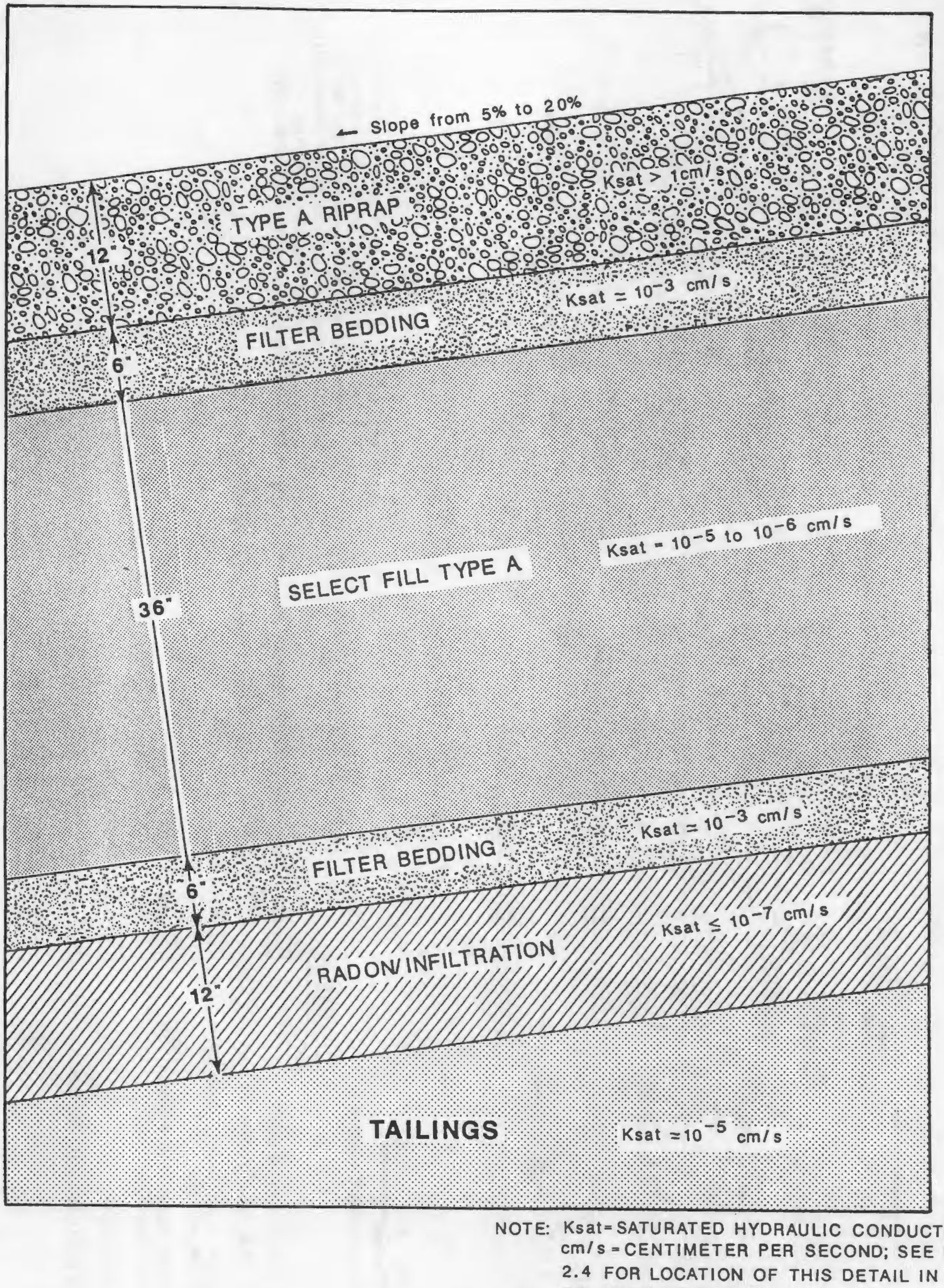
PROPOSED DISPOSAL SITE LOCATION, GREEN RIVER, UTAH, TAILINGS SITE



NOTE: IF ELEVATION OF SHALE OR SANDSTONE BEDROCK ON THE TAILINGS EMBANKMENT EXCAVATION SIDESLOPES IS LOWER THAN ELEVATION 4124 FEET, THE RADON BARRIER, BEDDING, FILTER, AND RIPRAP LAYERS SHALL BE EXTENDED TO MEET BEDROCK BY OVER EXCAVATION AND CONTINUATION ALONG THE 5:1 SLOPE SHOWN.

FIGURE 2.4

DIAGRAMMATIC CROSS SECTION OF PROPOSED DISPOSAL CELL AND FOUNDATION GREEN RIVER, UTAH, TAILINGS SITE



NOTE: Ksat = SATURATED HYDRAULIC CONDUCTIVITY; cm/s = CENTIMETER PER SECOND; SEE FIGURE 2.4 FOR LOCATION OF THIS DETAIL IN RELATION TO THE DISPOSAL CELL.

FIGURE 2.5
DISPOSAL CELL COVER SYSTEM
GREEN RIVER, UTAH, TAILINGS SITE

pile. The barrier would also inhibit the emanation of radon to ensure compliance with the EPA standards.

The stabilized tailings pile would be surrounded by a below-grade, tapered rock apron. The rock apron would be keyed to bedrock to protect against gully intrusion on the northeast and west sides of the pile. The apron would be seven feet wide and 10 feet deep along these sides. The remainder of the apron would be three feet wide and would extend four feet below the base of the pile. The roughly square tailings pile would cover eight acres, measuring 600 feet along each side. The stabilized pile would rise a maximum of 33 feet, averaging 14 feet, above the surrounding terrain.

All buildings and facilities on the site would be decontaminated and left intact after remedial action. The area of the existing tailings pile would be restored with uncontaminated fill from the disposal site excavation, graded to promote surface drainage, and revegetated. All other areas at the site disturbed by the remedial action would be backfilled with uncontaminated fill from the disposal site excavation and graded to promote surface drainage.

The disposal site would extend outside of the designated site boundary by six acres. The final restricted area would cover nine acres and would be enclosed by a fence. Forty-five acres of the 48-acre designated site would then be released for any use consistent with existing land use controls following completion of remedial action. The conceptual design is subject to change during the final design process.

2.2.2 Major construction activities

The major construction activities for stabilization of the tailings on the site would be upgrading access roads to the tailings and borrow sites, site preparation, decontamination of existing structures, construction of drainage control measures, excavation of the disposal area, excavation of borrow materials, consolidation of all tailings and contaminated materials, placement of cover materials onto the tailings and other contaminated materials, and restoration of the disturbed area at the site including the area of the existing tailings pile.

Construction of the stabilized tailings pile would require the use of borrow materials (earth, sand, gravel, and rock). For the purposes of evaluating impacts and for the conceptual design, specific borrow sites for radon barrier and erosion protection materials were identified; however, other borrow sites may be identified during the final design process and used for the remedial action. The impacts identified for these borrow sites are conservative and represent a realistic upper limit on the severity of impacts that may occur. Borrow site 1 is 3.5 road miles north of the tailings site (Figure 2.6); this borrow site

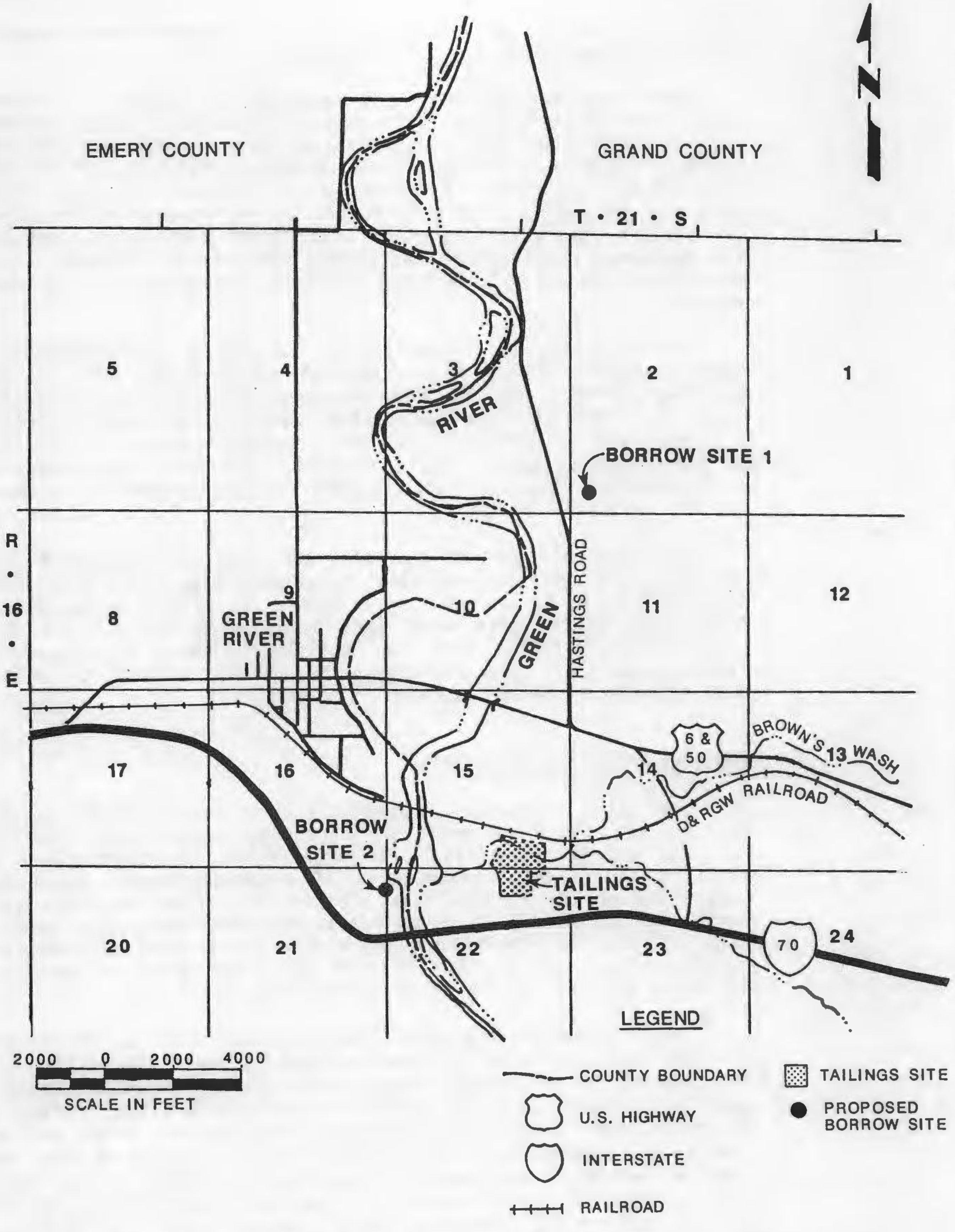


FIGURE 2.6 LOCATIONS OF PROPOSED BORROW SITES FOR THE GREEN RIVER, UTAH, TAILINGS SITE

would be the source of fine-grained earthen material for the radon/infiltration barrier. Sand and gravel for the filter and bedding layers, and materials to upgrade existing access roads would also be obtained from borrow site 1. Borrow site 2 is across the Green River five road miles from the tailings site (Figure 2.6) and would be used as the source of rock for erosion protection. Sufficient quantities of uncontaminated fill would be available from the excavation of the below-grade disposal site to provide the required amount of material necessary to construct the select fill layer (see Table 2.2). Earthen material for the floodplain and mill yard restoration would be obtained from the excavation of the disposal area.

It is estimated that stabilization on site would be completed in 15 months. This would involve 14 months of actual construction; the last month would involve limited personnel on the site and no equipment use.

2.2.3 Construction estimates

A summary of preliminary estimates of equipment and personnel requirements, energy and water consumptions, volumes of materials, and construction costs for the proposed action are presented in Table 2.2. The details of these estimates are contained in Section A.2.5 of Appendix A.

2.3 OTHER ALTERNATIVES

2.3.1 No action

The no action alternative consists of taking no steps toward remedial action at the Green River tailings site. The tailings pile would remain in its present condition and would continue to be subject to dispersion by wind and water erosion and unauthorized removal by man. The selection of this alternative would not be consistent with the intent of Congress in the UMTRCA (PL95-604) and would not result in compliance with the EPA standards (40 CFR Part 192).

2.3.2 Stabilization in place

Under the stabilization in place alternative, all of the tailings and other contaminated materials would be consolidated and stabilized at the location of the existing tailings pile, which is in the floodplain of Brown's Wash. Riprap would be placed on portions of Brown's Wash to prevent bank erosion toward the stabilized tailings pile. The pile would be recontoured and covered with compacted earth and rock similar to the proposed action. The design objectives for stabilization in place would be identical to those selected for the proposed action (Section A.1.2 of Appendix A).

Table 2.2 Summary of construction estimates for the proposed action, Green River, Utah, tailings site[a]

Equipment requirements	
Total equipment months	258
Average pieces of equipment per month	18
Personnel requirements	
Peak employment	69
Total man months	637
Average employment	46
Energy and water consumptions	
Total fuel consumption (gallons)	170,000
Total electric consumption (kilowatt hours)	180,000
Total water consumption (gallons)	3,800,000
Major earthwork volumes (estimated in-place cubic yards)[b]	
Site preparation	57,300
Tailings relocation/pile construction	435,200
Radon/infiltration barrier	85,000
Layer of select fill	16,000
Erosion protection barrier	85,000
Site restoration	213,000
Construction cost	
Total estimated cost (1987 dollars)	$2,950,000

[a] Estimates are based on 14 months of construction.

[b] For a more detailed breakdown see Table A.2.5, Appendix A, Conceptual Designs.

The final stabilized tailings pile would be the same size (8 acres) as that of the proposed action, but slightly less acreage would be disturbed during this alternative. Acreage outside the designated site boundary would not be required for the stabilized tailings pile. This alternative would require the same major construction activities as the proposed action except for the additional riprap that would be placed in portions of Brown's Wash to retard bank erosion toward the stabilized pile. As with the proposed action, all on-site buildings would be decontaminated and a fence would be constructed around the stabilized pile. It is estimated that this alternative would take 15 months. This would involve 14 months of actual construction; the last month would involve limited personnel on the site and no equipment use.

2.4 ALTERNATIVES ELIMINATED FROM DETAILED STUDY

Alternate disposal sites

Four alternate disposal sites (Figure 2.7) were evaluated on the basis of hydrology, meteorology, proximity to the tailings, on-site inspections, and economics (FBDU, 1981). All four sites are located on the Mancos Shale Formation, which is generally characterized by low-permeability shale and more permeable overlying alluvium and pediment areas. Placement of the tailings on the shale of the Mancos Shale Formation would probably result in excellent hydrologic isolation; placement on the alluvium or pediment would require lining the disposal site with finer-grained materials. Although the tailings could be stabilized at any of the four sites, these alternatives were eliminated due to the higher costs involved (principally for transporting the tailings a greater distance). Also, the relocation of tailings to any of the four sites would result in greater short-term impacts (e.g., air, noise), there would be no gain in long-term benefits (i.e., the long-term health effects and groundwater contamination would be the same as the proposed action). Furthermore, the proposed action (stabilization on site) meets the EPA standards.

Disposal at Atlas Mill, Moab, Utah

Moving the tailings and associated contaminated materials to the Atlas Mill tailings pile at Moab, Utah, 50 miles southeast of the Green River site, was considered (FBDU, 1981). The Atlas Mill tailings pile is part of a uranium processing facility that is under active NRC license and has not been approved for reclamation. The costs to the Federal government and state of Utah for relocation of the tailings and other contaminated materials to the active site would be much higher than the proposed action or the stabilization in place alternative. The relocation to Atlas Mill would also result in greater short-term impacts (e.g., air, noise); there would be no significant gain in long-term benefits (i.e., the long-term health effects and groundwater contamination would be the same as the proposed action). Moving the tailings to the Atlas Mill site was therefore not considered in this EA.

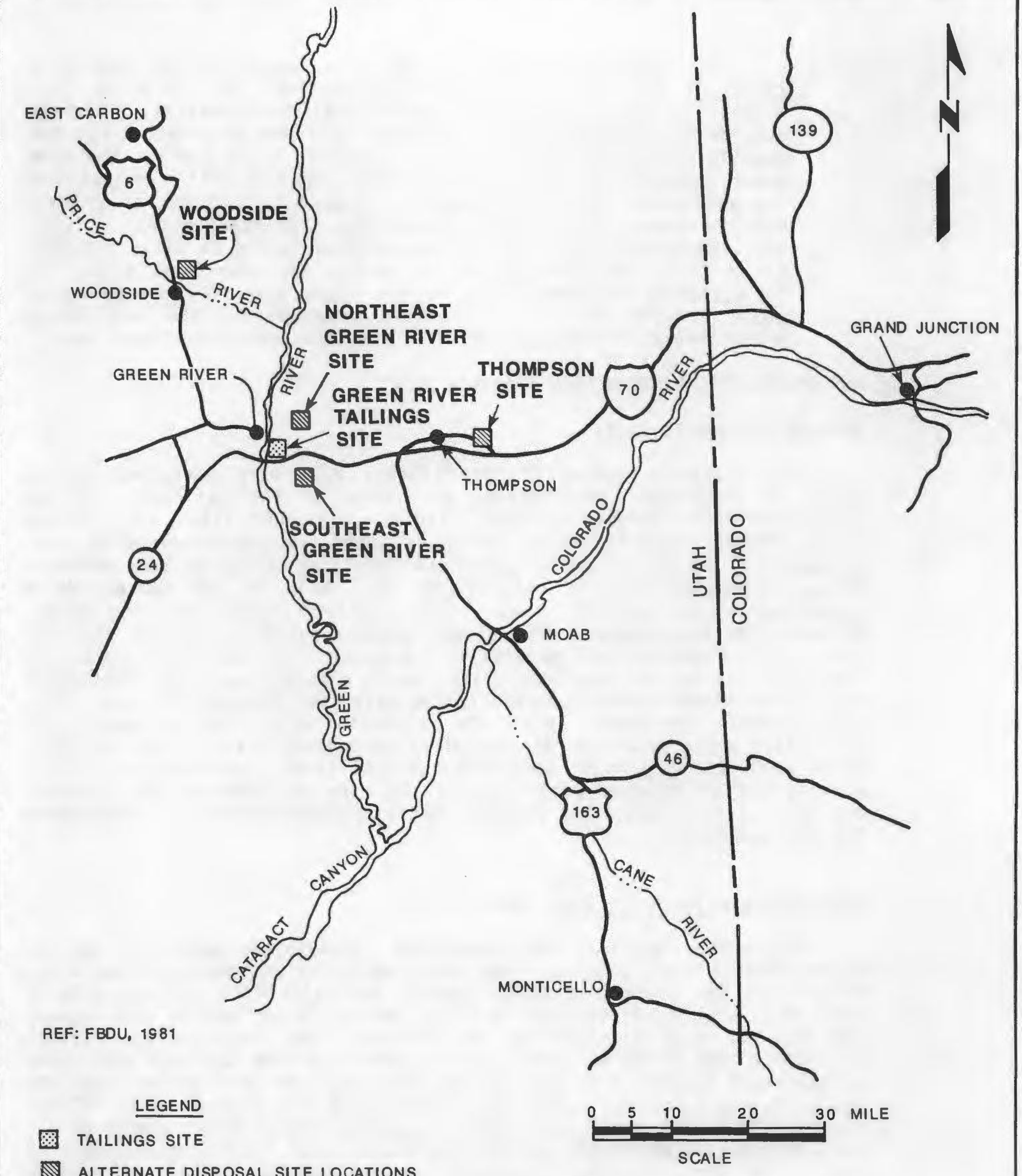


FIGURE 2.7
ALTERNATE DISPOSAL SITE LOCATIONS
FOR THE GREEN RIVER, UTAH, TAILINGS

Reprocessing the tailings

The feasibility of reprocessing the tailings to recover uranium and vanadium was evaluated by FBDU (1981); there are no other metals present in appreciable concentrations in the tailings. The evaluation concluded that reprocessing the tailings would not be practicable. Even if the uranium or vanadium could be recovered, the operating costs would be greater than the market prices for these metals. Reprocessing was therefore not considered in this EA.

REFERENCES FOR SECTION 2.0

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FBDU (Ford, Bacon & Davis Utah Inc.), 1981. Engineering Assessment of Inactive Uranium Mill Tailings, Green River Site, Green River, Utah, DOE-UMT-0144, FBDU 360-14, UC-70, prepared by FBDU, Salt Lake City, Utah, for the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

3.0 AFFECTED ENVIRONMENT

3.1 DESCRIPTION OF THE GREEN RIVER URANIUM MILL TAILINGS SITE

The mill at the Green River site was built in 1957 by Union Carbide Corporation and operated from March, 1958, through January, 1961, as an upgrader for ores from the Temple Mountain uranium mines 40 miles to the southwest. During the three years of operation, the mill processed 183,000 tons of ore averaging 0.29 percent uranium oxide (U_3O_8), producing an ore concentrate which was shipped by rail to the company's processing plant in Rifle, Colorado. There are 114,000 cubic yards (cy) of tailings at the Green River site.

When the Green River mill was shut down in January, 1961, the plant equipment was dismantled but the buildings were left intact. Union Carbide then leased the site to Celesco, a company under contract with the U.S. Department of Defense, which used some of the buildings for missile testing and assembly. Celesco has since halted operations at the site. Union Carbide (now UMETCO) still owns the site and buildings which are currently vacant but leased for use to the city of Green River.

The surface of the tailings pile was covered with a six-inch layer of earthen material in 1967. Since placement, this cover has eroded in places. Riprap and ditches were placed around the north and east edges of the pile to prevent water runoff into Brown's Wash which parallels the northern portion of the site (FBDU, 1981). The 48-acre designated site consists of the tailings pile (eight acres), the mill yard and ore storage area (21 acres), four main buildings, a water tower, and several small buildings. The buildings are structurally sound; radiological surveys indicate low levels of surface contamination inside the buildings. Access to the mill yard is restricted by a six-foot-high security fence with locked gates. The tailings pile is also fenced to restrict vehicle and livestock access; pedestrian traffic is not restricted. The remainder of the site is not fenced and access is not restricted. Radiation warning signs are posted on the fences at the site.

Dispersion of the tailings by wind and water erosion has contaminated 64 acres of which 40 (including the mill yard and ore storage area) and 24 acres are inside and outside of the designated site, respectively. The total volume of contaminated materials, including the tailings and underlying soils, is estimated to be 185,200 cy. Elevated concentrations of amonium, gross alpha activity, molybdenum, nitrate, selenium, and uranium exceed background and the proposed EPA maximum concentration limits in the groundwater in the unconsolidated alluvium and in the shallow shales and limestones beneath the alluvium. This contamination is localized beneath, and slightly downgradient of, the existing tailings pile.

3.2 WEATHER

The climate in the Green River area is arid with large ranges in daily and annual temperatures. Local weather information is available from a weather station in the city of Green River. Table 3.1 provides data on daily, monthly, and annual temperatures for the period 1951 through 1980. For the period of record, annual temperatures average 52°F with a range from 23°F in January to 78°F in July. June, July, and August were the warmest months with average maximum temperatures of 90° to 96°F while the coldest months of December and January had average maximum temperatures of 41°F and 37°F, respectively. Temperature extremes were a minimum of -25°F in January of 1979 and a maximum of 107°F in August of 1979. In July and August an average of 24 to 29 days per month had maximum temperatures above 90°F; from November through March 24 to 31 days per month had an average minimum temperature of 30°F or lower (NOAA, 1981).

Table 3.1 Average monthly temperature data for the period 1951 through 1980, Green River, Utah

	Temperature (°F)				
	Average			Extreme	
Month	Daily maximum	Daily minimum	Monthly	Highest recorded	Lowest recorded
January	37	9	23	65	-25
February	48	18	33	71	-19
March	58	26	42	81	6
April	69	35	52	88	15
May	79	44	62	97	23
June	90	51	71	105	35
July	96	61	78	106	41
August	93	57	75	107	39
September	85	46	65	101	25
October	71	35	53	90	12
November	54	23	38	74	-6
December	41	13	27	65	-16
Annual	68	35	52	107	-25

Ref. NOAA, 1981.

The average annual precipitation at Green River was six inches for the period 1951 through 1980; this includes an average annual snowfall of 10 inches (Table 3.2). The amount of rainfall was fairly evenly distributed throughout the year (typically 0.3 to 0.5 inch per month); however, August through September experienced slightly higher amounts of precipitation (0.6 to 0.8 inch per month). The highest daily rainfall during 1951 through 1980 was 1.3 inches in August, 1965, and in September, 1961. Such summer rains typically occur as thunderstorms that are limited in extent but can produce flash floods. The maximum snowfall occurred in January followed by February and December. The maximum monthly snowfall of 26 inches occurred in January, 1979 (NOAA, 1981).

Table 3.2 Precipitation data for the period 1951 through 1980, Green River, Utah

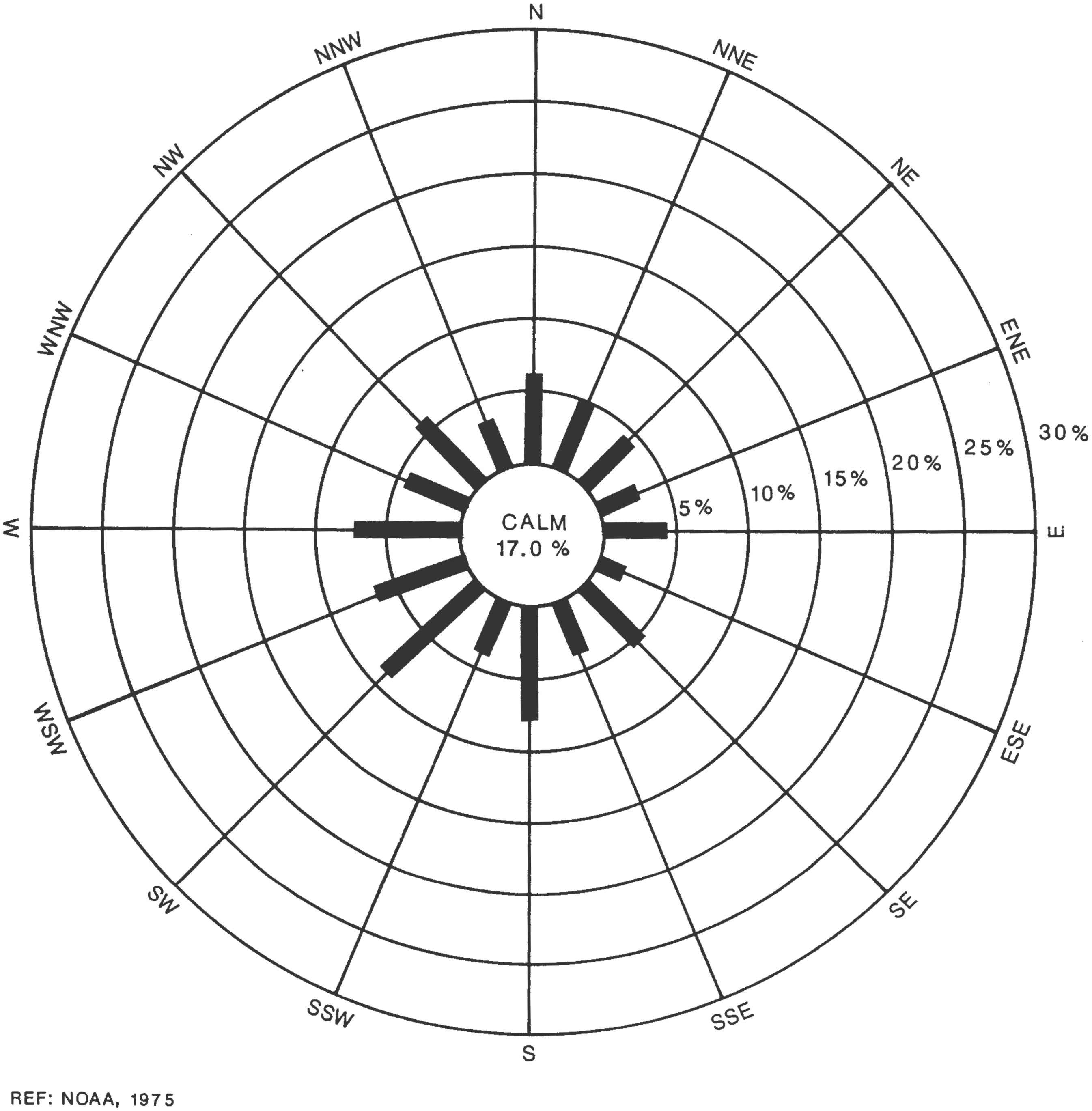
	Precipitation (inches)			Snowfall (inches)	
Month	Average	Greatest monthly	Greatest daily	Average	Greatest monthly
January	0.4	1.7	0.5	4.0	26.0
February	0.4	1.3	0.5	2.0	17.0
March	0.5	2.6	0.9	0.6	5.0
April	0.5	1.2	0.6	0.0	0.3
May	0.6	2.1	1.2	0.0	0.0
June	0.3	1.8	0.7	0.0	0.0
July	0.4	1.3	1.1	0.0	0.0
August	0.8	2.8	1.3	0.0	0.0
September	0.6	3.4	1.3	0.0	0.0
October	0.8	4.4	1.0	0.1	2.0
November	0.5	2.0	0.8	0.5	4.0
December	0.4	1.3	0.8	2.8	12.7
Annual	6.2	4.4	1.3	10.0	26.0

Ref. NOAA, 1981.

Wind measurements at Green River for the period 1962 through 1971 indicated that wind speeds were calm to three miles per hour 52 percent of the time and four to seven miles per hour 31 percent of the time. High winds of 19 to 38 miles per hour were relatively uncommon, occurring only two percent of the time (NOAA, 1975). The strongest winds are likely to occur during the months of March through June (DOE, 1983). No single wind direction dominated the wind flow pattern at Green River for the period between 1962 through 1971 (Figure 3.1). Winds were most frequently from the southwest (8.4 percent) followed by the south (7.7 percent) and west (7.3 percent) (NOAA, 1975).

3.3 AIR QUALITY

Table 3.3 presents the National Ambient Air Quality Standards (40 CFR Part 50). The primary standards define levels of air quality necessary, with an adequate margin of safety, to protect the public health. Secondary standards define levels of air quality necessary to protect the public from any known or anticipated adverse effects of pollutants. Annual standards are not to be exceeded while short-term standards are not to be exceeded more than once per year (40 CFR Part 50). State ambient air quality standards for Utah are the same as the national standards (Table 3.3) (Carlson, 1985). The Green River area is classified as an attainment area under the National Ambient Air Quality Standards (Dalley, 1986).



REF: NOAA, 1975

FIGURE 3.1 WIND ROSE DIAGRAM, 1962 THROUGH 1971, GREEN RIVER, UTAH

Table 3.3 National Ambient Air Quality Standards[a,b]

Pollutant	Primary standard[c]	Secondary standard[c]
Total suspended particulates (TSP)		
24-hour average	260 microg/m^3	150 microg/m^3
annual geometric mean	75 microg/m^3	60 microg/m^3
Sulfur dioxide (SO_2)		
24-hour average	365 microg/m^3 (0.14 ppm)	---
annual arithmetic mean	80 microg/m^3 (0.03 ppm)	---
3-hour maximum	---	1300 microg/m^3 (0.5 ppm)
Carbon monoxide (CO)		
8-hour maximum	10 mg/m^3 (9 ppm)	10 mg/m^3 (9 ppm)
1-hour maximum	40 mg/m^3 (35 ppm)	40 mg/m^3 (35 ppm)
Ozone (O_3)		
1-hour average	235 microg/m^3 (0.12 ppm)	235 microg/m^3 (0.12 ppm)
Nitrogen dioxide (NO_2)		
annual arithmetic mean	100 microg/m^3 (0.05 ppm)	100 microg/m^3 (0.05 ppm)
Lead (Pb)		
calendar quarterly arithmetic average	1.5 microg/m^3	1.5 microg/m^3

[a] 40 CFR Part 50.

[b] State ambient air-quality standards for Utah are the same as the National Ambient Air Quality Standards (Carlson, 1985).

[c] Microg/m^3 = micrograms per cubic meter; mg/m^3 = milligrams per cubic meter; ppm = parts per million.

The state of Utah maintains an air quality monitoring network that includes a station in Green River. Total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) are monitored at this site; pollutants not monitored are carbon monoxide (CO), ozone (O_3), and lead (Pb). Measurements of pollutants at the Green River station from 1980 through 1985 (Table 3.4) indicate that the measured pollutant concentrations were below the standards with the exception of TSP which exceeded the secondary standards (DOE, 1983).

Since there are no major pollutant sources in the immediate vicinity of the tailings and borrow sites, pollutant concentrations at these sites should be similar to those recorded at the Green River station.

Table 3.4 Air pollutant concentrations for the period 1980 through 1985, Green River, Utah

Pollutant	Concentration[a]
Total suspended particulates (TSP)	
24-hour average	163-196 microg/m^3
annual geometric mean	53-64 microg/m^3
Sulfur dioxide (SO_2)	
24-hour average	0.01-0.02 ppm
annual geometric mean	below detectable levels
Nitrogen dioxide (NO_2)	
24-hour average	0.03-0.06 ppm
annual geometric mean	0.007-0.01 ppm
Carbon monoxide (CO)	Not available
Ozone (O_3)	Not available
Lead (Pb)	Not available

[a] Microg/m^3 = micrograms per cubic meter; ppm = parts per million.

Ref. DOE, 1983.

3.4 SURFACE AND SUBSURFACE FEATURES

The Green River tailings and borrow sites are in the northern part of the Canyon Lands section of the Colorado Plateau physiographic province. The Colorado Plateau is a major tectonic block comprised chiefly of Paleozoic and Mesozoic sedimentary rocks underlain by a core of Precambrian rock encompassing Utah, Arizona, Colorado, and New Mexico (Harshbarger, 1953).

The Colorado Plateau has been only moderately deformed compared to the more intensely deformed surrounding regions, although uplift has occurred over the entire plateau since Late Tertiary time (Gable and Hatton, 1980). Numerous studies and the seismic history of the region indicate that the Colorado Plateau province is composed of a stable interior bounded on three sides by more active border zones (Eggleston and Reiter, 1984; Zoback and Zoback, 1980; Keller et al., 1979; Reiter et al., 1975).

The Canyon Lands section in which the site is located is characterized by large structural upwarps and intervening basins formed mostly in upper Paleozoic and lower Mesozoic sandstones and shales. The most prominent landforms in the region are broad mesas and pediment surfaces, narrow, rock-walled gullies, and deeply incised canyons (Hunt, 1967).

Major physiographic features of the site region are the Mancos Shale Lowland and Green River Desert (also referred to as the San Rafael Desert) to the south, the Book Cliffs-Roan Plateau to the north, the San Rafael Swell to the west, and the Salt Anticline to the east. The Mancos Shale Lowland and Green River Desert surround the Green River tailings and borrow sites.

Bedrock in the site region consists almost entirely of layered sedimentary units ranging in age from Late Paleozoic to Early and Middle Tertiary (Lines et al., 1984; Osterwald et al., 1981; Hintze, 1980; Witkind et al., 1978; Cashion, 1973; Williams and Hackman, 1971; and Williams, 1964). These units mainly consist of sandstone, shale, and mudstone with lesser amounts of salt, gypsum and potash, limestone, and conglomerate. Units generally decrease in age from south to north across the site region.

3.4.1 Green River tailings site

The geologic formations underlying the Green River tailings site are the Brown's Wash alluvium, the basal section of the Tununk Shale Member of the Mancos Shale Formation, the Dakota Sandstone, and the Cedar Mountain Formation (Williams and Hackman, 1971). The Brown's Wash alluvium (of Quaternary age) consists of a mixture of sand, gravel, and cobbles. The alluvium is underlain by the Tununk Shale Member of the Mancos Shale (of Cretaceous age), which is characterized by dark gray, grayish brown, and black carbonaceous shale interbedded with thin beds of pale yellow sandstone. The Dakota Sandstone (of Cretaceous age) unconformably underlies the Tununk Shale and consists of gray and brown sandstone, shale, and conglomerate. The Dakota Sandstone is underlain unconformably by the Cedar Mountain Formation which consists of light gray, brown, and white fine-grained sandstone and conglomerate, with lenses of greenish brown mudstone and limestone. The stratigraphy of the Green River site is described in detail in Section B.4.5 of Appendix B, Hydrology.

The existing tailings pile is on the Brown's Wash alluvium which ranges in thickness up to 35 feet and is directly underlain by bedrock of the Cedar Mountain Formation. The Tununk Shale is mostly eroded away by the Brown's Wash channel in the western half of the site area. The unit forms a wedge which thins southward and probably disappears completely beneath the tailings pile and the proposed disposal site. The proposed disposal area is principally underlain by gently northward-dipping sandstone and conglomerate of the Dakota Sandstone, which is in turn underlain by the sandstone, limestone, and shales of the Cedar Mountain Formation. The Mancos Shale Formation thickens to the north and is exposed on the escarpment above the existing tailings pile, but appears to pinch out before reaching the edge of the disposal area. The Dakota Sandstone is capped by a thin (maximum thickness is 15 feet) discontinuous layer of silt, sand, gravel, and cobbles deposited by alluvial and eolian processes and pediment gravels formed by the weathering of the Dakota Sandstone and conglomerate.

Known mineral deposits in the region include uranium and vanadium, coal, oil and gas, gypsum, salt, potash, oil shale, tar sands, sand and gravel, clay, and minor metallic ores. No production of these materials is known to have occurred near the site.

3.4.2 Proposed borrow sites

Proposed borrow site 1 is on private lands and would be the source of radon/infiltration barrier material and some of the erosion protection material. The borrow site is an existing borrow operation and consists of fine-grained clay and silt, sand, and gravel deposits. Alluvial sand and gravel overlie shale bedrock at depths greater than 12 feet. In the northeast corner of the borrow site, the sand and gravel is overlain by silty to sandy clay. A silty sand to sandy silt and clay form the upper one to two feet of site soil.

Proposed borrow site 2 is a privately-owned active quarry that would provide rock for erosion protection. The quarry consists of limestone and sandstone of the Cedar Mountain Formation.

There are no mineral or oil and gas leases at or in the vicinity of the borrow sites (Lasson, 1986; Sillimans, 1986).

3.4.3 Seismicity

The Green River tailings site lies within the relatively stable interior portion of the Colorado Plateau, 50 to 100 miles east of the highly active Intermountain Seismic Belt. Most of the major structural and tectonic features of the site region, with the exception of the Intermountain Seismic Belt, are Laramide uplifts and basins. These features are generally considered to be inactive under the present seismotectonic regime. The largest recorded events in the site region have been of magnitude 4.0 to 4.2 on the Richter scale. The majority of these are either known or suspected to be related to mining activities (Coffman, 1986; Algermissen and Perkins, 1976). The lack of large tectonic earthquakes and known active features, and the distance separating the site from highly active regional features such as the Intermountain Seismic Belt, indicate a relatively stable setting.

3.5 WATER

A more detailed discussion of the surface water and groundwater in the site area is provided in Appendix B, Hydrology.

3.5.1 Surface water

Green River tailings site

Surface-water features in the vicinity of the Green River tailings site include the Green River, Brown's Wash, and several ephemeral drainages. The existing tailings site is 0.5 mile east of the Green River, which drains southward and southwestward from the site area and joins the Colorado River 60 air miles south of the site. The Green River in the vicinity of the city of Green River has a drainage area of 40,590 square miles. Brown's Wash, an intermittent tributary of the Green River, borders the tailings site on the north. The wash has a drainage area of 85 square miles in the vicinity of the tailings site.

Runoff from the mill yard is directed northwest to Brown's Wash and eventually into the Green River. The southeastern portion of the mill yard is bordered by a man-made ditch six feet deep and 400 feet long. Approximately 110 acres bisected by the Interstate 70 (I-70) embankment drain to the proposed disposal area. Several small gullies direct runoff from this area southwest and northeast to Brown's Wash. Surface runoff north of the site is diverted from Brown's Wash and the tailings site by the railroad track embankment 30 feet north of Brown's Wash.

A U.S. Geological Survey (USGS) gaging station on the Green River near the city of Green River is 3200 feet upstream from the confluence with Brown's Wash. The recorded average maximum monthly and average mean monthly flows were 24,480 and 18,580 cubic feet per second (cfs), respectively. On June 27, 1917, a peak flow of 68,100 cfs was recorded. The proposed disposal site is approximately 100 feet above and 3000 feet away from the channel of the Green River. Therefore, the potential for floodwaters reaching the stabilized tailings pile is negligible.

A USGS gaging station was formerly operated on Brown's Wash approximately 950 feet northeast of the site under the railroad crossing. The recorded average maximum monthly and average mean monthly flows were 69 and 3.6 cfs, respectively, for the period of record from 1949 to 1968. On August 19, 1959, the peak flow of 5620 cfs was recorded (USGS, 1986). Seasonal flooding occurs in Brown's Wash, and such floods have undercut the stream bank and eroded tailings at the site. The likelihood of recurrence of similiar or greater floods is great.

There are no current uses of the water in Brown's Wash in the vicinity of the Green River tailings site. The city of Green River presently uses water from the Green River upstream of the tailings site for municipal use. Withdrawal of water downstream of the site is minimal.

The Utah State Board of Health and Utah Water Pollution Control Board classify the Green River and all of its tributaries as follows: Class 2B, protected for boating, water skiing, and similar uses, excluding recreational bathing; Class 3B, protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain; and Class 4, protected for agricultural uses including irrigation of crops and livestock watering.

Surface-water quality for Brown's Wash is dependent on the quantity of water in the wash. Concentrations of dissolved constituents are inversely proportional to the quantity of water in the channel. A comparison of analytical results of samples taken upstream and downstream of the tailings pile shows that concentrations of a few constituents increase only slightly (and others not at all) downstream of the pile with the exception of gross alpha activity, which increased by 50 picocuries per liter (pCi/l) during the June, 1982, sampling period. There was no measurable increase in uranium concentrations. The volume of water in Brown's Wash increases as it approaches the Green River and concentrations of dissolved constituents become diluted.

The effects of uranium tailings seepage on the quality of water in the Green River are minimal, as indicated in the water-quality analyses of samples collected from the Green River upstream and downstream of its confluence with Brown's Wash (see Section B.1.2, Appendix B).

Proposed borrow sites

Proposed borrow site 1 is about three miles north of the existing tailings site on the east side of the Green River and is 2340 feet east of a large meander in the Green River. The borrow site is in flat terrain with a total drainage area of 100 acres. An unnamed, ephemeral stream 1300 feet south of the proposed borrow site drains an area of 750 acres east and south of the proposed site. The ephemeral stream flows west into the Green River 2.6 miles upstream of the U.S. 6&50 bridge over the Green River.

Proposed borrow site 2 is 1560 feet west of the Green River. The total drainage area for the borrow area is 1120 acres. Saleratus Wash, a large ephemeral stream, is 1700 feet north of the proposed borrow site and flows east into the Green River one mile downstream of the U.S. 6&50 bridge.

No historical flow data exist for the ephemeral streams in the vicinities of the proposed borrow areas. However, the discussion of surface-water characteristics and historical flows for the Green River is also applicable to these sites.

Floodplains

According to computer modeling conducted by the DOE using the USGS stream gage data, a portion of the tailings site lies within the 100-year, 500-year, and the Probable Maximum Flood (PMF) floodplains of Brown's Wash. An area of approximately 16 acres of contaminated soils is within the 100-year and 500-year floodplains of Brown's Wash. An analysis of these flood events is provided in Appendix F, Floodplain Assessment.

3.5.2 Groundwater

Hydrostratigraphy

Bedrock at the surface and immediately underlying the existing tailings site consists of sedimentary units of Quaternary and Cretaceous age. The Cretaceous strata are underlain by sediments of Jurassic age. The geology of the hydrostratigraphic units is described in Section B.4.5.1 and hydrogeological cross sections are provided in Figures B.4.2 through B.4.6, Appendix B. Within the upper 200 feet of the Quaternary and Cretaceous sediments, four distinct water-bearing (hydrostratigraphic) units were defined at the Green River tailings site. These units are described as follows:

- The top hydrostratigraphic unit is the Brown's Wash alluvium. The alluvium is limited to an area that extends 300 to 400 feet on either side of Brown's Wash, and varies in thickness from zero to 35 feet. Groundwater in this unit is locally perched by the dense, well-cemented sandstone conglomerate of the Dakota Sandstone and the shale and limestone of the Cedar Mountain Formation (where these bedrock units are not fractured). Directly beneath the existing tailings pile, a paleochannel of Brown's Wash has eroded away the Dakota Sandstone, and the Brown's Wash alluvium directly overlies shale of the Cedar Mountain Formation. The Brown's Wash alluvium does not extend south of the tailings pile and is not present beneath the proposed disposal site.

- The upper-middle hydrostratigraphic unit consists of alternating layers of shale, limestone, and mudstone of the Cedar Mountain Formation. This unit is continuous beneath the existing tailings pile and the proposed disposal site.

- The lower-middle hydrostratigraphic unit is a relatively thick, but laterally limited, sandstone and conglomerate channel deposit within the Cedar Mountain Formation. The lower-middle unit intertongues with the upper-middle unit and is continuous beneath the present tailings pile and the proposed disposal site.

- The bottom hydrostratigraphic unit is the Buckhorn Conglomerate Member of the Cedar Mountain Formation. This basal sandstone and sandstone conglomerate unit is 15 to 25 feet thick beneath the site area and is confined by overlying shale and mudstone. The Buckhorn Conglomerate is continuous beneath the existing tailings pile and the proposed disposal site.

Groundwater flow

Groundwater flow in the hydrostratigraphic units beneath the tailings pile is west toward the Green River. The groundwater flow characteristics of these units are shown in Table 3.5. A more detailed discussion of groundwater flow is provided in Section B.4.7, Appendix B.

Table 3.5 Summary of groundwater flow characteristics, Green River, Utah, tailings site

Hydrostratigraphic unit	Average linear velocity[a] (feet per day)	Hydraulic gradient (foot per foot)	Average groundwater flux (gallons per minute)
Top	1.14	0.0029-0.0125	9.9
Upper-middle	0.08	0.0063-0.0083	4.9
Lower-middle	0.14	0.0083-0.025	NC[b]
Bottom	0.12	0.040-0.044	NC[b]

[a] Geometric mean.
[b] NC = not calculated.

Shallow, unconfined groundwater is present in the top hydrostratigraphic unit (Brown's Wash alluvium) beneath the existing tailings pile. The occurrence of this shallow groundwater is limited by the lateral extent of the alluvium. The depth to groundwater ranges from nine to 17 feet below the surface in the top unit. The hydraulic gradient within the top unit ranges from 0.0029 foot per foot (ft/ft) to 0.0125 ft/ft (Table 3.5). Groundwater in the top unit is recharged from the south by flow from the upper-middle shale unit, and by infiltration of surface runoff and precipitation in the channel of Brown's Wash. Groundwater discharges from Brown's Wash alluvium into the channel of Brown's Wash at a point west of the tailings pile where the site access bridge crosses Brown's Wash (see Figure B.4.1, Appendix B). From this point west to the Green River, the Dakota Sandstone and Cedar Mountain Formation inhibit the downward movement of water in the channel; however, some of this water probably infiltrates into the bedrock, especially where fractures are present. Water that flows west in the channel eventually mixes with backwater from the Green River (at surface-water sampling site 526, shown on Figure B.4.1, Appendix B). Groundwater also discharges from the Brown's Wash alluvium into the underlying upper-middle shale unit of the Cedar Mountain Formation, to the atmosphere as evaporation, and to the tamarisk vegetation that lines the channel of Brown's Wash. The DOE measured the base flow in Brown's Wash channel in November, 1985, at 2.3 gallons per minute (gpm). The measurement was made immediately west of the access bridge to the site near well point 564 (see Figure B.4.1, Appendix B). The remainder of the shallow alluvial groundwater from beneath the present tailings pile is lost to evapotranspiration and vertical downward leakage into the Cedar Mountain Formation. Since well points 564 and 821 and monitor well 706 are dry, very little flow is assumed to move downgradient to the alluvium west of monitor well 706.

Confined and semiconfined groundwater is present in the upper-middle unit beneath the Green River tailings site. This unit consists mostly of limestone and shale of the Cedar Mountain Formation. Beneath the tailings and the proposed disposal site, the upper-middle unit is separated into two units by a sandstone and conglomerate channel deposit. To the west and east of the tailings and proposed disposal site this sandstone and conglomerate is not present or intertongues as thin layers with the upper-middle shale unit (see Figures B.4.2, B.4.3, and B.4.4, Appendix B). Beneath the proposed disposal site, fracturing occurs in the upper- and lower-middle units. A total of six core holes were drilled beneath and peripheral to the proposed disposal site. Core from all of these holes shows moderate to intense vertical and horizontal fracturing and fractures extending from the upper-middle unit down into the lower-middle unit. Only well 816 encountered groundwater (at a depth of 60 feet). Depth to groundwater in the upper-middle unit beneath the tailings surface is about 26 feet at monitor well 701. The hydraulic gradient within the upper-middle hydrostratigraphic unit ranges from 0.0063 to 0.0083 ft/ft (Table 3.5). Groundwater flux in the upper-middle unit is controlled by fractures, joints, or minor faults, which are most evident in the vicinity of the existing tailings pile. A "trough" is present in the potentiometric surface, which trends east-west and is just south of the channel of Brown's Wash (see Figure B.4.8, Appendix B). Groundwater flux in the upper-middle unit is also controlled by vertical recharge from the overlying alluvial aquifer and the underlying lower-middle unit.

The lower-middle unit is the sandstone and conglomerate channel deposit within the upper-middle unit of the Cedar Mountain Formation. This unit is a maximum of 30 feet thick and is confined in the area of the present tailings pile by overlying shales and limestones of the upper-middle unit. The lower-middle unit does not appear to be present, or it intertongues as thin lenses with the limestone and shale, east and west of the existing tailings pile (see Figures B.4.2, B.4.3, and B.4.4). Because of the fracturing present in the upper-middle and lower-middle units at the disposal site, these two units are probably somewhat hydraulically connected. The depth to water in this unit is approximately 60 feet at the proposed disposal site. The hydraulic gradient within the lower-middle unit ranges from 0.0083 to 0.025 ft/ft (Table 3.5).

The flow of groundwater in the lower-middle unit is strongly influenced by the dip of the unit, its limited lateral extent to the east and west, and its recharge by underlying aquifers. Rock cores indicate this unit is fractured and is probably hydraulically connected with the overlying upper-middle shale unit beneath the proposed disposal site; however, the lower-middle unit is confined by the shale beneath the present tailings. The strong, vertically upward hydraulic gradient (Table 3.5) between the upper-middle and lower-middle units beneath the tailings pile has prevented any tailings seepage from moving into the lower-middle unit. Groundwater flux through the lower-middle unit beneath the tailings was not calculated since this unit has not been affected by tailings seepage.

The Buckhorn Conglomerate Member of the Cedar Mountain Formation has been defined as the bottom hydrostratigraphic unit. Confined groundwater is present beneath the tailings site vicinity in this unit. The unit is 15 to 25 feet thick in the site vicinity and is confined by the maroon to gray-blue shales and mudstones that separate the bottom unit from the overlying hydrostratigraphic units. The hydraulic gradient within the bottom unit ranges from 0.040 to 0.044 ft/ft (Table 3.5). Groundwater flux through the bottom unit beneath the tailings was not calculated since tailings seepage has not affected this unit. Because of overlying confining layers and strong, vertically upward hydraulic gradients between the bottom unit and the two presently contaminated units, the bottom unit will not become contaminated from tailings seepage.

Vertical hydraulic gradients

Strong, vertically upward hydraulic gradients exist between the bedrock units of the top and upper-middle hydrostratigraphic units in the vicinity of the Green River tailings site. These gradients have prevented the downward movement of tailings seepage into the lower-middle and bottom hydrostratigraphic units beneath the present tailings pile. Beneath the proposed disposal site the upward gradients in the upper-middle unit may limit the amount of mixing of any tailings seepage (as a result of the proposed remedial action) between the upper-middle and lower-middle units. Additionally, the strong gradients will restrict the movement of any tailings seepage into the bottom unit. (Tables B.4.12 and B.4.13, Appendix B summarize the vertical hydraulic gradients at the present tailings site and the proposed disposal site, respectively.)

3.5.3 Background groundwater quality

Background groundwater quality in the four hydrostratigraphic units at the Green River site was determined for the following constituents listed in the proposed EPA standards: chromium; molybdenum; nitrate; selenium; radium-226 and 228; uranium; and gross alpha. The other constituents listed in the proposed EPA standards (see Table 3.6) were found to have levels below detection for the first two rounds of sampling in June, 1986, and September, 1986; consequently, these remaining constituents were excluded from subsequent sampling rounds and are not considered to be present as contamination at the Green River tailings site. For a more detailed discussion see Section B.4.8 in Appendix B.

Top hydrostratigraphic unit

The background concentration range for the top hydrostratigraphic unit exceeds proposed EPA MCLs for all the constituents in Table 3.6 except for Ra-226 and 228 and gross alpha, the concentrations of which are below the proposed MCLs. Many other constituents exceed EPA secondary and state of Utah drinking water standards. These include (but are not limited to): chloride (>250 milligrams per liter, or mg/l); sulfate (>5500 mg/l); and TDS (>9000 mg/l).

Upper-middle hydrostratigraphic unit

The wide range of background quality for the upper-middle hydrostratigraphic unit reflects the range in concentrations found at each well. High concentrations of the contaminants listed in Table B.4.18 (Appendix B) are found at well 816, which is located south (upgradient) of the tailings at the proposed disposal site. Proposed EPA MCLs for nitrate and selenium concentrations are exceeded in monitor well 816. Radionuclides could not be tested because of the limited amount of sample water that could be collected from this well. The measured uranium concentration is very close to the proposed MCL. The nature of the contamination present in this well suggests the source may be from the surface, as well as from recharge by naturally contaminated water from underlying aquifers.

Table 3.6 Water quality standards and maximum concentration limits applicable to the Green River, Utah, tailings site[a]

Constituent	Proposed EPA groundwater maximum concentration limits[b]	EPA National Drinking Water Standards		State of Utah Drinking Water Standards
		Primary[c]	Secondary[d]	
Inorganic Chemical				
Arsenic	0.05	0.05		0.05
Barium	1.0	1.0		1.0
Boron				0.75
Cadmium	0.010	0.010		0.010
Chloride			250	250
Chromium	0.05	0.05		0.05
Copper			1.0	1.0
Iron			0.3	0.3
Lead	0.05	0.05		0.05
Manganese			0.05	0.05
Mercury	0.002	0.002		0.002
Molybdenum	0.1			
Nitrate	44	44		44
Selenium	0.01	0.01		0.01
Silver	0.05	0.05		0.05
Sulfate			250	250
Zinc			5.0	5.0
TDS			500	500
pH (standard units)			6.5-8.5	6.5-8.5
Radionuclides (picocuries/liter)				
Ra-226 and 228	5.0			5.0
U-234 and 238	30 (0.044 mg/l)			
Gross alpha	15			15

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[a] Standards are given in milligrams per liter (mg/l) except as noted.

[b] 52 FR 36000; proposed standards also include a list of hazardous organic constituents not normally associated with uranium mill tailings; see Appendix VII of 40 CFR Part 261.

[c] 40 CFR Part 141.

[d] 40 CFR Part 143.

Monitor well 807 is completed in the upper-middle shale unit below the lower-middle sandstone (see Figure B.4.2, Appendix B). The screened interval in well 807 is from 78 to 98 feet (see Table B.4.1, Appendix B). The water quality analysis of a sample taken from this well in October, 1987, (see Table B.4.16, Appendix B) shows that nitrate and selenium concentrations exceed proposed EPA MCLs and state of Utah drinking water standards for these constituents. The nitrate concentration was measured at 670 mg/l and selenium was measured at 0.17 mg/l; each of these concentrations are well over one order of magnitude greater than the proposed EPA MCLs and Utah drinking water standards for the constituents. In addition, the boron concentration was measured at 0.8 mg/l, which is slightly greater than the state of Utah standard for boron (see Table B.2.1, Appendix B); the molybdenum concentration was measured at 0.07 mg/l, which is slightly less than the proposed MCL of 0.10 mg/l for the EPA standard and the Utah standard. Finally, total dissolved solids were measured at 7550 mg/l, and the sulfate concentration was 4000 mg/l. Since this saturated zone within the Cedar Mountain Formation is isolated from surface contamination by strong, vertically upward hydraulic gradients, the source for the contaminants formed within this unit is from somewhere off the site, and possibly from below the elevation at which the well was screened.

Lower-middle hydrostratigraphic unit

The range for background quality for the lower-middle hydrostratigraphic unit is similar to that of the upper-middle unit. Beneath the proposed disposal area, the upper- and lower-middle hydrostratigraphic units may be hydraulically connected by numerous vertical fractures. To the north, away from the disposal area and toward the present tailings pile, the vertical fractures are not as intense or abundant and the lower-middle unit is confined by the overlying shales and limestones of the upper-middle unit. Background concentrations of molybdenum, nitrate, selenium, uranium, and gross alpha activity exceed the proposed EPA MCLs south (upgradient) of the tailings at the proposed disposal site. The source of this contamination, like that found in the upper-middle unit, is probably from upgradient sources south of the disposal area or from underlying aquifers. There is no evidence at the ground surface that the proposed disposal site is a source of contamination.

Bottom hydrostratigraphic unit

For the bottom hydrostratigraphic unit, chromium, molybdenum, and selenium concentrations are slightly higher than the proposed EPA MCLs for these constituents. These levels probably reflect high natural levels of these constituents, and indicate that the high levels of these constituents found in the overlying hydrostratigraphic units may also be from natural sources.

Summary of background groundwater quality

The range of background groundwater quality in the upper- and lower-middle hydrostratigraphic units (Cedar Mountain Formation) is wide because background monitor wells are located both east (upstream) and south (updip) of the tailings. The wells south of the existing tailings pile (at the proposed disposal site) indicate there is a source of contamination upgradient of the disposal site that is not related to the milling processes since it would be outside the boundary of the mill site. If the high nitrate levels are an indication of the source, it may be from activities associated with the White Sands Missile Range test complex (see Section 3.8, Land Use). High levels of chromium, molybdenum, and selenium in the bottom hydrostratigraphic unit indicate these constituents are from natural sources; because this unit is confined by a thick shale unit in the vicinity of the tailings site contamination from the surface is unlikely.

Because the high background levels of nitrate, molybdenum, chromium, and selenium indicate contamination from natural sources, groundwater in all four hydrostratigraphic units at the Green River site may be classified as Class III, according to 40 CFR Part 192.21(g), which states that Class III groundwater includes water that is not a current or potential source of drinking water because widespread, ambient contamination not due to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up by using treatment methods reasonably employed in public water-supply systems (see Table B.9.1, Appendix B).

3.5.4 Extent of contamination

Percolation of tailings seepage into the groundwater system beneath the tailings pile has adversely impacted the water quality in both the top and upper-middle hydrostratigraphic units. Amonium, gross alpha activity, molybdenum, nitrate, selenium, and uranium concentrations in the top and upper-middle hydrostratigraphic units exceed background levels, the proposed EPA MCLs, and the state of Utah drinking water standards beneath and downgradient of the tailings. The vertical extent of contamination is confined to these two shallow units by strong, vertically upward hydraulic gradients between the upper-middle unit and the underlying units. The maximum depth of contamination beneath the surface of the present tailings pile is about 65 feet.

3.5.5 Groundwater use

There are 15 registered wells in the vicinity of the Green River tailings site. Most or all of these wells are shallow and are completed in the Green River alluvium. The majority of the wells are not being used because of the poor groundwater quality, poor conditions of the wells, and the availability of better quality water from the city of Green River. The city takes its water from the Green River upstream of the tailings site and Brown's Wash. There is no reported use of groundwater at the Green River tailings site (see Section B.8, Appendix B).

3.5.6 Proposed borrow sites

There is no information on the presence or use of groundwater at the proposed borrow sites. There is no evidence of shallow groundwater within the existing excavations at these borrow sites.

3.6 FLORA AND FAUNA

The Green River tailings and borrow sites contain flora and fauna typical of an arid environment. Major habitat types present in the area of the tailings and borrow sites are the salt desert scrub, the riparian zone along the Green River, and the aquatic environment of Green River. Shadscale, saltbush, and greasewood are the dominant vegetation in the salt desert scrub type; cottonwood and willow are dominant in the riparian zone; and the Green River provides conditions for warm-water fisheries.

Few species of wildlife were observed at or near the Green River tailings site and proposed borrow sites during brief reconnaissance surveys (Mulford, 1986; DOE). The literature regarding the distribution of mammals in the Green River region indicates that 34 species would be expected to occur at or near the tailings site (see Table C.1.2, Appendix C, Flora and Fauna).

Fifteen species of migratory game birds, four species of upland game birds, 18 species of raptors, and 51 species of non-game birds could occur at or near the tailings and proposed borrow sites (see Table C.1.3, Appendix C). Two species of raptors (bald eagle and peregrine falcon) are endangered species (see Section C.2, Appendix C). The turkey vulture, American kestrel, mallard, horned lark, and chukar partridge were among the species observed at the three site areas.

An estimated 23 species of reptiles and seven species of amphibians may occur at or near the tailings site (see Table C.1.4, Appendix C). Reptiles observed at or near the tailings site were the Great Basin whiptail lizard, the desert spiny lizard, the side-blotched lizard, and the leopard lizard. No amphibians were observed (DOE).

At least 14 species of fish occur in the Green River near the tailings site (see Table C.1.5, Appendix C). The Colorado squawfish, an endangered species, is discussed in Section C.2 of Appendix C.

3.6.1 Green River tailings site

The Green River tailings pile and mill yard have very little vegetation. The periphery of the tailings pile consists mainly of greasewood and rabbitbrush, particularly on the northern portion near Brown's Wash. Saltbush, halogeton, Russian thistle, desert trumpet, Indian ricegrass, and cheatgrass are commonly found in the central part of the tailings pile. Plant species that are common in the mill yard area are halogeton, Russian thistle, sand dropseed, and cheatgrass; greasewood, rabbitbrush, and saltcedar are found in a ditch within the mill yard (Mulford, 1986; DOE).

The area surrounding the tailings pile and mill yard is sparsely vegetated and mainly characterized by shadscale, saltbush, rabbitbrush, globemallow, desert trumpet, spreading fleabane, halogeton, galleta, Indian ricegrass, sand dropseed, and cheatgrass. Dominant vegetation found in and along Brown's Wash near the site consists of greasewood, saltbush, rabbitbrush, saltcedar, and desert saltgrass. Cottonwood, willow, squawbush, and other phreatophytes are common along the Green River and the lower part of Brown's Wash near its confluence with the Green River (Mulford, 1986; DOE).

Few wildlife species are found in and around the tailings site. Species observed were the turkey vulture, American kestrel, mallard, magpie, starling, western kingbird, mockingbird, horned lark, desert cottontail, western whiptail, desert spiny lizard, side-blotched lizard, and leopard lizard (DOE, 1983).

3.6.2 Proposed borrow sites

Proposed borrow sites 1 and 2 have been highly disturbed by previous borrow activities and little vegetation is present. The dominant vegetation at both borrow sites is saltbush, shadscale, rabbitbrush, globemallow, galleta, and Indian ricegrass (DOE). Halogeton was also observed at borrow site 1 (Mulford, 1986; DOE).

Wildlife species present at the proposed borrow sites are similar to those observed at the tailings site.

3.6.3 Wetlands

There are no wetlands, as defined by the U.S. Fish and Wildlife Service (USFWS) and the U.S. Army Corps of Engineers (COE), at or around the tailings and borrow sites (Champ, 1986; Ruesink, 1986).

3.6.4 Threatened or endangered species

No listed or candidate threatened or endangered plant or wildlife species are known to occur at the Green River tailings and borrow sites. However, the bald eagle, peregrine falcon, and Colorado squawfish may occur near the sites. Details on these species are presented in Section C.2, Appendix C.

3.7 RADIATION

Background and existing radiation levels at the Green River tailings site are discussed below. Appendix D, Radiation, contains detailed discussions of radiation and radiation measurements relative to the Green River tailings site.

3.7.1 Background radiation

Radioactive elements occur naturally throughout the air, water, soil, and rock of the earth. The concentrations of these elements vary greatly throughout the United States, and the concentrations of natural radioactive elements in the Green River area are generally higher than the averages for other locations because of local uranium mineralization.

The background radiation exposure rate from both terrestrial and cosmic sources, measured at three feet above the ground, ranged from 12 to 17 microroentgens per hour (microR/hr) with an average value of approximately 14 microR/hr. Cosmic radiation from the sun and other sources external to the earth contributes approximately 5 microR/hr of the background exposure rate at the Green River tailings site (EG&G, 1982).

The average outdoor background radon concentration around the Green River area was 2.0 pCi/l with a range of 1.7 to 2.3 pCi/l (FBDU, 1981).

The background levels of radioactivity in surface water and groundwater around the tailings site can be estimated from samples taken upgradient and near the tailings site. Samples taken from the Green River upgradient of the Green River-Brown's Wash confluence contained 0.06 to 0.13 pCi/l of radium-226 (Ra-226) and 0.001 to 0.005 mg/l of uranium. A groundwater sample obtained from an alluvial well east (upgradient) of the site showed a uranium concentration of 0.012. A water sample taken from beneath the alluvium at another well upgradient of the site showed a uranium concentration of 0.0201 mg/l. A surface-water sample taken from Brown's Wash near and upgradient of the site showed a uranium concentration of 0.005 mg/l and Ra-226 concentration of less than 2 pCi/l.

The average background soil radionuclide concentrations near the tailings site, not influenced by the tailings, have been established as 0.8 picocurie per gram (pCi/g) of Ra-226 (BFEC, 1985).

3.7.2 Green River tailings site

The existing tailings pile at the Green River site covers eight acres with an average depth of nine feet. The average Ra-226 concentration of the tailings is 98 pCi/g. The soils beneath the tailings pile exceed the EPA standard for Ra-226 to an average depth of two feet below the bottom of the tailings.

The radon concentration in the approximate center of the tailings pile was 13.5 pCi/l. The radon flux on the tailings pile ranged from one to 180 picocuries per square meter per second (pCi/m^2s) (FBDU, 1981).

Gamma radiation exposure rates on the tailings pile ranged from 25 to 165 microR/hr. Across the mill yard and ore storage area, the exposure rates ranged from 13 to 282 and 20 to 130 microR/hr, respectively. The gamma exposure rates reach the average background rate of 14 microR/hr within 500 feet to the north and east, 1200 feet to the south, and 800 feet to the west from the corresponding edges of the tailings pile (BFEC, 1985).

Dispersion of the tailings by wind and water erosion has contaminated soils adjacent to the tailings pile. A field survey of the designated tailings site and the immediate vicinity was conducted to determine the areal extent of the displaced tailings (BFEC, 1985). Figure 3.2 shows the areas contaminated by the dispersion of the tailings (43 acres), the tailings pile (eight acres), the mill yard (12 acres), and the ore storage area (nine acres). The windblown and waterborne contamination around the tailings pile consists of diluted tailings, and generally the Ra-226 concentration is only slightly elevated above the EPA standard; however, there are locations immediately west of the mill yard with higher concentrations of Ra-226.

Surface-water samples were taken from Brown's Wash downgradient of the site. Radionuclide concentrations of 0.2 to 3 pCi/l of Ra-226 and 0.001 to 1.3 mg/l of uranium were found. A surface-water sample in Green River downstream of the Green River-Brown's Wash confluence showed uranium concentrations of 0.002 to 0.004 mg/l. Groundwater samples from immediately beneath the tailings pile showed Ra-226 concentrations of less than 0.3 pCi/l and uranium concentrations ranging from 0.04 to 3.0 mg/l.

Radionuclide contamination measurements were taken at four buildings at the tailings site. Direct alpha measurements gave results to maxima of 167, 2338, 2672, and 801 disintegrations per minute per 100 square centimeters ($dpm/100\ cm^2$) for the office, crusher, roaster, and mill, respectively. The majority of the alpha contamination is removable by minor scrubbing or washing. Gamma radiation exposure rates ranged from 11 to 30 microR/hr. Radon daughters concentration measurements gave average results of 2.00×10^{-3} to 3.91×10^{-3} working level (WL) for the various

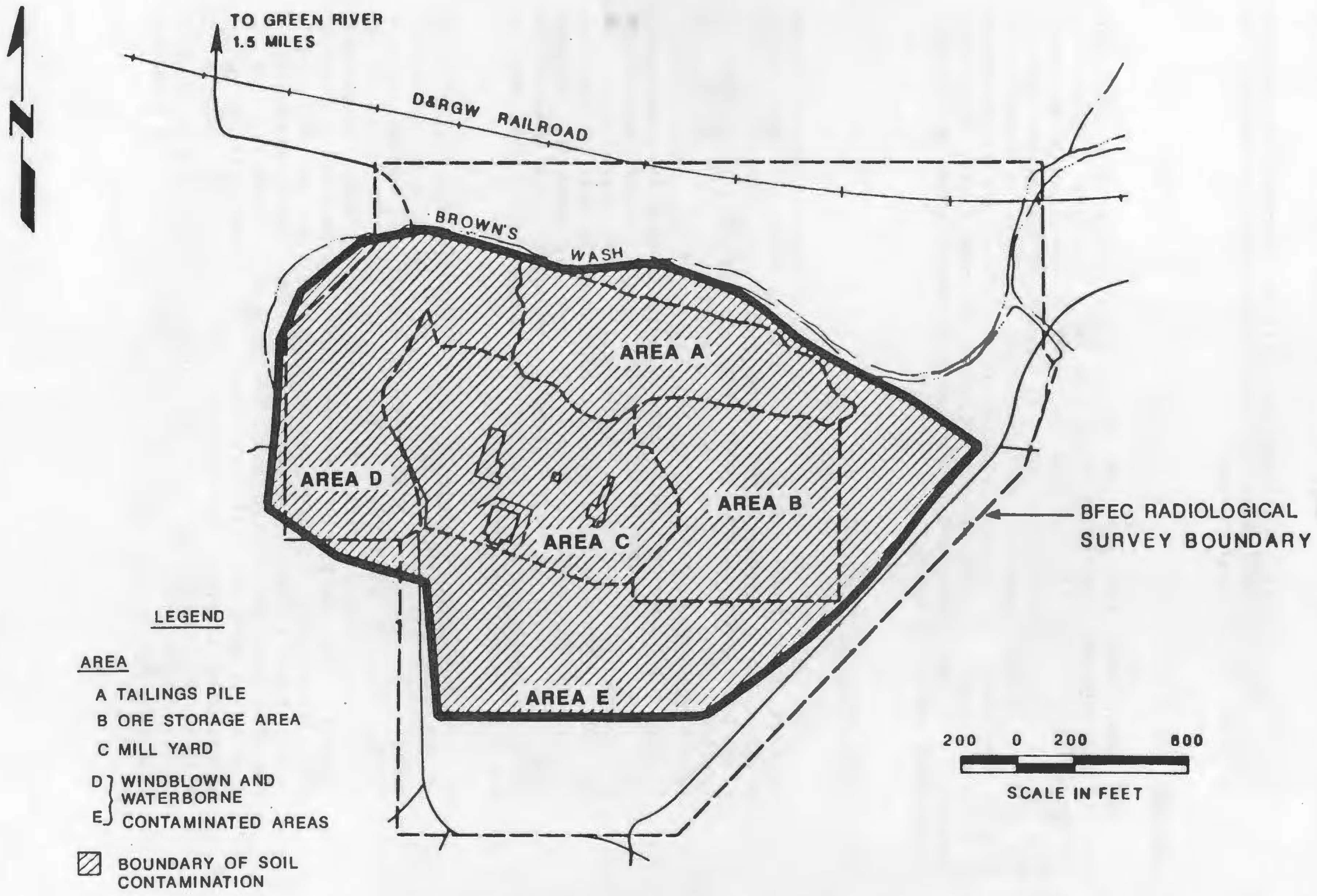

FIGURE 3.2 AREAL EXTENT OF RADIUM - 226 CONCENTRATION EXCEEDING 5 PICOCURIES PER GRAM, GREEN RIVER, UTAH, TAILINGS SITE

buildings. Six of 17 boreholes drilled through the building floors revealed contamination beneath the concrete; however, the concrete was not contaminated.

3.8 LAND USE

The Green River tailings site is in Grand County, Utah, 0.5 mile east of the boundary separating Grand and Emery Counties (Figure 3.3). The Grand-Emery county line follows the center of the Green River except next to the city of Green River where it follows an old meander path of the river. In both counties, 80 percent of the land is owned by the Federal government, 13 percent is owned by the state, and seven percent is privately owned. In the agricultural area of Green River, the primary land use is irrigated cropland (2165 acres) and pastureland (455 acres). Urban areas consist of 395 acres.

3.8.1 Green River tailings site

The Green River tailings site is one mile southeast of the city of Green River, which is across the river in Emery County (Figure 3.3). However, the Green River city limits cross the river and the Emery-Grand county line and include a portion of the tailings site. The Green River city limits also include the former community of Elgin, which is east of the river in Grand County; Elgin, for the most part, appears to have been abandoned. Land uses in and immediately adjacent to the city of Green River are primarily residential, agricultural, and commercial. The residential and agricultural areas are primarily west of the Green River, and the commercial areas are generally along U.S. Highway 6&50 (U.S. 6&50) on both sides of the river. The Green River State Recreation Area is on the west side of the river south of the U.S. 6&50 bridge crossing.

The buildings remaining at the tailing site and virtually all of the land within 0.5 mile of the tailings site are privately owned. The buildings are currently vacant but leased for use to the city of Green River. Most of the land is leased to the Federal government for the White Sands Missile Range (WSMR) test complex. The headquarters for the WSMR are immediately north of the site (within the Green River city limits), and the missile launch area is four miles southeast of the site. Operations at the WSMR have been discontinued for many years; however, land use within the WSMR is still restricted. The D&RGW Railroad passes between the tailings site and the WSMR headquarters; I-70 is 0.5 mile south of the site. U.S. 6&50 passes within one mile north of the site, and a Utah Power and Light Company electrical transmission line passes just south of the site.

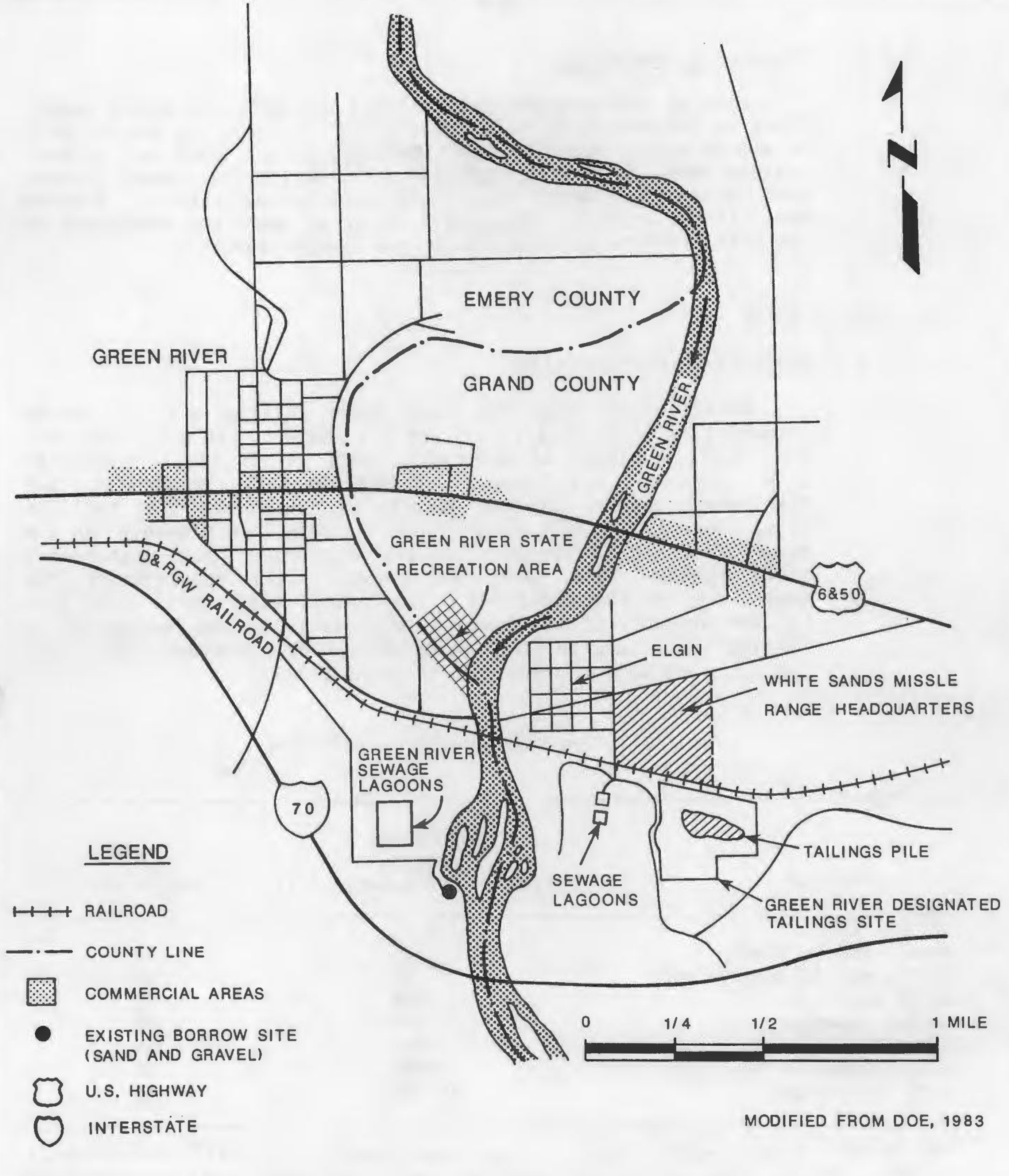

FIGURE 3.3 LAND USE, GREEN RIVER, UTAH, TAILINGS SITE

3.8.2 Proposed borrow sites

Both of the proposed borrow sites are existing borrow operations on private lands. The only other land uses in the vicinity of borrow site 1 are the Elgin Cemetery to the south and an auto salvage yard and two residences to the west. The sewage lagoons for the city of Green River are near borrow site 2. Limited agricultural activity apparently occurred west and northwest of the site prior to construction of the sewage lagoons.

3.9 AMBIENT NOISE

3.9.1 Green River tailings site

Ambient noise near the Green River tailings site is caused primarily by roads (e.g., I-70 and U.S. 6&50). Table 3.7 presents some typical values of day-night sound levels (L_{dn}) associated with various land uses. Considering the population and development pattern in the vicinity of the Green River tailings site, the L_{dn} in the Green River vicinity are probably in the range of 40 to 55 decibels on the A-weighted sound measurement scale (dBA). This sound measurement scale approximates the sensitivity of the human ear. Immediately adjacent to I-70, the L_{dn} are probably 60 to 70 dBA at a distance of 100 feet based on the traffic volume of 3770 vehicles per day (Hanshew, 1986) and the noise estimation procedures of Swing (1975).

Table 3.7 Typical day-night sound levels

Land use	Population density (people per square mile)	L_{dn}[a] (decibels)
Rural, undeveloped	20	35
Rural, partially developed	60	40
Quiet suburban	200	45
Normal suburban	600	50
Urban	2000	55
Noisy urban	6000	60
Very noisy urban	20,000	65

[a] Day-night sound level (L_{dn}) is an EPA description of environmental sound. It is the average of daytime and nighttime A-weighted energy-equivalent sound levels with nighttime sound given a penalty of 10 decibels (dBA).

Ref. NAS, 1977.

In October, 1982, noise levels were measured at several locations near the tailings site (DOE, 1983). East of the tailings pile, noise levels averaged less than 40 dBA. At a park in the center of the city of Green River, a noise level of 70 dBA was measured. At the nearest residence 0.5 mile west of the tailings pile, noise levels averaged 45 dBA. At two sites near U.S. 6&50 north of the tailings pile, noise levels of 52 and 66 dBA were measured.

3.9.2 Proposed borrow sites

Noise levels have not been measured at the proposed borrow sites; however, noise levels at these sites are probably similar to those at the tailings site. Noise levels at the borrow sites probably range from 40 to 70 dBA depending on the specific distances from the city of Green River, U.S. 6&50, and I-70.

3.10 CULTURAL RESOURCES

3.10.1 Green River tailings site

Two historic sites and one isolated historic find, all ineligible for inclusion on the National Register of Historic Places (NRHP), were identified in a cultural resource survey of 110 acres at the tailings site (CASA, 1986; Martin, 1986). One historic site consists of a trash dump associated with the railroad and the other consists of two rock cairns south of the mill buildings. One isolated projectile point (found within the historic trash dump) that is not eligible to the NRHP was also identified by the survey (CASA, 1986; Martin, 1986).

3.10.2 Proposed borrow sites

The proposed borrow sites have not been surveyed for cultural resources. Because the borrow sites have been previously disturbed by borrow operations, they are not expected to yield any cultural resources.

3.11 SOCIOECONOMIC CHARACTERISTICS

Although the city of Green River is in Emery County, Grand County socioeconomic data were used in this EA because the socioeconomic characteristics of this county are more representative of Green River than those of Emery County. Moab and Price, Utah, are the main service centers for residents of Green River; they are 55 miles southeast and 65 miles northwest, respectively, of Green River.

3.11.1 Population

Historically, population growth in the Green River area has been related primarily to uranium mining and milling activities. Beginning in 1980, the population began to decline as a result of the decrease in energy exploration and production, closure of area uranium mines, and lack of other employment opportunities. The population of Grand County decreased by 16 percent between 1981 and 1985 (Jensen, 1986). The majority of the county population resides in the Moab and Spanish Valley areas. The 1986 populations of the town of Moab and Grand County are estimated at 5000 and 6000, respectively (Keogh, 1986). The population of Green River has also declined since 1980 and the current population of Green River is estimated at 850 residents (Curtis, 1986). Green River and Grand County populations are still changing due to the lack of employment opportunities in the area.

3.11.2 Employment and economic base

The economy of the area is based primarily on government services and energy development. In 1985, the government and mining sectors provided 53 percent of all earnings in Grand County. Wholesale and retail trade, transportation, communications and other public utilities, and services were the other economic sectors of significance in Grand County (Jensen, 1986).

Employment by sector in Grand County is shown in Table 3.8. The majority of employment is within the wholesale and retail trade, government, and services sectors. Because agricultural employment is difficult to assess, it is not included in the table; however, it is estimated at two percent of all employment in Grand County (Jensen, 1986). Tourism is currently the main economic base in both Green River and Moab and is the likely source of employment in the wholesale and retail trade and services sectors. During the tourist season of April through September, approximately 200 persons of the available 400-person civilian work force in Green River are employed by the tourist industry (Curtis, 1986).

Employment in the government sector remains fairly stable. The decreases shown on Table 3.8 reflect a change in census procedures and, to a small degree, the decline in the uranium market. The decline in the uranium industry primarily occurred between 1980 and 1981; unemployment in Grand County was 6.9 percent in 1980. By 1983, the loss of employment in the uranium industry had peaked and unemployment reached 19.5 percent. The estimated 1985 unemployment level of 13.0 percent may indicate that employment in the area is beginning to stabilize (Jensen, 1986).

Table 3.8 Employment by sector in Grand County, Utah[a]

Employment sector	1980	Percent of total	1985	Percent of total	Percent change 1980-1985
Mining	732	22	322	15	-56
Construction	345	11	77	4	-78
Manufacturing	69	2	68	3	-1
Transportation, communications, and public utilities	245	7	163	7	-33
Wholesale and retail trade	809	25	595	27	-26
Finance, insurance, and real estate	88	3	71	3	-19
Services	401	12	392	18	-2
Government[b]	579	18	503	23	-13
Total employment	3268	100	2191	100	-33

[a] Employment related to agricultural activities is not included; it is estimated at two percent of all employment in Grand County.
[b] Includes employment by Federal, state, and local agencies and school districts.

Ref. Jensen, 1986.

At the present, there are no known projects that would increase employment opportunities in the Green River area. Although the numbers of unemployed persons with specific job skills are unknown, it is likely that the majority of unemployed persons are those with job skills related to the mining and construction industries who would be readily available for work. There are currently 20 to 25 experienced truck drivers and 10 to 15 heavy equipment operators available in Green River (Curtis, 1986).

3.11.3 Public finance

Grand County revenues are primarily from the property tax, sales tax, revenue sharing, B-road allotments (state funding), and payments in lieu of taxes. In 1984, county expenditures were primarily for the road and sheriff's departments. The 1984 budget for Grand County was $3,193,204 (Domenick, 1986).

3.11.4 Housing

Grand County had an estimated 1986 total housing stock of 1500 units. The city of Green River had a total of 332 units of all housing types (apartments, single-family residences, and the like) with 43 units vacant in September, 1986. The majority of the vacant units are a result of people moving to areas having better employment opportunities. In addition to conventional housing, Green River has 438 motel rooms and 303 recreational camping sites within and adjacent to the city limits (Acerson, 1986).

3.11.5 Community services

There are two schools in Green River. The elementary and high schools have current enrollments of 130 and 103 students with maximum capacities of 220 and 300 students, respectively. The major portion of the revenue base supporting the school system is the property tax (Evans, 1986).

There are no medical facilities in Green River; however, hospital, emergency, and outpatient care are available in Moab and Price, Utah. Allen Memorial Hospital in Moab has 38 beds and is currently operating at seven to nine percent of its capacity. Treatment of acute injuries is also available through the use of Air Lift from Moab to Grand Junction, Colorado. Castleview Hospital in Price has 88 beds and averages 45 percent occupancy (Marshall, 1986; Prater, 1986). Emergency medical attention is also provided by the Emery County sheriff's department (Hansen, 1986). Social services in Price are available to residents of Green River.

Law enforcement in Green River is provided by the Emery County Sheriff's department, which also has responsibility for the tailings site. One officer is on duty in the Green River area at all times. The city of Green River maintains a 25-person volunteer fire department (Hansen, 1986).

The Green River water and sewage treatment plants were operating below capacity in 1986. Average daily potable water use is 400,000 gallons, and peak use may reach 750,000 gallons. The water treatment plant production capacity is 1.5 million gallons per day (gpd) (Flucky, 1986). The sewage treatment plant is designed to process 331,000 gpd. The average 1986 use was 69,000 gpd and peak use was 90,000 gpd (Acerson, 1986).

3.12 TRANSPORTATION

The primary highway access between the tailings and borrow sites is U.S. 6&50. In 1985, average daily traffic (ADT) on this paved, two-lane highway at the Emery-Grand County line in Green River was 1890 vehicles (Labrum, 1986). Average hourly traffic (12 percent of ADT) at this location was 227 vehicles, which is well below the highway design capacity of 850 vehicles (Riddle, 1986).

U.S. 6&50 was the main east-west highway access through the Green River area before I-70 was completed. Pre-1985 ADT counts were two times the 1985 count and apparently did not reflect local traffic (Labrum, 1986). I-70 is presently the main transportation corridor in this area of Utah. It originates east of Denver, Colorado, and provides access to Salt Lake City, Utah, west of Green River. In 1985, traffic on I-70 in the vicinity of Green River averaged 3000 vehicles per day (Hood, 1986).

No fatal accidents were recorded on U.S. 6&50 at the Emery-Grand County line in 1985; however, two injuries and two property accidents were recorded at that location. The combined injury and property accident rate was 4.01 per one million vehicle-miles (Labrum, 1986).

The D&RGW Railroad, just north of the tailings site, currently carries two passenger and 14 freight trains daily (Green, 1986). Green River is also serviced by commercial bus service and a small municipal airport.

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4.0 ENVIRONMENTAL IMPACTS

The environmental impacts of the proposed remedial action are discussed in this section and represent a realistic upper limit for the severity of the environmental impacts that may occur. Although the remedial action period would be 15 months, the environmental impacts are based on a 14-month period because the last month would not involve construction; thus, there would be limited personnel on the site and no equipment use. The 14-month projected schedule includes a period of three months for possible shutdowns due to severe weather or other unforeseeable circumstances. Both of the action alternatives include remedial action for structures on the site and at 15 vicinity properties. It should also be noted that, for the purpose of evaluating impacts and for conceptual design, specific borrow sites were identified; however, other borrow sites may be identified during the final design and used for remedial action. The impacts identified for these borrow sites are conservative and represent a realistic upper limit on the severity of the impacts that may occur. The impacts of remedial action at the vicinity properties were previously assessed in a programmatic environmental report (DOE, 1985a) and are therefore not considered in this section.

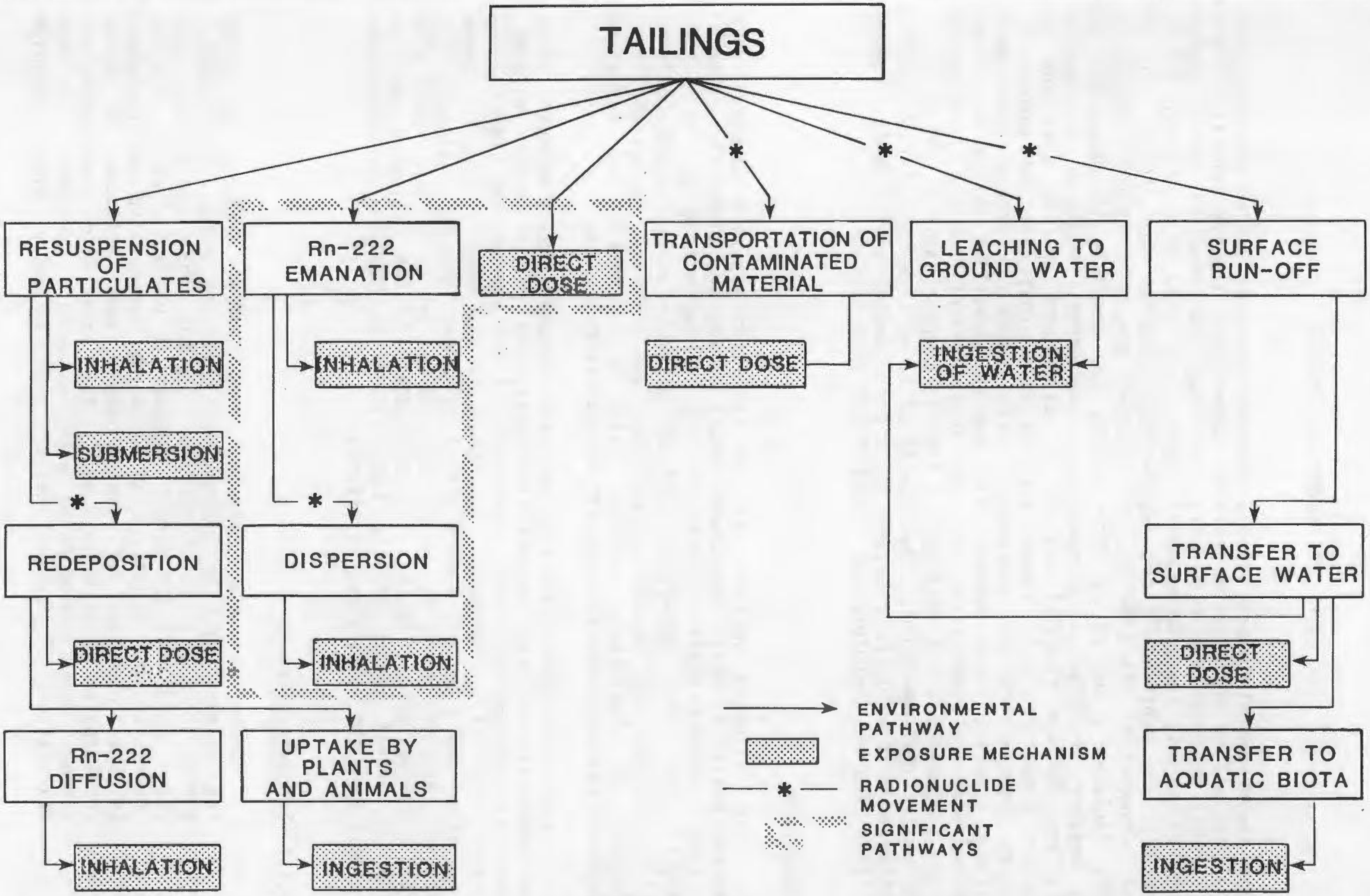
4.1 RADIATION

The following sections discuss radiation exposure pathways, the excess health effects that would result during and after the remedial action, and the health effects of construction-related accidents that might occur. The procedures used to estimate excess health effects (i.e., cancers) are based on realistic, but conservative, assumptions. Appendix D, Radiation, contains detailed discussions of radiation exposure pathways and excess health effects calculations.

Exposure to gamma radiation may cause somatic health effects, which are manifested in the exposed individual, and genetic health effects, which are manifested in the descendants of the exposed individual. The genetic risk is approximately two-thirds of the somatic risk for gamma radiation, and a genetic health effect in general may be considered less severe. Measures taken to reduce the somatic health effects would also reduce the genetic effects. The discussions in the following sections and the excess health effects calculations in Appendix D, Radiation, reflect only the somatic health effects.

4.1.1 Exposure pathways

There are five principal radiological pathways by which individuals could be exposed to radiation during the remedial action (Figure 4.1). These are: (1) the inhalation of radon and radon daughters; (2) direct exposure to gamma radiation; (3) the inhalation and ingestion of airborne radioactive particulates; (4) the ingestion of contaminated foods produced in areas contaminated by tailings; and (5) the ingestion of groundwater and surface water contaminated with radioactive materials. For the calculation of excess health effects, only those pathways



REF : NRC, 1981a,b; 1980

FIGURE 4.1
POTENTIAL RADIATION EXPOSURE PATHWAYS
TO THE GENERAL PUBLIC AND REMEDIAL ACTION WORKERS

that would result in the largest radiological doses to the general population were considered in detail. These are the inhalation of radon and radon daughters and direct exposure to gamma radiation. Section D.2 of Appendix D briefly discusses why the other pathways were not considered quantitatively.

Radon is an inert gas (i.e., it does not react chemically with other elements) produced from the radioactive decay of Ra-226 in the U-238 decay series. As a gas, radon can diffuse through the tailings and into the atmosphere where it is transported by atmospheric winds. In the atmosphere, radon decays into its solid daughter products, which attach to airborne dust particles and may be inhaled by humans. These dust particles, with the radon daughter products attached, may adhere to the lining of the lungs and decay, releasing alpha radiation directly to the lungs.

Gamma radiation is also emitted by many members of the U-238 decay series. Gamma radiation behaves independently of atmospheric conditions and travels in a straight line until it interacts with matter. Gamma radiation emitted from the tailings delivers an external exposure to the whole body. Gamma radiation levels become negligible beyond 0.3 mile from the perimeter of a tailings pile due to the interaction of the gamma particles with matter in the air. At the Green River tailings site, gamma radiation exposure rates reach the average background rate within 0.2 mile of the existing tailings pile.

The general population may be exposed to radon daughters and direct gamma radiation from the uncovered Green River tailings pile. Currently, there are no effective barriers to prevent continued dispersion and unauthorized removal and use of the tailings by man, which could increase the general population's exposure to radon daughters and gamma radiation.

During remedial action, the radon daughters and gamma radiation exposure to the general population would increase as the tailings are disturbed. Remedial action workers would also be exposed to these pathways during remedial action. Following remedial action, there would be no exposure to direct gamma radiation since the tailings would be covered with earthen material which would attenuate the gamma radiation to a negligible level. However, there would continue to be a small public exposure to radon and radon daughters following remedial action because the earthen cover would substantially reduce the release of radon to the atmosphere (to the EPA standard) but would not entirely eliminate this release. The earthen cover would have a very low permeability and most of the radon would decay into its solid daughter products before it could diffuse through the cover and enter the atmosphere.

4.1.2 Excess health effects during remedial action

Proposed action

Table 4.1 lists the estimated excess health effects that would occur during remedial action for the proposed action.

Table 4.1 Estimated excess health effects during the proposed action, Green River, Utah, tailings site

	Excess health effects		
	Radon daughters	Gamma exposure	Total
Remedial action workers	0.0002	0.0003	0.0005
General population	0.00009	0.0	0.00009
Total			0.0006

The percentage increase in radon released from the tailings during remedial action would be small relative to the radon released prior to remedial action because there are large radon fluxes from the existing tailings pile under present conditions. During remedial action, increases in gamma exposure rates and airborne radioactive particulates concentrations would be larger than the radon concentration increase compared to levels prior to remedial action. These increased exposure rates would be due to disturbance of the tailings. However, control measures would be applied during remedial action to keep airborne radioactive particulate concentrations at a nonhazardous level.

The elevated gamma exposure rates during disturbance of the tailings would increase the excess health effects to the remedial action workers. The maximum risk to remedial action workers from inhalation of airborne radioactive particulates would be only a small percentage of the risk from exposure to radon daughters and gamma radiation, and the airborne radioactive particulates exposure to the general population would be even less (DOE, 1985b,c; 1984a,b; 1983). Inhalation of radon daughters would be the dominant exposure pathway in the excess health effects calculations for the general population.

The excess health effects to the general population during remedial action are principally dependent on the amount of tailings and contaminated materials to be moved and the number of people who live nearby. The estimated excess health effects are very small in comparison to the natural incidence of cancer. For example, the proposed action would result in a total of 0.00009 (the sum of radon daughters and gamma radiation) general population excess health effects during the remedial action based on the present population distribution in the vicinity of the Green River tailings site. This is a 0.00001 percent chance (based on 0.00009 excess health effects and an exposed population of 800 people) of contracting a cancer due to radiation from the tailings site or one chance in 100,000. In the United States, an individual has a 16 percent chance (or approximately one chance in six) of contracting cancer (NAS, 1980).

No action

The no action alternative would result in a total of 0.0001 estimated excess health effects per year. This number is not directly correlated to the total estimated excess health effects (0.0006) listed in Table 4.1 because the excess health effects associated with the proposed action are for 10 months of tailings exposure and disturbance and account for increased radon levels due to tailings disturbance. In addition, the total estimated excess health effects for the no action alternative do not consider factors such as dispersion or unauthorized removal and use of the tailings which could lead to greater excess health effects than those calculated.

Stabilization in place

The stabilization in place alternative would result in fewer total excess health effects than the proposed action. Since the tailings would not be moved, it is assumed that the tailings would be uncovered for a shorter time, the radon release from the pile would be limited, and, therefore, the resulting downwind radon concentrations would be smaller.

4.1.3 Excess health effects after remedial action

As stated previously, there would be no exposure to direct gamma radiation after remedial action because the use of an earthen cover for the stabilized tailings would reduce gamma radiation to approximately background levels. This cover would also ensure that, after remedial action, radon releases would be no greater than allowed by the EPA standard.

Proposed action

Table 4.2 lists the estimated yearly excess health effects after the proposed action. These effects would occur because the tailings would remain near the city of Green River.

Table 4.2 Estimated yearly excess health effects to the general population after the proposed action, Green River, Utah, tailings site

Excess health effects		
Radon daughters	Gamma Exposure	Total
0.00003	0.0	0.00003

Table 4.3 lists the estimated total excess health effects that would occur over five, 10, 100, 200, and 1000 years following the proposed action and no action. These excess health effects are the sum of the total excess health effects that would occur during remedial action (Table 4.1) and the integrated yearly excess health effects that would occur after remedial action (Table 4.2). The estimates in Table 4.3 reflect a stable population; the total excess health effects would increase if the nearby population increased.

Table 4.3 Estimated total excess health effects five, 10, 100, 200, and 1000 years after remedial action, Green River, Utah, tailings site

Remedial action alternative	Number of years after remedial action				
	5	10	100	200	1000
Proposed action	0.0007	0.0009	0.004	0.006	0.03
No action	0.0005	0.001	0.01	0.02	0.1

No action

The no action alternative would result in 0.0001 yearly excess health effects to the general population, which is three times greater than after the proposed action. The estimated excess health effects for the no action alternative do not consider the dispersion of the tailings by natural erosion or by man because there is no way to accurately predict the level or rate of dispersion. However, without remedial action, dispersion would occur over time, and the actual total excess health effects might be greater than those shown in Table 4.3.

Stabilization in place

The radon daughters excess health effects to the general population after stabilization in place would be the same as those estimated for the proposed action.

4.2 AIR QUALITY

Proposed action

The air-quality impacts of the proposed action were estimated by developing a detailed emissions inventory and modeling the resultant air pollutant concentrations. The emissions inventory includes estimated combustion emissions from construction equipment and fugitive dust emissions (total suspended particulates, or TSP) from wind erosion and the movement of tailings and borrow materials. Combustion emissions include hydrocarbons (HC), nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), and TSP. The combustion and fugitive dust emissions for construction equipment and the movement of materials were calculated using air pollutant emission factors for construction equipment and associated operations (Table 4.4). These emissions calculations were based on parameters such as fuel consumption, vehicle-miles travelled, vehicle speed, and the volumes of materials moved. Fugitive dust emissions from wind erosion were calculated using an adaptation of the universal soil loss equation, which includes components for soil erodibility, local climate, the size of the exposed area, and the vegetative cover (Colorado Department of Health, 1981).

Estimated total air pollutant emissions during the proposed action are shown in Table 4.5. The most prominent gaseous air pollutants would be NO_x and CO. The total combustion emissions shown in Table 4.5 are relatively small and would be only temporary (14 months). Furthermore, these emissions would include emissions from haul trucks, most of which would operate over wide areas between the tailings and borrow sites. Although TSP from fugitive dust emissions would be high, combustion emissions would be a very minor source of TSP.

Ambient air pollution concentrations were estimated using the Industrial Source Complex Short Term (ISCST) dispersion model (EPA, 1983). Given information concerning emission rates, source locations, and meteorology, this computer model predicts air pollutant concentrations downwind from the source. The ISCST model is particularly appropriate for this analysis because it considers gravitational settling of particulates and it can accommodate both large area emissions sources and line emissions sources such as haul roads. For the proposed action, only fugitive TSP concentrations were estimated with the ISCST model; emissions of gaseous air pollutants would be much lower than fugitive TSP emissions (Table 4.5), and the resulting concentrations of gaseous air pollutants would be well below the applicable air quality standards (see Table 3.3).

Table 4.4 Air pollutant emission factors

Type of equipment	Fugitive dust emissions[a]	Combustion emissions[b,c]				
	TSP	HC	NO_X	SO_X	CO	TSP
Crane	None	33.7	368	31.1	153.5	30.1
Compactor	7 lb/hr[c]	30.1	405	31.1	188.4	24.2
Bulldozer	32 lb/hr[d]	13.2	286	31.2	123.5	14.8
Front-end loader (5-cy)[a]	0.037 lb/cy[d]	43.2	321	31.2	98.7	29.3
Grader	32 lb/hr[d]	12.7	254	31.1	54.6	22.2
Scraper	16 lb/hr[d]	19.0	259	31.2	84.6	27.3
Haul truck (10 cy)[a]						
on-site hauling	17 lb/hr[c]	13.2	286	31.2	123.5	17.7
dumping	0.04 lb/cy[d]	None	None	None	None	None
Haul truck (20 cy)[a]						
hauling (unpaved)	26.07 lb/mi[c]	3.0	18	2.8	9.0	1.7
dumping	0.04 lb/cy[d]	None	None	None	None	None
Water truck	7 lb/hr[c]	13.2	286	31.2	123.5	17.7
Pick-up truck	7 lb/hr[c]	130.0	96	5.3	3960.0	6.1
Flat-bed truck	7 lb/hr[c]	33.7	368	31.1	153.5	30.1
Backhoe	16 lb/hr[c]	33.7	368	31.1	153.5	30.1

[a] TSP = total suspended particulates; lb/hr = pounds per hour; lb/cy = pounds per cubic yard; lb/mi = pounds per mile; cy = cubic yard.

[b] HC = hydrocarbons; NO_X = nitrogen oxides; SO_X = sulfur oxides; CO = carbon monoxide; combustion emission factors are in pounds per 1000 gallons of fuel consumed except those for 20-cubic-yard trucks, which are in grams per mile.

[c] Ref. EPA, 1985.

[d] Ref. Colorado Department of Health, 1981.

Table 4.5 Estimated total air pollutant emissions during the proposed action, Green River, Utah, tailings site[a]

Activity	Combustion emissions					Fugitive dust emissions
	HC	NO_x	SO_x	CO	TSP	TSP
Proposed action, Green River tailings site	1.27	15.80	1.66	11.95	1.25	178.91
Borrow activities, borrow sites 1 and 2	0.49	5.87	0.63	4.73	0.46	47.07
Truck haulage to and from borrow sites 1 and 2	0.12	0.73	0.12	0.37	0.07	232.00
Totals	1.88	22.40	2.41	17.05	1.78	457.98

[a] Emissions are in total tons for the duration of remedial action; HC = hydrocarbons; NO_x = nitrogen oxides; SO_x = sulfur oxides; TSP = total suspended particulates.

Modeling for the proposed action was performed for the remedial action activities at the tailings and borrow sites and for truck haulage between the tailings and borrow sites. The short-term fugitive TSP emission rates used in the modeling (Table 4.6) represent those that would occur in the months of maximum activity, and it was conservatively assumed that all equipment used during these peak periods at the tailings and borrow sites would be operating concurrently. For wind erosion, the average rate of fugitive TSP emissions for the remedial action was used. Emissions from unpaved haul roads between the tailings and borrow sites were based on peak truck traffic (i.e., maximum truck trips per hour) over 900-meter lengths of each haul road. Dust control measures at the tailings and borrow sites (water sprays) and on the unpaved haul roads (chemical dust suppressant) were assumed to be 50 and 85 percent effective, respectively (Colorado Department of Health, 1981). For the ISCST model, receptors were placed downwind of the tailings and borrow sites and haul roads at 250-meter intervals out to a distance of 1500 meters. Light winds (2.5 meters per second) were assumed to blow persistently from a single direction under stable meteorological conditions (Pasquil-Gifford Category F), and these conditions were allowed to persist for the first six hours of the 24-hour modeling period. For the haul roads, the wind was assumed to blow perpendicularly to the roads.

The estimated maximum 24-hour increases in TSP concentrations for the proposed action are presented in Table 4.7. It is expected that maximum 24-hour TSP concentrations at or near the tailings and

Table 4.6 Estimated maximum hourly fugitive total suspended particulates emission rates for the proposed action, Green River, Utah, tailings site[a]

	Tailings site	Borrow site 1	Borrow site 2
Month of maximum activity	7	9	12
Uncontrolled emissions[b] (lb/hr)			
Compactors	21.00	14.00	None
Bulldozers	96.00	96.00	128.00
Front-end loaders	4.07	4.85	3.44
Graders	96.00	64.00	None
Scrapers	112.00	64.00	None
Water trucks	21.00	14.00	None
Pick-up trucks	14.00	14.00	14.00
On-site trucks	51.00	34.00	51.00
Truck dumping	13.36	None	None
Wind erosion	12.46	2.05	0.42
Total uncontrolled emissions[b] (lb/hr)	440.89	306.90	196.87
Total controlled emissions[b] (lb/hr)	220.44	153.45	98.44
Total controlled emissions[b] (g/s)	27.78	19.34	12.40

[a] Emissions from the Green River tailings site were assumed to be from a single 217,700-square-meter (53.8-acre) area source. Emissions from borrow site 1 were assumed to be from a single 48,500-square-meter (12-acre) area source, and emissions from borrow site 2 were assumed to be from a single 10,100-square-meter (2.5-acre) area source.

[b] Estimated emission rates are presented in pounds per hour (lb/hr) and grams per second (g/s).

Table 4.7 Estimated maximum 24-hour increases in total suspended particulate (TSP) concentrations for the proposed action, Green River, Utah, tailings site[a]

Source	Estimated maximum 24-hour increase in TSP concentration
Tailings site	323
Borrow site 1	434
Borrow site 2	1110
Haul road to borrow site 1	57
Haul road to borrow site 2	41

[a] Estimated maximum 24-hour increases in TSP concentrations are in micrograms per cubic meter (microg/m^3) and do not include background TSP concentrations.

borrow sites would exceed the applicable primary (260 micrograms per cubic meter, or microg/m^3) and secondary (150 microg/m^3) standards because the estimated project increments by themselves greatly exceed those standards. The estimated maximum 24-hour TSP concentration increases along the unpaved haul roads represent less than 50 percent of the applicable secondary 24-hour TSP standards, assuming 85 percent dust control with chemical dust suppressants.

The maximum increases in annual TSP concentrations during the proposed action were not estimated due to the lack of data on the annual distribution of wind speeds and stability classes for the Green River area. Maximum increases in annual TSP concentrations would be substantially less than the conservatively estimated maximum 24-hour TSP increases. However, it is likely that annual TSP concentrations in areas very near the tailings and borrow sites would exceed applicable annual TSP standards (Table 3.3). The Green River area is an attainment area (Dalley, 1986), although air quality data for 1980 through 1985 (Table 3.4) indicate that annual TSP concentrations exceed the annual secondary standard.

No action

The no action alternative would not involve any remedial action; therefore, there would be no sources for emissions of gaseous air pollutants (HC, NO_x, SO_x, and CO). However, this alternative would contribute fugitive TSP to the ambient atmosphere due to the dispersion of the tailings by wind erosion. This contribution would be somewhat greater than that from undisturbed areas due to the sparse vegetative cover on the existing tailings pile.

Stabilization in place

The stabilization in place alternative would result in lower maximum gaseous pollutant and TSP concentrations at the tailings site relative to the proposed action due to reduced emissions rates from lower equipment activity levels. However, this alternative would result in slightly greater emissions rates at the borrow sites due to the slightly larger volumes of borrow materials required. Fugitive dust emissions and resultant TSP concentrations along the gravelled haul roads would be slightly greater relative to the proposed action because of the increased truck trips for hauling borrow materials.

4.3 MINERAL RESOURCES AND SOILS

4.3.1 Mineral resources

The action alternatives would result in the consumption of borrow materials (earth, sand, gravel, and rock). The consumption of these materials from the proposed local sources would constitute a permanent loss of these resources and would affect the availability and cost of these resources in the Green River area because sources of these materials are limited. The action alternatives would not be expected to have an impact on other mineral resources in the area. While the formations beneath the tailings and borrow sites are known to contain mineral deposits in some areas, no mineral production has occurred in the immediate site area.

Stabilization of the tailings at the Green River site would not necessarily preclude future development of any potential mineral or oil and gas resources beneath the site. Public Law 95-604 (PL95-604) requires that the mineral rights for the disposal site be transferred to the Federal government along with the disposal site. PL95-604 also authorizes the Secretary of the Interior, with the concurrence of the Secretary of Energy and the Nuclear Regulatory Commission, to dispose "of any subsurface mineral rights by sale or lease . . . if the Secretary of the Interior takes such action as the Commission deems necessary pursuant to a license issued by the Commission to assure that the residual radioactive materials will not be disturbed by reason of any activity carried on following such disposition." Any development of mineral, oil, or gas resources from beneath the site would be governed by license conditions to prevent any disturbance of the stabilized tailings pile. If the costs of avoiding disturbance of the pile were too high, resource development would be precluded.

Proposed action

The estimated in-place volumes of uncontaminated borrow materials that would be required for the proposed action are 208,000 cy of earthen materials, 8000 cy of sand and gravel, and

28,000 cy of rock. The sources and uses of these borrow materials are described in Section 2.2 and Section A.2 of Appendix A, Conceptual Designs.

There are no mining claims or mineral leases on file for the two borrow sites. The temporary borrow activities at the sites would not permanently preclude any potential mining or oil and gas activities.

No action

The no action alternative would not require the consumption of borrow materials because there would be no remedial action.

Stabilization in place

The in-place volumes of uncontaminated borrow materials that would be required for the stabilization in place alternative at the Green River tailings site would be similar to those required for the proposed action; however, slightly greater amounts of earthen and rock borrow materials would be required for restoration of the mill yard and floodplain area and for erosion protection. These borrow materials would be obtained from the same proposed borrow sites.

4.3.2 Soils

Proposed action

The proposed action at the Green River tailings site would result in the permanent loss of 78 acres of soils during the cleanup of the areas contaminated by the tailings pile (eight acres), the mill yard and ore storage area (21 acres), the windblown and waterborne tailings (43 acres), and the site of the stabilized pile (six acres). Sixty-nine acres (eight acres at the existing tailings pile, 21 acres at the mill yard and ore storage area, and 40 acres of windblown and waterborne contamination) of the 78 acres disturbed would be restored with uncontaminated fill and graded to promote surface drainage. The eight acres of the existing tailings pile would also be revegetated.

The proposed action would require the use of borrow materials (earth, sand, gravel, and rock). Both proposed borrow sites have been previously disturbed by borrow operations. At borrow site 1, 12 acres of soil would be permanently lost during the excavation of earthen, sand, and gravel materials. Three acres of soil would be permanently lost at borrow site 2 during the excavation of rock. The borrow sites would not be restored or revegetated. Earthen material for the layer of select fill and the restoration of the floodplain and mill yard would be obtained from the excavation of the below-grade disposal area.

Existing roads to borrow sites 1 and 2 would be used during remedial action; therefore, no additional acreage would be required for the construction of haul roads. These roads, however, would be upgraded for remedial action use.

No action

The no action alternative would not involve remedial action; therefore, no new disturbance or loss of soils would occur. The contamination (with Ra-226) of soils adjacent to the existing tailings pile due to dispersion of the tailings by wind and water erosion would continue. The rate of this continuing contamination cannot be accurately estimated, but 64 acres of soils have been contaminated to date.

Stabilization in place

Stabilization of the tailings and contaminated materials at the existing tailings pile would result in a similar amount of soils disturbance as the proposed action; however, acreage outside the designated tailings site boundary would not be required for the stabilized pile. Additional borrow materials would be required from proposed borrow sites 1 and 2 to restore the floodplain and mill yard and for erosion protection; however, this would not require additional acreage to be disturbed at the proposed borrow sites. Relative to the proposed action, there would be equal amounts of soils permanently lost at the borrow sites.

4.4 WATER

4.4.1 Surface water

The following section describes the potential surface-water impacts from the remedial action alternatives and summarizes water use during each of the remedial action alternatives. Additional details are provided in Section B.1 of Appendix B, Hydrology.

Proposed action

During the proposed action, the cleanup and consolidation of the tailings and other contaminated materials would result in surface disturbance, and runoff from these disturbed areas could be contaminated. Also, contaminated waste water would be generated by activities such as equipment washing. The remedial action design includes the construction of drainage and erosion controls, including waste-water retention pond(s), to prevent the discharge of contaminated water from the site. These control measures would be constructed according to applicable regulations (see Appendix E, Permits, Licenses, and Approvals). The contaminated water would be retained for evaporation or use in the compaction of the tailings and contaminated materials and any sediments from the pond(s) would be consolidated with the tailings during the final shaping of the stabilized tailings pile.

Appropriate drainage and erosion controls would be used at both proposed borrow sites to minimize or prevent erosion and any corresponding surface-water impacts. Since the sites have been previously disturbed by borrow operations, they would not be restored.

After remedial action, surface runoff created by excessive rainfall would not cause erosion of the stabilized tailings pile and transport of contaminants into local surface waters because several erosion control features are incorporated into the remedial action design. The sideslopes of the pile would be limited to ten horizontal to one vertical (10 percent); the top of the pile would be gently sloped (five percent) to promote drainage from the pile with nonerosive flow velocities. A rock erosion protection barrier would be placed on the top and sideslopes of the stabilized pile to resist the erosive forces of severe rainfall events such as a PMP. The below-grade rock apron, designed to withstand the runoff from the PMP on the pile and the upstream drainage area, would also prevent erosion of the stabilized tailings pile and contamination of nearby surface water.

No action

The no action alternative would result in the continued exposure of the existing tailings pile to erosion from surface runoff and flood flows in Brown's Wash. Eventual erosion of the tailings would result in the transport of contaminants into Brown's Wash, which could result in increases in the concentrations of contaminants in the wash and in the Green River.

Stabilization in place

The stabilization in place alternative would incorporate erosion protection measures similar to the proposed action to prevent the release of contaminants from the site and to ensure the long-term stability of the pile. These measures would include construction of drainage and erosion controls at the tailings site, placement of a rock erosion protection barrier over the stabilized pile, and construction of a rock apron around the stabilized pile to prevent erosion of the base of the pile. Surface waters near the tailings site would not be impacted after remedial action because features incorporated into the design would minimize the amount of surface water coming in contact with the tailings.

4.4.2 Groundwater

Proposed action

The disposal cell design incorporates many natural, durable components that would minimize infiltration and leachate generation. This, in turn, would cause the least impact to the groundwater. Compliance with the proposed EPA standards would be achieved by the following:

- Below-grade disposal of the tailings to limit the exposed area of the stabilized pile, thereby maximizing evaporation and minimizing stabilized percolation of precipitation through the tailings.
- Emplacement of a cover system consisting of filter layers, an erosion protection barrier, a radon/infiltration barrier to reduce infiltration and promote surface runoff and evaporation, and a layer to protect the radon/infiltration barrier from frost action.
- Minimization of tailings seepage by the use of a low hydraulic conductivity radon/infiltration barrier to reduce infiltration.
- Consistent, uniform, vertical fracturing of the foundation bedrock to prevent ponding ("bathtubbing") in the tailings and promote drainage of runoff from the toe of the cell.
- Natural geochemical attenuation of contaminants in the tailings seepage by adsorption and precipitation reactions within the Cedar Mountain Formation fractured bedrock beneath and downgradient of the disposal cell.
- Strong, upward, vertical hydraulic gradients in the saturated bedrock downgradient of the disposal site to inhibit downward migration of contamination.
- Natural dilution (mixing) of the tailings seepage by groundwater underflow in the Cedar Mountain Formation.
- Limitation of the lateral extent of any future contamination from tailings seepage from the disposal cell; the prevailing flow of the shallow groundwater is toward the existing contaminant plume at the mill site.

Compliance

Of the 14 constituents for which there are proposed MCLs, only nitrate, uranium, and gross alpha are predicted to exceed the MCLs at the toe of the disposal cell. A detailed discussion of the ability of the proposed remedial action to achieve compliance is provided in Section B.5 of Appendix B, Hydrology, and is summarized below.

Seepage impacts were calculated for the upper- and lower-middle hydrostratigraphic units. The top hydrostratigraphic unit (Brown's Wash alluvium) is not present beneath the disposal site. The strong, vertically upward hydraulic gradients that exist between the bedrock units would restrict the movement of any tailings seepage into the bottom hydrostratigraphic unit (see Section B.4.7.5, Appendix B).

For modeling purposes, it was assumed that the tailings seepage would mix with the upper-middle unit and the saturated lower-middle unit beneath the disposal cell. Results of the mixing calculations predict that uranium, nitrate, and gross alpha are the only constituents that would exceed the proposed EPA MCLs and background levels at the toe of the disposal cell for both hydrostratigraphic units (see Section B.5.2.1, Appendix B).

Migration of the equilibrated leachate through the groundwater was modeled using the Domenico and Robbins (1985) approximate analytical solution of the convection-dispersion equation. Modeling input and results are summarized in Table B.5.4 of Appendix B. Assuming no geochemical attenuation, nitrate would disperse to a background level of 85 mg/l at a distance of 440 feet downgradient of the mixing zone in the upper-middle unit (see Table B.5.5, Appendix B). Nitrate would disperse to a background level of 90 mg/l at a distance 435 feet downgradient of the mixing zone; however, since the mixing zone for the lower-middle unit is beneath the northern half of the disposal cell, this distance is approximately the downgradient toe of the disposal cell (see Table B.5.6, Appendix B).

Dispersion of uranium and gross alpha was not modeled because of the high resultant concentrations of these constituents estimated by mixing calculations. Geochemical attenuation is expected to be an important factor in removing these contaminants from the groundwater downgradient of the disposal cell. Based on the uranium plume at the existing tailings site, uranium and gross alpha are predicted to disperse to background levels or the proposed MCLs within 600 feet of the mixing zone (see Tables B.5.5 and B.5.6, Appendix B and Section 4.2.6.2, Natural flushing, below).

The presence of pyrite in the fractures suggests that relatively reducing conditions exist in portions of the Cedar Mountain aquifer (DOE, 1987). Uranium would remain in solution in groundwater following neutralization until it encounters reducing conditions sufficient to precipitate uranium (forming uraninite). Additional sampling will be conducted to determine whether or not the groundwater is sufficiently chemically reducing to precipitate uranium out of solution. In addition to the existing mineralogical evidence (presence of pyrite and organic matter), data on redox couples will be the most important information gathered to determine if uranium is precipitating from solution beneath the existing pile (see Section B.5.2.4, Appendix B).

Alternate concentration limits

In the event compliance with the proposed standards for nitrate, uranium, and gross alpha cannot be achieved with the proposed conceptual design, one or more alternative designs such as those described in Section A.1.3.1 of Appendix A, Conceptual Designs, would be considered. Alternate concentrations limits (ACLs) may also be considered. However, any proposal to apply ACLs must have the concurrence of the NRC and would be justified only if it can 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)). ACLs could be applied provided that, after considering practicable corrective actions, 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 (ALARA).

A preliminary evaluation indicates that groundwater in the vicinity of the disposal site is of naturally poor quality (Class II or possibly Class III) and is currently not used in the Green River area. There is an ample supply of good-quality water available from the Green River, which is currently used for drinking water and other purposes. The continued supply of water from this source makes it unlikely that the groundwater in the disposal site area would be needed for future water supplies. Given the natural geochemical attenuation of contaminants coupled with the natural dilution of tailings seepage, the probability of a present or potential hazard to human health is low (see Section B.5.3.1, Appendix B).

Supplemental standards

Background water quality for the subject constituents indicates widespread ambient contamination (see Section 4.2.3, Aquifer restoration, below); therefore, the proposed remedial action at the Green River tailings site may be eligible for supplemental standards (40 CFR Part 192.21(g)). However, the DOE believes that the use of ACLs is more appropriate than supplemental standards at the Green River site.

No action

Under existing conditions, the volume of recharge to the tailings pile has dropped to only that produced during natural precipitation and infiltration. Both the quantity and rate of seepage from the tailings pile has decreased significantly from the period of active milling. Both nitrate and uranium plumes in the upper-middle unit beneath the existing tailings pile appear to be attenuated. Given a velocity of 0.41 ft/day, nitrate and uranium should have traveled about 2500 feet downgradient. However, the naturally occurring geochemical attenuating capacity of the groundwater and fractured bedrock have inhibited the extent of the existing contamination.

If there is no remedial action, it may be expected that continued leaching of contaminants from the tailings piles would continue at a decreasing rate, and the discharge of groundwater contaminated by tailings leachate would ultimately cease.

Stabilization in place

Stabilization in place would involve consolidation, reconfiguration, and compaction of the tailings and contaminated material. This action would cause a slight temporary increase in drainage from the pile and a subsequent minor insurgence of contaminants into the top and upper-middle hydrostratigraphic units. This minor influx would be of short duration, during and immediately following remedial action. The pile would be stabilized similar to the proposed action; thus, the leaching of contaminants into the underlying aquifers would be minimized similar to the proposed action unless shallow groundwater were to rise up and intercept the base of the stabilized pile. This scenario is unlikely since, at a minimum, the water table is five feet beneath the base of the present tailings. The substantial decrease in generation and migration of contamination from the tailings pile would eventually reduce the concentrations of contaminants toward background levels as shown in Section B.5, Appendix B.

4.4.3 Aquifer restoration

Cleanup of contaminated groundwater is required under the conditions of Subpart B of the proposed standards. The actual need for and extent of aquifer restoration at the Green River site will 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.

Aquifer restoration methods

Active restoration methods fall into two general categories: (1) above-ground removal 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 to mobilize the contamination in the subsurface aquifer system. An aquifer restoration program at the Green River site may involve one or more of the restoration methods discussed below.

Extraction

Contaminated groundwater can be extracted with wells or trenches. The use of trenches is limited to relatively shallow contamination (generally less than 100 feet deep) and is most useful in materials with low permeability. For most cases where the contamination is in permeable materials and in cases of low permeability but deep contamination, wells are the preferred extraction method.

Treatment

The need for treatment prior to discharge or reinjection into an aquifer depends upon the concentrations of contaminants in the extracted groundwater and the regulations regarding discharge of effluent to surface and groundwater. Various methods for treating the contaminated water are available. Most of the treatment methods are chemical. These include chemical precipitation, coagulation, ion exchange, flocculation, neutralization, sorption, and reverse osmosis. Contamination can be separated physically from water using evaporation ponds. Biological treatment can be used to transform nitrate to nitrogen gas and oxygen gas. The preferred treatment methods depend on the specific mix of contaminants, the concentration of the contaminants, the general water quality, the volumetric flow of the treatment stream, and the available area for treatment facilities.

In-situ treatment

In addition to above-ground treatment, two in-situ treatment methods may be applied. These are lixiviant injection and permeable treatment beds or walls. Both methods can be used to cause reducing geochemical conditions, which would cause the trace metal contaminants to precipitate or adsorb out of solution into the solid phase. Although chemical reduction could reduce solute concentrations to less than the appropriate concentration limits, dissolution or desorption could occur as the geochemical environment reequilibrates. Therefore, chemical reduction does not provide long-term assurances that adequate water quality could be maintained. The preferred in-situ treatment would result in mobilizing contaminants by causing oxidizing conditions so that contaminants can be removed expeditiously from the subsurface. Permeable treatment beds or walls cannot be used effectively for this purpose.

A lixiviant is a solution of complexing species (either ions or molecules) which enhance the solubility of species (metals) to be removed from the aquifer during restoration. Injection of oxidizing lixiviants containing hydrogen peroxide or oxygen to oxidize the system and sodium bicarbonate to increase the pH may be useful for removing contaminants that may leach from the solid phase. Although this technology is unproven, it may be the only practicable method to remove trace metal contamination, primarily in the solid phase, that leaches to the groundwater at concentrations above the acceptable concentration limits.

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 contaminants, and be extracted at the leading edge of the contaminant plume.

Discharge

Following the extraction, or extraction and treatment, of contaminated water, the water would be discharged. Options for discharge include:

- Discharge to surface water.
- Infiltration.
- 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 over time by the natural flow of groundwater. Under Subpart B of the proposed EPA standards, passive restoration may be permitted if it can be demonstrated that natural flushing can occur within a period of 100 years or less and where groundwater is not now and is not projected to be used for a community water supply (or other substantial use) within this period. At sites where affected aquifers can be classified as Class III groundwater (see Section B.9.1, Appendix B), natural flushing would be considered as the sole remedial method (52 FR

36000). Natural flushing may be employed as the sole method for aquifer restoration, or it may be used in conjunction with any of the active restoration methods described above.

4.4.4 Aquifer restoration at the Green River uranium mill tailings site

Existing contamination and background groundwater quality

At the Green River uranium mill tailings site, contamination by tailings seepage is limited to the Brown's Wash alluvium (top hydrostratigraphic unit) and the upper-middle shale unit of the Cedar Mountain Formation beneath the present tailings pile. Major contaminants introduced by tailings seepage to these units include ammonium, molybdenum, nitrate, selenium, uranium, and gross alpha (see Section B.4.10, Appendix B).

Contour maps for the Brown's Wash alluvium indicate that the existing contamination plumes are bounded by Brown's Wash north of the tailings site (see Figures B.4.12 through B.4.17, Appendix B). Analyses of surface-water samples from Brown's Wash and the Green River indicate that contamination in the wash is diluted by factors of 10^5 or 10^6 upon reaching the river (see Sections B.1.4 and B.4.10.1, Appendix B).

Background groundwater quality in all four hydrostratigraphic units is characterized by concentrations of total dissolved solids (TDS), sulfate, and chloride that exceed EPA and state of Utah Secondary Drinking Water Standards. Groundwater in all four units is classified as Class II based on TDS (TDS greater than 1000 but less than 10,000 mg/l), but it may be classified as Class III because of the concentrations of selenium, chromium, nitrate, and uranium in background samples that exceed proposed EPA MCLs for these constituents.

Current and future use

The city of Green River's municipal water supply is drawn from the Green River upstream of its confluence with Brown's Wash (see Section B.1.5, Appendix B).

Of the 15 registered wells in the Green River area, only one well is on the east side of the Green River. The majority of these 15 wells are completed in the shallow alluvium; however, the majority of these wells are currently not in use because of poor groundwater quality and the availability of better quality water from the city's municipal supply. Groundwater in the area is not considered to be potable. Because of the naturally poor water quality and low yield of the aquifers in the area, future use of groundwater for domestic consumption is not expected (see Section B.8, Appendix B).

The existing mill tailings site area will, in all probability, be developed for industrial use when the remedial action is completed. Therefore, the potential for future domestic use of contaminated groundwater would be diminished even further. Also, given the existing hydrogeological conditions that affect the movement of groundwater, it is unlikely the existing contamination would affect the one current user of groundwater downgradient from the site.

Natural flushing

Removal of the tailings from the floodplain of Brown's Wash would effectively remove the source of contamination. Contaminant concentrations currently found in the Brown's Wash alluvium and the upper-middle shale unit of the Cedar Mountain Formation would begin to decrease toward background. Preliminary estimates indicate there are 8,463,500 and 20,632,300 gallons of contaminated groundwater in the top and upper-middle hydrostratigraphic units, respectively, beneath and downgradient of the existing tailings pile.

The migration and dispersion of existing groundwater contamination at the existing tailings site were modeled using the Javandel steady-state solute transport model (Javandel et al., 1984). The Javandel model is based on an analytical solution to the two-dimensional advection-dispersion equation for solute transport in groundwater (Cleary and Ungs, 1978). The model is strictly valid only for homogeneous, isotropic aquifers with steady-state unidirectional flow. Idealized (symmetrical) contaminant plumes are calibrated by varying key input parameters in order to match observed plume concentrations at various downgradient points to model outputs. Critical input parameters, for which site-specific estimates must be made, include groundwater velocity, source length, and dispersivity values. After plume calibration, future contaminant migration and dispersion under the remedial action scenario is simulated by assuming an exponential decay constant for the source concentration term. Because this model is based on highly idealized assumptions, it is useful only in providing broad estimates of the times and distances required for contaminant dispersion in groundwater.

Nitrate and uranium were modeled because: (1) they exceed the proposed MCLs; (2) they are present in the highest concentrations within the affected aquifers; and (3) they represent the least (nitrate) and most (uranium) retarded contaminants (see below). For modeling purposes it was assumed that contaminated water from Brown's Wash alluvium discharges into Brown's Wash 400 feet downgradient from the existing tailings pile. No point of discharge was assumed for the upper-middle shale unit.

Preliminary results of the modeling indicate that natural flushing would reduce the concentrations of nitrate in Brown's Wash alluvium to the proposed MCL (10 mg/l, as N) in 90 years. Concentrations of nitrate in the upper-middle shale would be reduced to the proposed MCL in 30 years. Natural flushing would reduce uranium concentrations to the proposed MCL (0.044 mg/l) in less than 160 years (Brown's Wash alluvium) and in less than 260 years (upper-middle shale unit).

Both the nitrate and uranium plumes in the upper-middle unit beneath the existing tailings pile appear to be attenuated (see Section B.5.2.3, Geochemical attenuation and Section B.5.2.4, Geochemical modeling, Appendix B). Calculated groundwater velocities in this unit indicate that the contaminants should be traveling at the rate of about 0.41 ft/day with the flow of groundwater. Given this velocity, these constituents should have traveled about 2500 feet. However, nitrate has not traveled much beyond 1200 feet (Figure B.4.20, Appendix B) and uranium has not left the immediate area of the existing tailings pile (less than 600 feet of travel; Figure B.4.22, Appendix B).

When the additional geochemical data has been analyzed (see Section 4.2.1), it may be possible to determine the effects of geochemical attenuation on the existing plumes beneath the mill site. At that time, a more accurate determination of the time required to restore the aquifer under natural flushing conditions will be calculated.

When the final EPA standards are promulgated, the DOE will reevaluate its groundwater protection plan and undertake such action as is necessary to ensure that the revised standards are met. The need for and extent of aquifer restoration will be evaluated in a separate NEPA decision-making process. At that time, appropriate hydrological and geochemical parameters from the Green River uranium mill tailings site will be used to determine the best approach at the site. Should it be determined that aquifer restoration is required at the Green River site, the restoration option best suited to the site-specific conditions will be selected at that time.

4.5 FLORA AND FAUNA

Flora and fauna would be impacted directly and indirectly by the remedial action. Direct impacts would include the loss of wildlife habitat due to surface disturbance, the loss of less mobile species, and the displacement of wildlife from affected areas. Indirect impacts include increased fugitive dust emissions, elevated noise levels, and increased human activities created by the remedial action.

Proposed action

Stabilization of the tailings and other contaminated materials on the site would directly affect 78 acres at and adjacent to the tailings site. As indicated in Section 3.6, the tailings pile and mill yard have very little vegetation and, therefore, provide only marginal habitat for wildlife. For this reason, the clearing of these areas would have a minimal impact on vegetation and wildlife. After remedial action, the eight acres covered by the stabilized pile would not be suitable for wildlife habitat. The remaining 70 acres (one acre of which would be within the final restricted area) would be restored with uncontaminated fill material and graded to promote surface drainage; the area of the existing tailings pile (eight acres) would also be revegetated.

The proposed action would result in direct impacts to 15 acres at and around proposed borrow sites 1 (12 acres) and 2 (three acres). As indicated in Section 3.6, the proposed borrow areas have been highly disturbed by previous borrow activities and little vegetative cover is present to provide habitat for wildlife. For this reason, obtaining borrow materials from these sites would have only a minimal impact on vegetation and wildlife. After remedial action, the 15 acres of disturbed land at the borrow sites would not be restored or reclaimed. It is expected that the 15 acres would not be suitable for wildlife habitat.

The proposed action would not be expected to have any impacts on threatened or endangered species (see Section C.2 of Appendix C, Flora and Fauna).

No action

The no action alternative would not involve any remedial action; therefore, there would be no impacts to flora and fauna.

Stabilization in place

Stabilization of the tailings and other contaminated materials at the existing tailings pile would result in the disturbance of a lesser amount of acreage at and adjacent to the tailings site than the proposed action; no off-site acreage would be required for the stabilized pile. Therefore, there would be fewer impacts to flora and fauna for this alternative.

Following remedial action, the disturbed areas surrounding the stabilized tailings pile would be restored with uncontaminated fill material and graded to promote surface drainage. The acreage containing the rock-covered stabilized tailings pile would not be revegetated and, therefore, would not be suitable for wildlife habitat.

The stabilization in place alternative would result in the disturbance of the same amount of acreage at and adjacent to the proposed borrow sites as the proposed action; the resulting impacts would be the same as for the proposed action. After remedial action, the disturbed acreage at the borrow sites would not be restored or reclaimed. It is expected that the disturbed acreage would not be suitable for wildlife habitat.

As with the proposed action, the stabilization in place alternative would not be expected to have any impacts on threatened or endangered species.

4.6 LAND USE

Proposed action

The final restricted disposal site containing the stabilized tailings pile would encompass nine acres. Three of these nine acres would be within the designated tailings site, and six acres would be outside the designated site. The disposal site would be under the control of the Federal government and would be permanently restricted from any public access; consequently, other uses of these nine acres would be permanently precluded.

During the remedial action, 72 acres within and adjacent to the designated tailings site would be temporarily disturbed for the cleanup of the tailings pile (eight acres), mill yard and ore storage area (21 acres), and windblown and waterborne tailings (43 acres). Some of these disturbed areas would also be used for construction purposes such as staging areas, materials stockpiles (both contaminated and uncontaminated), drainage facilities, and equipment access routes after the cleanup is complete. After remedial action, 69 of these disturbed acres would be restored with uncontaminated fill material and graded to promote surface drainage; the area of the existing tailings pile would also be revegetated. The 69 acres would then be released for use consistent with existing land use controls. Three of the 72 disturbed acres would be covered by a portion of the final restricted disposal site.

The proposed action would have no effect on existing land use at the designated tailings site because the designated site and the land immediately around it are not being used at the present time. If operations at the WSMR test complex were to resume prior to or during the remedial action, they should not be affected as none of the lands used by the WSMR are within the areas to be disturbed by remedial action. However, the remedial action activities would be coordinated with the WSMR to avoid or minimize any interference with the WSMR operations.

The proposed action would result in the disturbance of 15 acres at proposed borrow sites 1 (12 acres) and 2 (three acres). These disturbances would not affect existing land uses at these existing borrow sites. The borrow activities would not affect the Elgin Cemetery south of borrow site 1 or the sewage lagoons northwest of borrow site 2.

No action

The no action alternative would allow the tailings pile to continue to affect existing land use patterns. The area currently occupied by the pile (eight acres) would not be available for alternate uses. In addition, dispersion of the tailings by wind and water erosion would continue to contaminate lands adjacent to the pile. The existing tailings pile has not been stabilized to provide protection against erosion from severe weather, and erosion of the tailings has contaminated 64 acres of land adjacent to the pile.

Stabilization in place

Stabilization in place would have the same effects on land use as the proposed action except that the final tailings disposal site would be entirely within the designated tailings site. The borrow activities associated with this alternative would result in the same amount of land disturbance as the proposed action.

4.7 NOISE

Proposed action

The major noise sources would be the construction equipment used at the tailings and borrow sites and the trucks used to haul tailings and borrow materials. Typical sound levels generated by the types of equipment used in the remedial action are presented in Table 4.8.

A noise prediction model (Kessler et al., 1978) was used to estimate the maximum A-weighted noise level in decibels (dBA) that would be emitted from each of the sites during the remedial action (Table 4.9).

The noise prediction model is based on the numbers and types of equipment operating at each site, usage factors for operation in the noisiest modes, and the distance from the activity to the nearest noise-sensitive receptors (e.g., residences). The model tends to overpredict noise levels because it assumes a clustering of equipment when, in reality, the equipment would be located over several acres. The elevated noise levels from the construction activities at the tailings and proposed borrow sites would occur only for the duration of the construction work (a maximum of 14 months) and only during daytime working hours.

The residents of Green River are one to two miles from the tailings site; these residents would be subjected to noise levels of 55 to 61 dBA, depending on their respective distances from the construction activities at the tailings site (Table 4.9). These noise levels would be equal to or greater than the 55-dBA level for annoyance from outdoor activity but less than the 70-dBA level established for the protection of hearing (EPA, 1974). Even during peak construction periods, the construction activities would result in an average outdoor noise intensity level of substantially less than 70 dBA because the construction would be

Table 4.8 Sound levels for remedial action equipment

Equipment	Maximum sound level at 50 feet (dBA)
Compactor	87
Bulldozer	89
Front-end loader	86
Grader	83
Scraper	87
Water truck	89
Crane	86
Haul truck	86
Pickup truck	72

Ref. Kessler et al., 1978.

Table 4.9 Estimated noise levels created by the proposed action, Green River, Utah, tailings site

Site	Maximum noise level in dBA at various distances from areas of activity		
	50 feet	One mile	Two miles
Green River tailings site	102	61	55
Borrow site 1	98	57	51
Borrow site 2	98	55	48

conducted only during normal daytime working hours. Furthermore, indoor noise levels from the construction activities would typically be reduced by 15 dBA.

At proposed borrow sites 1 and 2, the projected maximum noise levels at 50 feet from the source are 98 dBA (Table 4.9). Both proposed borrow areas are relatively isolated from residential areas; the nearest residences are 0.5 to one mile from these areas. Noise levels from the borrow sites are expected to be attenuated by 20 to 30 dBA over a distance of one mile.

Finally, trucks traveling between the tailings site and borrow site 2 could be expected to produce noise levels that would approximate 82 and 76 dBA at distances of 100 and 200 feet from the transportation routes, respectively. These noise levels would annoy residents along the transportation routes, especially along Green River Boulevard and Green River Avenue. These elevated noise levels would be extremely brief in duration at any single location as the trucks passed by and would occur only during normal daytime working hours.

No action

The no action alternative would not involve any remedial action; consequently, there would be no sources of elevated noise levels.

Stabilization in place

Due to the lower equipment activity levels, the stabilization in place alternative would produce less noise at the tailings site than the proposed action. However, slightly greater noise impacts along the haul roads would occur relative to the proposed action because of the increased number of truck trips. Noise levels at the proposed borrow sites are expected to be the same as those described for the proposed action.

4.8 CULTURAL RESOURCES

Proposed action

No historic resources eligible to the National Register of Historic Places (NRHP) would be impacted under the proposed action. Two historic trash dumps may be impacted by the remedial action; these sites have been determined to be ineligible to the NRHP. No cultural resources would be impacted by the remedial actions at the tailings site under the proposed action (CASA, 1986; Martin, 1986).

The borrow sites have not been surveyed for cultural resources. Both borrow sites are disturbed, and are not expected to yield any historic sites or cultural resources. Surveys would be conducted prior to any surface disturbance in undisturbed locations. If eligible historic or cultural resources are identified and if they are to be impacted, the DOE, in consultation with the State Historic Preservation Officer (SHPO), would implement a data recovery plan prior to surface disturbance.

No action

Since there would be no remedial action, there would be no impacts to cultural resources with the no action alternative.

Stabilization in place

Impacts associated with the stabilization in place alternative would be the same as those described for the proposed action.

4.9 POPULATION AND EMPLOYMENT

Proposed action

Impacts on population and employment in the Green River area were assessed by evaluating the effects of the average and peak labor requirements for the proposed remedial action and the effects of indirect employment resulting from remedial action expenditures in the area. It was assumed that the general labor force of truck drivers, heavy equipment operators, mechanics, and the like would be available locally. Currently, there is a surplus of workers with these skills who would be readily available for work (Curtis, 1986). All supervisory positions would likely be filled by people provided by the Remedial Action Contractor (RAC).

The average general work force would consist of 32 construction workers and 14 supervisors (e.g., project manager and engineer, surveyors, and security guards). The number of supervisory positions would be constant during the 14-month remedial action, whereas other workforce needs would vary from a minimum of 14 to a maximum of 55 employees. The 14-month projected schedule includes a period of three months for possible shutdowns due to severe weather or other unforeseeable circumstances; it does not include the final month when only supervisory personnel would be required.

In addition to employment directly related to the remedial action, additional employment would be generated by expenditures related to the remedial action in the local economy. A conservative estimate of this indirect employment would be an additional 20 jobs based on an indirect employment multiplier of 1.44 developed for rural areas (Gibson and Stephenson, 1983). Using the projected average work force requirement of 32 workers hired locally and a conservative estimate of an additional 20 indirect local jobs, Grand County unemployment would decrease by 1.6 percent based on the estimated 1985 unemployment rate of 13.0 percent (Jensen, 1986).

To determine the total number of people who would move into the Green River area, it was assumed that eight workers (60 percent of 14 supervisory personnel) would bring families, and six would not (Mountain West Research, 1979). Using the 1985 average family size of 3.23 in the United States (DOC, 1985), eight workers with spouses and ten children and six workers without families totals 32. This would represent a population increase of four percent over the 1986 population of Green River.

No action

The no action alternative would not involve any remedial action, and there would be no remedial action jobs to affect existing population and employment levels.

Stabilization in place

The stabilization in place alternative would require a similar number of remedial action workers as for the proposed action. The impacts to population and employment for this alternative would be very similar to those described for the proposed action.

4.10 HOUSING AND COMMUNITY SERVICES

Proposed action

The proposed action would result in 14 remedial action workers moving into the area (see Section 4.9); therefore, a maximum of 14 housing units would be needed for workers and their families. Due to the surplus of housing in Green River, this would not impact available housing. It is also likely that some workers may choose to live in Moab, where housing is also available.

Due to the decline in the population of Green River, all community services are under-utilized. An increase in school enrollments by 10 school-aged children would have a negligible effect on elementary or high schools in Green River since both schools are currently operating below capacity. Other services such as medical care, law enforcement, fire protection, and sewage or water treatment are also capable of handling larger populations.

No action

The no action alternative would not involve any remedial action, and there would be no influx of people to affect the existing housing or community services.

Stabilization in place

This alternative would require a similar number of remedial action workers as for the proposed action. The impacts on housing and community service for this alternative would be the same as those described for the proposed action.

4.11 ECONOMIC STRUCTURE

Remedial action would have a direct impact on the local economy through wages and salaries paid to remedial action workers and expenditures for materials, supplies, and equipment. There would also be indirect impacts on the local economy as these wages, salaries, and other expenditures are respent locally on other goods and services. Indirect expenditures would also generate tax revenues received by state and local governments. Direct expenditures would not be subject to taxes because the Federal government is exempt from paying taxes on expenditures for Federally funded projects.

Proposed action

The estimated construction cost of the proposed action is $2,950,000, which includes costs associated with labor and the purchase and rental of equipment, materials, and supplies. This cost includes $1,060,000 for local wages and salaries and $472,000 for local supplies, materials, and contracts. In addition, an estimated $1,430,000 would be spent for labor, equipment, and supplies that are not locally available. Local materials and supply purchases would include borrow materials, fencing, fuel, tools, equipment repairs, and the like.

The wages and salaries and other expenditures would also generate additional revenue for the local area. Research on the impacts on rural areas of energy projects similar to the proposed remedial action in the western United States suggests an indirect income multiplier of 1.23 (every dollar in wages, salaries, and other expenditures would generate an additional $0.23 in indirect expenditures) (Mountain West Research, Inc., 1979). Indirect revenues are estimated at $352,000. The estimated total gross revenue which would impact the local economy would be $1,880.000. Once the remedial action is completed, the nine-acre fenced, restricted site would remain the property of the Federal government and would therefore not be subject to property tax. The decontaminated adjacent areas would revert to the original owner for unrestricted use. Based on the projected 1986 property tax values, Grand County would lose approximately $670 annually in property tax payments. The adjacent decontaminated areas would likely experience little change in property tax assessment due to the present and projected lack of demand for such commercial property. In Grand County, property taxes are based on market value rather than an assessed value (Stock, 1986).

No action

The no action alternative would not impact the local economy because there would be no remedial action to generate wages, salaries, or other expenditures.

Stabilization in place

The stabilization in place alternative would require a similar amount of remedial action workers, equipment, materials, and supplies as the proposed action. However, a slightly larger volume of borrow materials would be required; the additional cost of the borrow materials for this alternative would result in slightly greater impacts on the Green River economy than the proposed action.

4.12 TRANSPORTATION

The action alternatives would require use of U.S. 6&50 and several local roads for the transportation of borrow materials, worker commute trips, and miscellaneous trips between all sites. Worker commute traffic would occur before and after the remedial action activities during periods of normal traffic flow and would have little effect on the average daily traffic patterns in the Green River area.

Proposed action

Maximum transportation impacts for the proposed action would occur along a 200-foot segment of U.S. 6&50 during the ninth month of construction activity (see Section A.2.5, Appendix A, Conceptual Designs). Trucks transporting borrow materials from proposed borrow site 1 would turn off Hastings Road onto U.S. 6&50 before turning onto County Road 1170E to access the tailings site. There would be a total of 242 daily trips comprised of 74 truck trips, 138 worker commuting trips, and 30 miscellaneous trips. Average daily traffic levels would increase 13 percent over 1985 levels during the ninth month. This increase would be negligible due to the existing light traffic volume of 1890 vehicles per day (Labrum, 1986) and the fact that the trucks would be traversing U.S. 6&50 in an unpopulated area. This increase would raise the average hourly traffic to 256 vehicles, which would still be below the highway design capacity of 850 vehicles.

Increased transportation impacts during the tenth through the thirteenth months would also occur on U.S. 6&50 when truck traffic originates at both borrow sites (see Sections A.2.3 and A.2.5, Appendix A). A total of 194 trips per day would increase existing traffic levels by ten percent (62 truck trips, 92 worker commuting trips, and 40 miscellaneous trips). It should be noted that remedial action traffic impacts would occur during normal weekday working hours and that they would be short-term (i.e., only during remedial action).

No action

The no action alternative would not involve remedial action, and, consequently, the existing traffic patterns would continue.

Stabilization in place

The stabilization in place alternative would require a slightly larger volume of borrow materials from both borrow sources than the proposed action. However, the analysis of truck trips for the proposed action was conservative, and more efficient use of the haul trucks and stockpiling of materials is proposed under this alternative. Additional vehicle traffic due to this alternative would be negligible.

4.13 ENERGY AND WATER CONSUMPTION

Proposed action

The proposed remedial action would require the consumption of fuel and electricity to operate the construction equipment and for on-site operations (e.g., field offices). In addition, water would be needed for the remedial action workers, the shower and laundry facilities, and for activities such as compaction of the tailings, washing of the construction equipment, and dust control.

Total estimated fuel, electricity, and water consumption for the proposed action are 170,000 gallons, 180,000 kilowatt-hours, and 3,800,000 gallons, respectively. The figure for water consumption does not include water consumed by remedial action workers and their families that move into the area. Section A.2.5 of Appendix A, Conceptual Designs, provides details on the estimated energy and water consumption for the proposed action.

The fuel for the proposed action would be trucked from a commercial source(s) to the tailings site and would probably be stored at the site in tanks. No impacts on local fuel sources would be expected. Electricity would probably be supplied by the Utah Power and Light Company at the site (an electric powerline and transformer are present on the site); this would not affect the availability of electricity to the surrounding areas. Both potable and nonpotable water for the activities at the site would probably be supplied by the city of Green River which obtains its water from the Green River. The use of water from the city of Green River would not affect the availability of water in the city.

No action

The no action alternative would not involve any remedial action; therefore, no fuel, electricity, or water would be required.

Stabilization in place

Stabilization in place would require a similar amount of fuel, electricity, and water as the proposed action; thus, the resulting impacts would be similar.

4.14 ACCIDENTS NOT INVOLVING RADIATION

The remedial action would involve extensive use of heavy construction equipment (e.g., bulldozers, scrapers, front-end loaders) and haul trucks as tailings, other contaminated materials, and clean borrow materials are transported between the tailings and borrow sites. Remedial action workers would also be commuting between their homes and the work sites.

The construction equipment used and transportation activities associated with the remedial action would pose the risk of accidents and resulting injuries and fatalities. In addition to injury and fatal accidents related to remedial action traffic, accidents associated with the operation of construction equipment and materials handling activities could occur during the proposed action. These hazards would be similar to those encountered in any large earthmoving project such as surface mining or heavy construction. Based on 1981 accident data for the mining and construction industries, 0.042 injury accidents and 0.00045 fatal accidents would occur per man-year of labor (DOC, 1983).

For the purpose of estimating nonradiological accidents, it was assumed that: (1) all workers would live in Green River and commute to the tailings site; (2) the average, one-way commuting distance would be three miles; (3) the construction equipment would remain at the respective site; and (4) the haul trucks would be returned to the tailings site at the end of each work day. The total off-site haul truck mileage for the proposed action was estimated conservatively.

The action alternatives would involve two crossings of the D&RGW Railroad primarily by haul trucks. Given the frequency of train traffic at this crossing (Section 3.12), there would be the possibility of accidents (i.e., collisions) involving trains and vehicular traffic. However, no assessment of such accidents was made due to the lack of accident rates.

Proposed action

The proposed action would involve an estimated 159,164 off-site vehicle miles and 54 man-years of labor. Based on the local traffic accident rate presented in Section 3.12, an estimated 0.64 traffic accident involving property damage and injury could occur during the remedial action. Based on a three-year history of fatal accidents for Green River and the low local traffic volume, it is unlikely that there would be any fatal accidents associated with the remedial action.

The estimated number of equipment-use accidents was based on the total man-years of labor associated with the remedial action. An estimated 2.3 equipment-use injury and 0.024 equipment-use fatal accidents may occur over the period of the remedial action.

No action

The no action alternative would not involve any remedial action; therefore, there would not be any traffic or equipment-use accidents.

Stabilization in place

The stabilization in place alternative would require a similar amount of remedial action workers and equipment as for the proposed action. However, a slightly larger volume of borrow materials would be required resulting in a slightly greater number of truck trips. Consequently, the number of traffic and equipment-use accidents could be slightly higher than for the proposed action.

4.15 MITIGATIVE MEASURES

The following mitigative measures were incorporated into the design and approach for the remedial action alternatives in order to reduce the environmental impacts:

- Construction of erosion and sediment control measures for disturbed areas to prevent increased siltation in the Green River.
- Application of water or chemical dust suppressants to disturbed areas and gravelled haul roads to inhibit dust emissions.
- Immediate cleanup of any off-site spills of contaminated materials in compliance with applicable regulations.
- Selection of borrow sites that are as close to the disposal site as possible to reduce costs and eliminate the impacts of long haul distances.
- Backfilling, grading, and revegetating (as required) the areas disturbed during the cleanup and consolidation of the tailings and contaminated materials.
- Implementation of a preventative equipment maintenance program to assure proper functioning of combustion emissions and noise control devices.
- Use of trucks with tight-fitting tailgates and covers to prevent the dispersion of the contaminated material and borrow materials while being transported.

- Maintaining haul roads to reduce secondary noise impacts from nonuniform road conditions, chuckholes, or washboard effects.

- Cleanup of any equipment used before release to prevent the spread of contaminated materials.

- Use of local labor whenever possible to reduce the sociological impacts to the local communities and to provide economic benefits.

- Conducting operations only during normal work hours to minimize noise disturbance to local residents.

- Maintaining close communication with the local population through an established public information task force.

Mitigative measures necessary to ensure the protection of remedial action workers and the long-term stability of the tailings are described in the UMTRA Project Environmental, Health, and Safety Plan (DOE, 1985d), the Remedial Action Plan (DOE, 1988), and Guidance for UMTRA Project Surveillance and Maintenance (DOE, 1986).

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GLOSSARY

absorbed dose, radiological	Radiation energy absorbed per unit mass, usually given in units of rads.
alluvium	Sediment deposited by a flowing river.
alpha particle	A positively charged particle emitted from certain radionuclides. It is composed of two protons and two neutrons and is identical to the helium nucleus.
aquifer	A subsurface formation containing sufficiently saturated permeable material to yield usable quantities of water.
atom	A unit of matter; the smallest unit of an element consisting of a dense, central, positively charged nucleus surrounded by a system of electrons, equal in number to the number of nuclear protons and characteristically remaining undivided in chemical reactions except for a limited removal, transfer, or exchange of certain electrons.
attainment area	An area where air quality levels are better than the National Air Quality Standards.
A-weighted scale	Sound level scale which most closely matches the response of the human ear. This scale is most commonly used to measure environmental noise and is often supplemented by the time and duration of the noise to determine the total quantity of sound affecting people.
background radiation	Radiation arising from radioactive material other than that under consideration. Background radiation due to cosmic rays and natural radioactivity is always present, and there is always background radiation due to the presence of radioactive substances in building materials, and the like.
bentonite	A clay formed from the decomposition of volcanic ash, largely composed of the clay mineral montmorillonite; it has the ability to absorb or adsorb water and swell accordingly.
beta particle	Charged particle emitted from the nucleus of an atom during radioactive decay with mass and charge equal to those of an electron.
Class I groundwater	As defined by the U.S. EPA, special groundwater highly vulnerable to contamination characterized as an irreplaceable source of drinking water or ecologically vital, and, therefore, in need of special protective measures. The number of Class I groundwaters is small.

Class II groundwater	As defined by the U.S. EPA, current and potential sources of drinking water and water having other beneficial uses. Class IIA groundwaters are current sources of drinking water; Class IIB groundwaters are potential sources of drinking water. Class II groundwaters comprise the majority of the drinking water sources.
Class III groundwater	As defined by the U.S. EPA, groundwaters that are not potential sources of drinking water and are of limited beneficial use; are characterized by TDS over 10,000 mg/l; or are so contaminated by naturally occurring conditions or human activity they cannot be cleaned up using treatment reasonably employed in public water supply systems; or, have an insufficient yield at any depth. Subclasses are Class IIIA and Class IIIB.
contamination	In this report, the presence of any material or substance in excess of naturally occurring background levels which requires regulatory attention; for example, radioactive materials, organic pollutants, trace elements, and heavy metals.
Curie (Ci)	The unit of radioactivity of any nuclide, defined as precisely equal to 3.7×10^{10} disintegrations per second.
daughter product(s)	A nuclide resulting from radioactive disintegration of a radionuclide, formed either directly or as a result of successive transformations in a radioactive series; it may be either radioactive or stable.
decay, radioactive	Disintegration of the nucleus of an unstable nuclide by spontaneous emission of charged particles, photons, or both.
decontamination	The reduction of contamination in an area to a predetermined level set by a standards-setting body such as the EPA by removing the contaminated material.
disintegrations per minute or second	The number of radioactive decay events occurring per minute or second.
disposal	In this report, the planned, safe, permanent placement of radioactive or hazardous waste.
dose	A general term denoting the quantity of radiation or energy absorbed, usually by a person; for special purposes, it must be qualified; if unqualified, it refers to absorbed dose.

GLOSSARY (Continued)

dose, absorbed	The amount of energy imparted to matter by ionizing radiation per unit mass of irradiated material at the point of interest; given in units of rads.
dose commitment	The cumulative dose equivalent that will result from exposure to radioactive materials over a discrete time period; given in units of rems.
dose equivalent	The quantity that expresses all kinds of radiation on a common scale for calculating the effective absorbed dose; defined as the product of the absorbed dose in rads and modifying factors, especially the qualifying factor; given in terms of rems; often abbreviated "dose."
exposure	In this report, the presence of gamma radiation that may deposit energy in an individual; given in units of roentgens or microroentgens.
external dose	The absorbed dose that is due to a radioactive source external to the individual as opposed to radiation emitted by inhaled or ingested sources.
fault	A surface or zone of rock fracture along which there has been movement.
floodplain	A lowland or relatively flat area that is subject to flooding. A 100-year floodplain has a one percent or greater probability of flooding in any given year.
flux, radon	The emission of radon gas from the earth or other material; usually measured in units of picocuries per square meter per second (pCi/m^{2}s).
gamma	A high-energy and deeply penetrating form of radiation.
gamma dose	Radiation dose caused by gamma radiation.
gamma logging (or logs)	A technique for determining gamma radiation levels at various depths in a borehole.
gamma ray	High energy electromagnetic radiation emitted from some radionuclides. The energy levels are specified for different radionuclides.
gamma spectral analysis (gamma spectroscopy)	An analytical technique for identifying radionuclides based on their different gamma energy levels.

general-storm PMP	Probable Maximum Precipitation (PMP) estimated for basin sizes of 10 to 5000 square miles and duration of six to 72 hours based on convergence (precipitation due to atmospheric processes not affected by terrain) and orographic (precipitation from moist air forced upward by mountain slopes and the triggering of rainfall near first upslopes) PMP components.
groundwater	Water below the land surface, generally in a zone of saturation.
groundwater, confined	Confined groundwater is under pressure significantly greater than atmospheric, and its upper limit is the bottom of the bed of distinctly lower hydraulic conductivity than that of the material in which the confined water occurs.
groundwater, unconfined	Unconfined groundwater in an aquifer that has a water table.
half-life	The time required for 50 percent of the quantity of a radionuclide to decay into its daughters.
head	When used alone, it is understood to mean static head. The static head is the height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point.
head, total	The total head of a liquid at a given point is the sum of three components: (1) elevation head, h_e, (2) pressure head, h_p, and (3) velocity head, h_v. Under conditions to which Darcy's Law may be applied, the velocity of groundwater is so small that the velocity head, $h_v = v^2/2g$, is negligible.
health effect	Adverse physiological response from radiation exposure (in this report, one health effect is defined as one cancer death from exposure to radioactivity).
hydraulic conductivity	The volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.
hydraulic gradient	The change in static head per unit of distance in a given direction.
inert gas	One of the chemically unreactive gases: helium, neon, argon, krypton, xenon, and radon.

in-situ	In the natural or original position.
internal dose	The absorbed dose or dose commitment resulting from inhaled or ingested radioactivity.
isotopes	Nuclides having the same number of protons in their nuclei but differing in the number of neutrons; the chemical properties of isotopes of a particular element are almost identical.
leachate	Leachate is the solution generated by the percolation of water through a body of soil, waste rock, or solid waste.
licensing	In this report, the process by which the NRC will, after the remedial actions are completed, approve the final disposition and controls over a disposal site. It will include a finding that the site does not and will not constitute a danger to the public health and safety.
lixiviant	A solution of complexing species (either ions or molecules) which enhance the solubility of species (metals) to be removed from the aquifer during restoration.
local-storm PMP	Probable Maximum Precipitation (PMP) estimated for basin sizes up to 500 square miles and durations from 15 minutes to six hours based on storms resulting from convective lifting of moist air.
maintenance, custodial (passive)	The repair of fencing, the repair or replacement of monitoring equipment, revegetation, minor additions to soil cover, and general disposal site upkeep such as mowing grass.
micro	A prefix meaning one millionth (1/1,000,000 or 10^{-6}).
milli	A prefix meaning one thousandth (1/1000 or 10^{-3}).
mitigative measure	A measure implemented to reduce the adverse environmental impacts of remedial action (e.g., the application of water and chemical suppressants to dirt and gravelled haul roads to inhibit dust emissions.
monitor	To observe and make measurements to provide data for evaluating the performance and characteristics of the disposal site.
National Register of Historic Places	Established by the Historic Preservation Act of 1966, the Register is a listing of archaeological, historical, and architectural sites nominated for their local, state, or national significance by state and Federal agencies and approved by the Register staff.

natural flushing	A passive aquifer restoration method whereby dissolved or precipitated contaminants in groundwater are dispersed over time by the natural flow of groundwater.
nuclide	A general term applicable to all atomic forms of the elements; nuclides comprise all the isotopic forms of all the elements. Nuclides are distinguished by their atomic number, atomic mass, and energy state.
pediment	A gently inclined planar surface carved in bedrock during the erosion of a retreating mountain front. Pediment surfaces are usually covered with fluvial gravels.
perched groundwater	Groundwater separated from an underlying body of groundwater by unsaturated rock.
permeability	The ease with which liquids or gases penetrate or pass through a layer of soil. Technically, it is the volume of fluid that will flow through a unit area under a unit hydraulic gradient; measured in centimeters per second or equivalent units.
permissible dose	That dose of ionizing radiation that is considered acceptable by standards-setting bodies such as the EPA.
person-rem	Unit of population exposure obtained by summing individual dose equivalent values for all people in the population. Thus, the number of person-rems attributed to one person exposed to 100 rems is equal to that attributed to 100 people each exposed to one rem.
pico	A prefix meaning one trillionth (1/1,000,000,000,000 or 10^{-12}).
picocurie	A unit of radioactivity defined as 0.037 disintegrations per second.
Point of compliance	As defined by the U.S. Environmental Protection Agency, a vertical surface established hydraulically downgradient from the disposal cell.
porosity	The porosity of a rock or soil is its property of containing interstices or voids and may be expressed quantitatively as the ratio of the volume of its interstices to its total volume. Also called total porosity.
porosity, effective	Effective porosity refers to the amount of interconnected pore space available for fluid transmission.

potentiometric surface	The potentiometric surface is the surface obtained by connecting equilibrium (static) water levels in wells penetrating the confined aquifer. Also called the piezometric surface.
practicable	To be able to put into practice. In this report it applies to engineering designs or methods that are proposed and seem possible, but have not been tested in use.
Probable Maximum Flood (PMF)	The hypothetical flood (peak discharge, volume, and hydrograph shape) that is considered to be the most severe reasonably possible, based on comprehensive hydrometeorological application of the Probable Maximum Precipitation (PMP) and other hydrologic factors favorable for maximum flood runoff such as sequential storms and snowmelt.
Probable Maximum Precipitation (PMP)	The estimated depth of precipitation for a given duration, drainage area, and time of year for which there is virtually no risk of exceedence.
quality factor (QF)	The principal modifying factor by which absorbed doses are multiplied to obtain dose equivalents for radiation protection purposes and thus express the effectiveness of absorbed doses on a common scale for all kinds of ionizing radiation. The quality factor depends on the type and energy of the radiation being considered.
rad	A unit of measure for the absorbed dose of radiation. It is equivalent to 100 ergs per gram of material.
radioactive decay chain	A succession of nuclides, each of which transforms by radioactive disintegration into the next nuclide until a stable nuclide results.
radioactivity (radioactive decay)	The property of some nuclides of spontaneously emitting particles or gamma radiation or of spontaneous fission.
radioisotope	A radioactive isotope of an element with which it shares almost identical chemical properties.
radionuclide	An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation.
radium-226 (Ra-226)	A radioactive daughter product of uranium-238. Radium is present in all uranium bearing ores; it has a half-life of 1620 years.

radon-222 (Rn-222)	The gaseous radioactive daughter product of radium-226; it has a half-life of 3.8 days.
radon-daughter product	One of several short-lived radioactive daughter products of radon-222. All are solids.
recharge	Resupply or replenish.
rem	A unit of dose equivalent equal to the absorbed dose in rads times the quality factor times any other necessary modifying factor. It represents the quantity of radiation that is equivalent in biological damage to one rad of X-rays.
Richter scale (magnitude)	A measure of the total energy released by an earthquake.
roentgen	A unit of measure of ionizing radiation in air; one roentgen in air is approximately equal to one rad and one rem in tissue.
slimes	In this report, fine-grained waste materials from uranium ore processing that are mixed with small amounts of water.
sodium bentonite	A sodium-rich (greater than 50 percent), highly plastic, swelling, clay mineral.
soil infiltration rate	The rate at which water enters the soil surface and moves vertically.
SOILMOIST	A one-dimensional finite difference unsaturated flow model used to estimate long-term infiltration and percolation across the disposal cell boundaries and the moisture content within the cell. These conditions are estimated using the hydrologic characteristics of the disposal cell soils and a statistical characterization of the site climate.
soil percolation rate	The rate at which water moves through soil in all directions.
solifluction	The slow viscous downslope flow of saturated soil and other unsorted surficial material; especially the flow occurring at high elevations in regions underlain by frozen ground that acts as a downward barrier to water percolation.
specie	A chemical specie is the actual form in which the metal is in solution. For example, uranium may be in solution as one or more of the following species: UO_2^{2+}, $UO_2(CO_8)_2^{2-}$, $UO_2(CO_3)_3^{4-}$, U^{6+}, and so forth.

stabilization	The reduction of radioactive contamination in an area to a predetermined level by a standards-setting body such as the EPA by encapsulating or covering the contaminated material.
storage coefficient	The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.
surveillance	In this report, the observation of the disposal site for purposes of visual detection of need for custodial care, evidence of intrusion, and compliance with other license requirements.
tailings, uranium mill	The wastes remaining after most of the uranium has been extracted from uranium ore.
thorium-230 (Th-230)	A radioactive daughter product of uranium-238; it has a half-life of 80,000 years and is the parent of radium-226.
thorium-232 (Th-232)	A naturally occurring radioisotope with a half-life of 14 billion years.
transmissivity	Transmissivity is the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient.
UMTRA Project	Uranium Mill Tailings Remedial Action Project of the U.S. Department of Energy.
unconfined aquifer	An aquifer without an upper confining layer. Also known as phreatic or water-table aquifers.
uranium-238	A naturally-occurring radioisotope with a half-life of 4.5 billion years; it is the parent of uranium-234, thorium-230, radium-226, radon-222, and others.
vicinity property	A property in the vicinity of the Green River site that is determined by the DOE, in consultation with the NRC, to be contaminated with residual radioactive material derived from the Green River site and which is determined by the DOE to require remedial action.
water table	The surface of a body of unconfined water at which the pressure is equal to that of the atmosphere.

GLOSSARY (Concluded)

working level (WL)	A measure of radon daughter products concentrations; technically, it is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130,000 million electron volts.
working level-month (WLM)	The exposure resulting from inhalation of air with a concentration of one WL for 170 working hours. Continuous exposure of a member of the general public to one WL for one year results in approximately 53 WLM.
zone, unsaturated	The unsaturated zone is the zone between the land surface and the deepest water table.

ABBREVIATIONS AND ACRONYMS

ADT	Average daily traffic
ACL	Alternate concentration limit
ALARA	As low as reasonably achievable
BEIR	Advisory Committee on the Biological Effects of Ionizing Radiation of the National Academy of Sciences (also their report)
BFEC	Bendix Field Engineering Corporation, Grand Junction, Colorado
CASA	Complete Archaeological Service Associates, Cortez, Colorado
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second
cfs/ft	Cubic feet per second per foot
Ci	Curie; a unit of radioactivity equal to 3.7 x 10^{10} radioactive disintegrations per second
cm	Centimeter
cm/s	Centimeters per second
CO	Carbon monoxide
COE	U.S. Army Corps of Engineers
CRA	Classification review area
Cy	Cubic yard; a unit of volume equal to 27 cubic feet
dBA	Decibels on the A scale; a logarithmically based unit of sound intensity weighted to account for human auditory responses
dpm/100cm^2	Disintegrations per minute per 100 square centimeters
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation

ABBREVIATIONS AND ACRONYMS

D&RGW	Denver and Rio Grande Western Railroad
EA	Environmental assessment
EGR	External gamma radiation
EIS	Environmental impact statement
EPA	U.S. Environmental Protection Agency
°F	Degrees Fahrenheit
FBDU, FBD	Ford, Bacon & Davis Utah Inc.
fps	Feet per second
FR	Federal Register
ft^2	Square foot
ft	Foot
g	Gram; a unit of weight equal to 0.035 ounce; also a measure of acceleration where 1 g equals 32 feet per second per second
gpd	Gallons per day
gpm	Gallons per minute
g/s	Grams per second
HC	Hydrocarbon
hr	Hour
ISCST	Industrial Source Complex Short-Term dispersion model; an air quality computer code
km	Kilometer; one thousand meters
kw	Kilowatt; one thousand watts
kwh	Kilowatt-hours

ABBREVIATIONS AND ACRONYMS (Continued)

l	Liter; a unit of volume equal to 1.057 quarts
lb	Pound; a unit of weight equal to 16 ounces
lb/cy	Pounds per cubic yard
lb/hr	Pounds per hour
lb/mile	Pounds per mile
L_{dn}	Day-night sound level measured in decibels
L_{eq}	Equivalent sound level measured in decibels
LLD	Lower limit of detection
m	Meter; a unit of length equal to 3.28 feet; also milli, a prefix meaning one-thousandth (1/1000 or 10^{-3})
m^2	Square meter; a unit of area equal to 10.76 square feet
MCL	Maximum concentration limit
MeV	Million electron volts
mg/l	Milligrams per liter
mg/m^3	Milligrams per cubic meter
micro	Micro, a prefix meaning one-millionth (1/1,000,000 or 10^{-6})
microg	Microgram; a millionth of a gram
$microg/m^3$	Micrograms per cubic meter
microR	Microroentgen; a millionth of a roentgen
microR/hr	Microroentgens per hour
mg	Milligram; a thousandth of a gram
mgd	Million gallons per day
mph	Miles per hour
NAAQS	National Ambient Air Quality Standards

ABBREVIATIONS AND ACRONYMS (Continued)

NAS	National Academy of Sciences
NEPA	National Environmental Policy Act of 1969 (PL91-190)
NOAA	National Oceanic and Atmospheric Administration, U.S. Department of Commerce
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
O_3	Ozone
p	Pico, a prefix meaning one trillionth (1/1,000,000,000,000 or 10^{-12})
Pb-210	Lead-210
pCi/g	Picocuries per gram
pCi/l	Picocuries per liter
pH	A logarithmic scale of hydrogen-ion concentration, and hence, an indication of acidity or alkalinity; pH equal to 7 is neutral; pH less than 7 is acidic; pH greater than 7 is alkaline
PL95-604	Public Law 95-604, Uranium Mill Tailings Radiation Control Act of 1978
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
POC	Point of compliance
ppm	Parts per million
R	Roentgen; a unit of gamma radiation equal to one rem
RAC	Remedial Action Contractor
Ra-226	Radium-226
RCRA	Resource Conservation and Recovery Act

ABBREVIATIONS AND ACRONYMS (Concluded)

RDC	Radon daughter concentration
Rn-222	Radon-222
SHPO	State Historic Preservation Officer
SO_2	Sulfur dioxide
SO_x	Sulfur oxides
TAC	Technical Assistance Contractor
TDS	Total dissolved solids
Th-230	Thorium-230
Th-232	Thorium-232
TOC	Total organic carbon
TSP	Total suspended particulates
TSS	Total suspended solids
U-234	Uranium-234
U-235	Uranium-235
U-238	Uranium-238
U_3O_8	Uranium oxide, also called yellowcake
UMTRA Project	Uranium Mill Tailings Remedial Action Project
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978 (PL95-604)
USFWS	U.S. Fish and Wildlife Service, U.S. Department of the Interior
USGS	U.S. Geological Survey, U.S. Department of the Interior
WL	Working level (a measure of radon daughter product concentration)
WLM	Working-level month (exposure to one WL for 170 hours)
yr	Year(s)
YOY	Young-of-the-year

AGENCIES, ORGANIZATIONS, AND PERSONS CONSULTED

Agency/Organization	Person	Subject
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Bureau of Reclamation Moab, Utah	Gregg Dawson	Groundwater
Castleview Hospital Price, Utah	Melanie Marshall	Socioeconomics
City of Green River City Engineer Green River, Utah	Randy Spadafora	Engineering/ Water supply
City of Green River City Recorder Green River, Utah	Maxine Baker	Water supply/ usage rates
City of Green River Green River, Utah	Laura Acerson	Socioeconomics
Denver and Rio Grande Western Railroad Grand Junction, Colorado	Pat Green	Transportation
Emery County Sheriff's Department Castle Dale, Utah	Wade Hansen	Socioeconomics
G and O, Inc. Green River, Utah	Carol Lasson	Borrow site
Grand County Assessor Moab, Utah	Norma Stocks	Socioeconomics
Grand County Clerk Moab, Utah	Bobbie Domenick	Socioeconomics
Grand County Planning Commission Moab, Utah	John Keogh	Socioeconomics
Green River Schools Green River, Utah	Blaine Evans	Socioeconomics
Green River Water Treatment Plant Green River, Utah	Gary Flucky	Socioeconomics

AGENCIES, ORGANIZATIONS, AND PERSONS CONSULTED (Concluded)

Agency/Organization	Person	Subject
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Union Carbide Corporation Grand Junction, Colorado	Jack Frost	Groundwater
U.S. Fish and Wildlife Service Salt Lake City, Utah Vernal, Utah	Robert Ruesink Harold Tyus	Threatened or endangered species, wetlands
Utah Department of Employment Security Moab, Utah Salt Lake City, Utah	Ken Curtis Kenneth Jensen	Socioeconomics
Utah Department of Health Salt Lake City, Utah	George Carlson	Air quality
Utah Department of Natural Resources Water Projects Price, Utah	Mark Page	Water projects
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Utah Department of Transportation Salt Lake City, Utah	Vicki Hanshew Robin Hood Bill Labrum	Transportation
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APPENDIX A

CONCEPTUAL DESIGNS

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A.1 INTRODUCTION

A.1.1 PURPOSE

This appendix provides the information needed to understand the conceptual designs for the remedial action alternatives addressed in this environmental assessment (EA). This appendix also is intended to provide sufficient detail for the reader to evaluate the feasibility and assess the environmental impacts of each remedial action alternative. However, this appendix is not intended to provide the detailed engineering necessary to implement the alternatives. The conceptual design for the selected alternative is subject to change during the final design process.

The details of the conceptual design (e.g., radon/infiltration barrier thickness) for the proposed action are based upon field studies, laboratory testing, and various modeling techniques. The data and calculations for these details are available in the Remedial Action Plan (RAP) (DOE, 1988a). In addition, the Technical Approach Document (DOE, 1988b) describes the general approaches and design criteria that have been adopted by the U.S. Department of Energy (DOE) in order to prepare a RAP and final design that comply with the U.S. Environmental Protection Agency (EPA) standards (40 CFR Part 192). For the alternative design, assumptions regarding various factors (e.g., soil type and availability) have been made based upon the data and calculations applicable to the proposed action.

A.1.2 DESIGN OBJECTIVES

Under Title I of the Uranium Mill Tailings Radiation Control Act (UMTRCA), Public Law (PL) 95-604, the remedial action design must be effective for 1000 years, to the extent reasonably achievable, and, at any rate, for at least 200 years. The purpose of the remedial action is to stabilize and control the uranium mill tailings (residual radioactive wastes) and other contaminated materials at Title I (inactive) Uranium Mill Tailings Remedial Action (UMTRA) Project sites in a manner that complies with the EPA standards. Consistent with the EPA standards, the following major design objectives have been established:

- o Design controls to remain effective for up to 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years.
- o Reduce the average radon flux from the site to 20 picocuries per square meter per second (pCi/m^2s) or 0.5 picocurie per liter (pCi/l) above background levels outside the disposal site.
- o Reduce radium-226 (Ra-226) concentrations in areas released for unrestricted use to 5 picocuries per gram (pCi/g) averaged in

the first 15 centimeters (cm) of soil below the surface and 15 pCi/g averaged in 15-cm-thick layers of soil more than 15 cm below the surface.

- Make a reasonable effort to achieve, in any occupied or habitable building, an annual average (or equivalent) radon decay product concentration (including background) not exceeding 0.02 working level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and the level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour (microR/hr).
- Minimize the land area to be occupied by the stabilized tailings.
- Protect against releases of contaminants from the site during construction.
- Minimize the areas disturbed during construction, and minimize human exposure to contaminated materials.
- Prevent inadvertent human intrusion into the stabilized tailings.
- Minimize plant root penetration and burrowing by animals into the stabilized tailings.
- Ensure, to the extent practicable, that existing or anticipated beneficial uses of surface water and groundwater are not adversely affected.

With specific regard to the final objective, the disposal cell must be designed so that contaminants entering the groundwater from the disposal cell do not exceed the concentration limits established for these constituents in the uppermost aquifer beyond the point of compliance (POC), a vertical surface established hydraulically downgradient from the disposal cell.

A.1.3 COMPLIANCE WITH THE PROPOSED EPA STANDARDS FOR GROUNDWATER PROTECTION

The current conceptual design incorporates several features to reduce infiltration into the stabilized tailings and thereby reduce contaminant releases into the groundwater beneath the disposal cell. The conceptual design is described in Sections A.2.2 through A.2.4 of this appendix; additional details are provided in the RAP (DOE, 1988a). The ability of the conceptual design to comply with Subpart A of the proposed standards for groundwater protection is presented in Section B.5 of Appendix B, Hydrology. If it is determined that the current conceptual design cannot achieve compliance, to the extent practicable, alternative design features (or components) may be considered for the proposed Green River disposal cell.

A.1.3.1 Alternative design considerations

The DOE is evaluating several design alternatives to assess their ability to reduce the predicted concentrations of contaminants entering the groundwater at the Green River disposal site. These design alternatives under consideration focus on either reducing infiltration or reducing source concentrations in the stabilized pile. These alternatives and the potential benefits are summarized in Table A.1.1. Those features that are determined to be technically feasible will be evaluated for the following:

- Suitability for the proposed disposal cell.
- Effectiveness in decreasing the contaminant concentrations entering the groundwater.
- Additional impacts to the affected environment.

Physical parameters such as climate, topography, and the availability and suitability of cover materials will be weighted against the technical criteria evaluation. If initial consultation with the U.S. Nuclear Regulatory Commission (NRC) or the EPA indicates that a design feature is clearly inappropriate for the proposed Green River disposal cell, efforts will focus on features having greater benefits.

A.1.3.2 Alternative design considerations - Green River site

Based on a preliminary qualitative assessment of the design alternatives currently being evaluated (Table A.1.1), the rock-soil matrix, the geomembrane, and the sodium-amended cover are the only features that have a high probability of significantly lowering the contaminant concentrations currently predicted to enter the groundwater beneath the proposed Green River disposal cell. A more detailed discussion of their suitability is provided below. The potential for changes in the impacts currently assessed in this EA cannot be quantitatively evaluated at this time. However, given the conservative approach used to assess impacts, it is unlikely that the impacts associated with the three design features currently under discussion would require any additional impacts assessment (see Table A.1.1). If design modifications become necessary, the DOE will seek a determination of the appropriate method for satisfying any outstanding National Environmental Policy Act (NEPA) requirements.

The decision as to whether or not the existing conceptual design will be modified to include one or more of these design features will be determined based on the ability of these features to substantially increase the existing conceptual

Table A.1.1 Design alternatives under consideration for the Green River, Utah, tailings site

	Potential benefit	Site suitability	Potential impacts to groundwater	Potential environmental impacts[a]
Sodium-amended cover	Results in a reduction of the soil's hydraulic conductivity, thereby reducing infiltration through the tailings.	If shown to be suitable for long-term application, this alternative could be applied to the Green River disposal cell by increasing the existing percentage of sodium bentonite applied to the radon/infiltration barrier.	Has the potential to further reduce the predicted rate of tailings seepage, thereby enhancing the potential for achieving compliance.	An increased quantity of sodium bentonite would be required. The method for mixing and emplacement would not change.
Geomembranes	Regardless of the performance period, infiltration would be near zero for a number of years. If degradation occurs, a large area would still be present to impede infiltrating water.	A geomembrane would be suitable for the Green River disposal cell if incorporated into the middle of the radon/infiltration barrier to protect it from any environmental stress.	Long-term ability to achieve compliance could not be guaranteed.	Would increase the schedule duration to include placement of geomembrane. Would not impact other construction-related activities or environment.
Alternative cover materials (not geomembranes)	Would reduce infiltration, thereby minimizing tailings seepage. (The hydraulic conductivity of bitumen asphalt can be as low as 10^{-12} cm/s.)	It is doubtful an alternative cover material will be found that is capable of meeting the longevity requirement of the UMTRA Project. However, site conditions at Green River are suitable for incorporation of a rock-soil matrix into the cover design.	The rock-soil matrix alone or in combination with other design features could further reduce the predicted rate of tailings seepage, thereby enhancing the potential for achieving compliance.	A rock-soil matrix would require some additional borrow material (about 5% more) from the radon/infiltration barrier borrow source area. This could require additional transportation and personnel depending on scheduled construction activity.[b]

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[a] If design modifications become necessary, the DOE will seek a determination on the appropriate method for satisfying any outstanding NEPA requirements.

[b] The current estimates for construction activities and associated impacts were assessed conservatively; variances of up to 20 percent are factored into the calculations. The additional borrow materials and possible additional transportation needs represent an additional five percent increase. Reevaluation of impacts would not be required if the existing cover system was altered to include a rock-soil matrix.

design's ability to achieve compliance with the proposed EPA groundwater protection standards (see Section B.5.4, Groundwater Impacts, Appendix B).

The following factors were of primary importance in evaluating the practicability of the alternative design features for the proposed Green River disposal cell:

- Climate.
- Tailings source concentrations.
- Background groundwater quality.
- Geochemical attenuating capacity of naturally occurring minerals in the foundation bedrock.

Rock-soil matrix

The average annual precipitation of Green River is six inches (see Section 3.2 of this EA and Section B.4.4, Appendix B). Although the arid climate precludes the use of a vegetated cover, a rock cover with a soil matrix could be suitable. If a rock-soil matrix cover can be constructed that approximates natural surface conditions of the site, bare-soil evaporation and surface-water runoff processes that now occur in the site vicinity may be enhanced. In the Green River area, it is currently estimated that deep percolation of infiltration to the shallow groundwater system (recharge) is less than one percent of the average annual precipitation, for a long-term rate of about 5×10^{-9} centimeters per second (cm/s) (Rush et al., 1982). The current rock cover system is estimated to impede natural evaporation from the surface of the disposal cell so that the long-term infiltration rate through the stabilized tailings would be 1×10^{-8} cm/s, or about two times the quantity estimated to infiltrate under normal conditions. When the effects of constructability on long-term infiltration rates through the stabilized tailings have been determined, the suitability of a rock-soil matrix will be evaluated for the Green River disposal cell.

Geomembrane

The average concentrations of uranium (448 milligrams per liter, or mg/l) and nitrate (2251 mg/l) in the tailings pore fluid must be lowered over four orders of magnitude to meet the average background concentrations or the proposed maximum concentration limits (MCLs) (0.044 mg/l for uranium and 44 mg/l for nitrate) at the hydraulically downgradient edge (toe) of the engineered disposal cell. Preliminary modeling using the Domenico and Robbins (1985) analytical solution predicts that the uranium concentration entering the groundwater beneath the disposal cell would range between 3.07 and 4.23 mg/l. The estimated infiltration rate (1×10^{-7} cm/s) would have to be lowered to 1×10^{-10} cm/s to meet the MCL for uranium at the toe of the disposal cell. Background concentrations of uranium beneath the proposed disposal cell are very close to or above the proposed MCL for uranium; therefore, dilution of uranium in the tailings seepage by groundwater underflow would be negligible. A similar argument can be applied to nitrate concentrations. A geomembrane with a hydraulic conductivity (K) of 1×10^{-11} cm/s or less would prevent infiltration through the stabilized tailings, thereby preventing tailings seepage. Compliance with the proposed EPA standards could be achieved with the addition of a geomembrane; however, the ability of this feature to meet the longevity requirements of the UMTRCA has not been demonstrated. (See Appendix B for further discussion.)

Sodium-amended cover

Under the existing conceptual design, the radon/infiltration barrier will be amended with sodium bentonite (three percent) and then compacted to ensure that the hydraulic conductivity of the cover will equal 10^{-7} cm/s to inhibit infiltration and diminish the rate of seepage through the bottom of the stabilized pile (Section A.2.2). The radon/infiltration material will be tested to determine whether or not the physical properties of the soils could permit an increase in the current percentage of sodium bentonite to be added and to determine whether or not this increase would significantly reduce infiltration.

A.1.4 ADDITIONAL STUDIES

A.1.4.1 Radon/infiltration barrier freezing

The conceptual design currently incorporates a three-foot-thick layer of compacted select fill in the cover system to protect the radon/infiltration barrier from frost action (Section A.2.2). As part of the special studies currently under way, the effects of freeze-thaw cycles on the density and hydraulic conductivity of the radon/infiltration barrier materials are being evaluated. Laboratory tests will be conducted on the radon/infiltration barrier material to record changes in the density and hydraulic conductivity of the saturated, fine-grained soil. If it is determined that the seasonal freeze-thaw cycles do not affect these physical properties, the frost protection layer will be removed.

A.1.4.2 Radon/infiltration barrier saturation

A study to evaluate the SOILMOIST model will be conducted concurrently with the alternate design studies. This model is used to estimate long-term infiltration and percolation across the disposal cell boundaries and the moisture content within the cell. For the period of simulation, the model predicted that the radon/infiltration barrier will remain saturated. The prediction that this barrier is continuously saturated is thought to be overly conservative and unrealistic. The study will evaluate the veracity of this prediction. Field measurements may indicate that ultimate saturation of the radon/infiltration barrier is unlikely. From the field measurements, it will be possible to determine whether the moisture content of the radon/infiltration barrier changes after construction and whether it approaches saturation, as predicted by the modeling. It also will be possible to observe moisture content changes in the barrier. These data will be used to validate the mathematical treatment of the engineered barrier and filter layer and to validate the evaporation algorithm, which provide the upper boundary condition for the radon/infiltration barrier in SOILMOIST. Valid representations of these processes are necessary for any numerical models that may be used to simulate seepage flux through contaminated materials. When this study is completed, it will be possible to predict more properly the ability of the existing cover design to achieve compliance with the proposed EPA standards.

A.2 PROPOSED ACTION--STABILIZATION ON SITE

A.2.1 PRESENT CONDITIONS

The Green River tailings site is in the Gunnison Valley 0.5 mile east of the Green River. The valley is bordered on the north by the Book Cliffs and on the south by the San Rafael Valley. The area is characterized by cliffs, mesas, and the Gray Canyon of the Green River.

The designated tailings site covers 48 acres and includes the tailings pile, mill yard, and the ore storage area. The tailings pile covers eight acres, is surrounded by a fence, and contains 114,000 cubic yards (cy) of tailings. Approximately 43,000 cy of windblown tailings and contaminated materials are contained in the mill yard and ore storage areas (1.5 acres). Dispersion of the tailings by wind and water erosion has contaminated an additional 43 acres of the designated site and the area immediately surrounding the designated site; these 43 acres contain 28,000 cy of contaminated materials. The estimated total volume of tailings and contaminated materials is 185,000 cy. The limits of soil contamination are shown in Figure A.2.1. Elevated concentrations of molybdenum, nitrate, selenium, uranium, and gross alpha activity exceed background levels and the proposed EPA MCLs in the groundwater in the unconsolidated alluvium and in the shallow shales and limestones beneath the alluvium at the mill tailings site. The contamination is localized beneath, and slightly downgradient of, the tailings pile.

The tailings pile rests against a natural embankment on the south and slopes gently toward Brown's Wash on the north (Figure A.2.2). Mainline tracks of the Denver and Rio Grande Western (D&RGW) Railroad are also to the north, a few hundred feet from the edge of the tailings and north of Brown's Wash. Limited riprap has been placed at the north and east edges of the pile, and small dikes have been constructed on the north, east, and west sides. Earth and weathered shales from the exposed Mancos Shale bluff south of the pile were removed and placed on the tailings by the former owner as a temporary stabilization cover. However, there is evidence of recent surface erosion of the tailings pile.

The mill yard contains four main buildings (i.e., office, mill, roaster, and crusher) and a water tower. All of the facilities within the mill yard are usable; this 10-acre area is enclosed by a fence.

A.2.2 FINAL CONDITIONS

The proposed action for the Green River tailings is stabilization on the site. All tailings and contaminated materials would be removed from the floodplain of Brown's Wash and placed in an excavated area 600 feet south of the existing tailings pile (Figure A.2.3). The below-grade excavation would average 14 feet deep, extending to a

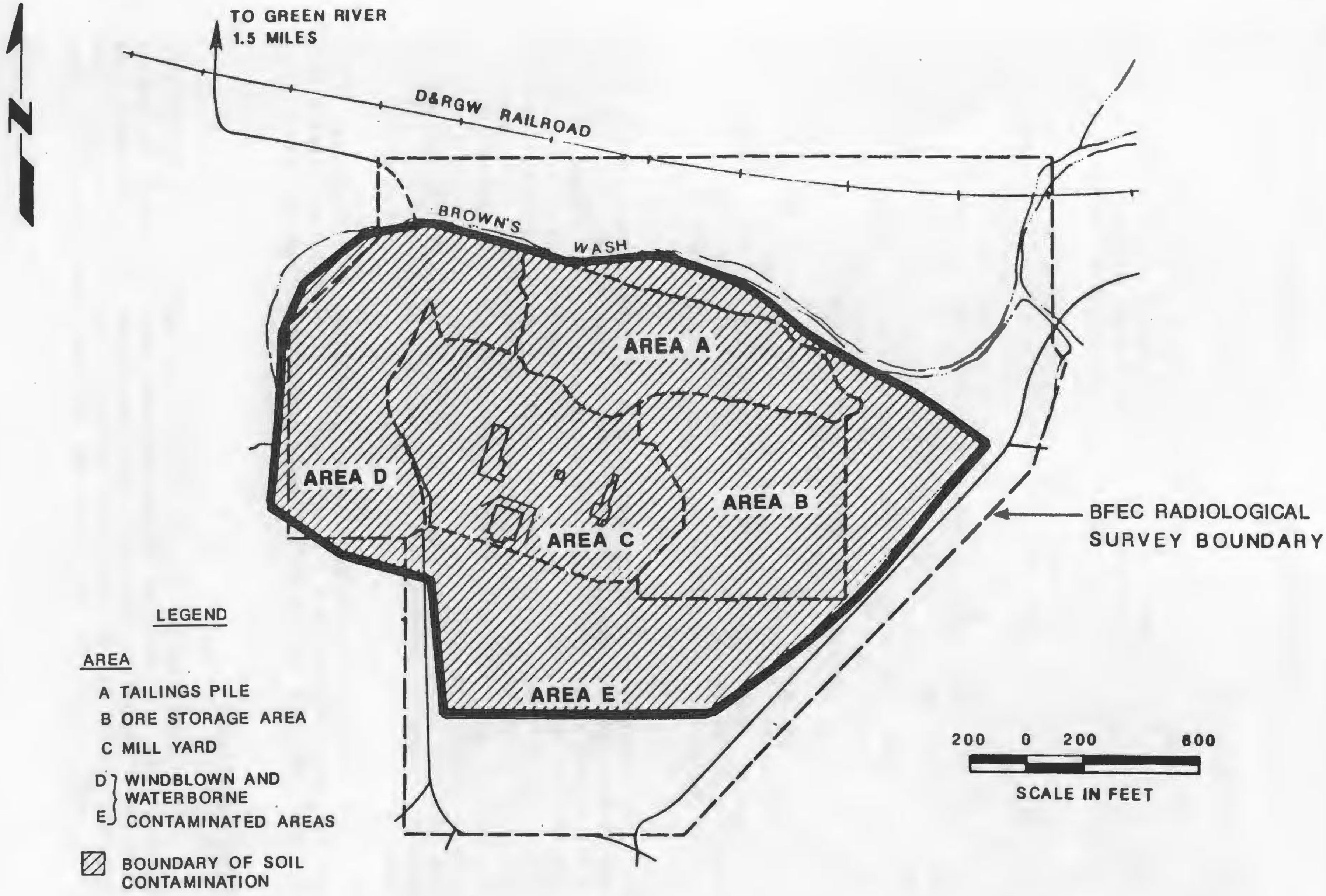


FIGURE A.2.1 AREAL EXTENT OF RADIUM - 226 CONCENTRATION EXCEEDING 5 PICOCURIES PER GRAM, GREEN RIVER, UTAH, TAILINGS SITE

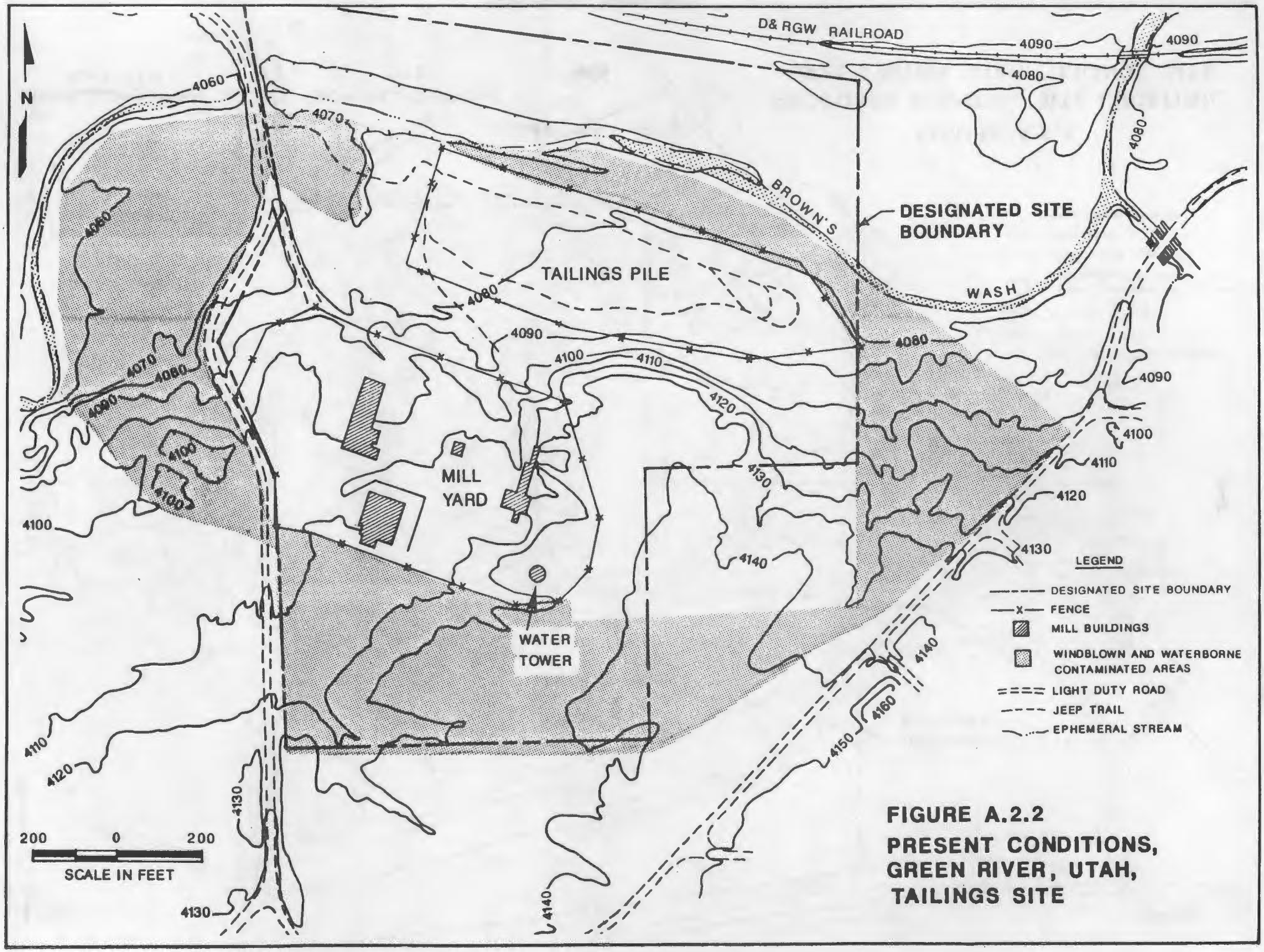


FIGURE A.2.2
PRESENT CONDITIONS, GREEN RIVER, UTAH, TAILINGS SITE

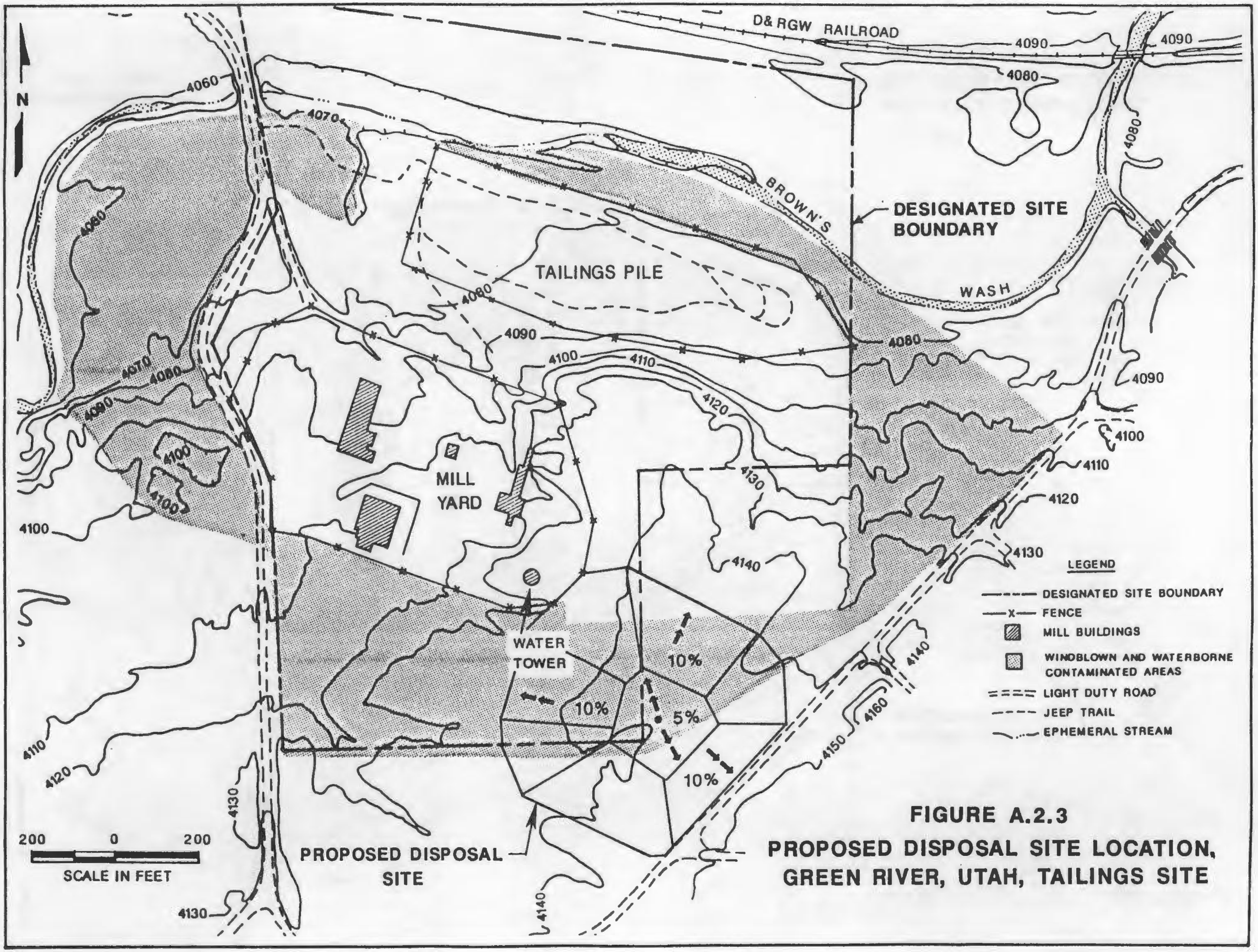


FIGURE A.2.3
PROPOSED DISPOSAL SITE LOCATION, GREEN RIVER, UTAH, TAILINGS SITE

maximum of 20 feet below the existing surface (Figure A.2.4). The base of the excavation would be 50 feet above the streambed of Brown's Wash.

The relocated pile would have sideslopes of 10 percent (10 horizontal to one vertical) and a topslope of five percent. The cover system (Figure A.2.5) would be comprised of five components: (1) a rock cover (riprap) to prevent surface erosion, penetration by animals, and inadvertent human intrusion; (2) a sand bedding layer to prevent piping of fine-grained material through the rock cover and promote runoff of precipitation; (3) a layer of select fill to protect the radon/infiltration barrier from frost action; (4) a filter layer to promote drainage of infiltration through the overlying layers; and (5) a radon/infiltration barrier. The radon/infiltration barrier would be constructed of silty clay taken from a local alluvial borrow source, amended with sodium bentonite (three percent), and then compacted to assure that the hydraulic conductivity (K) of the barrier is 10^{-7} cm/s to inhibit the infiltration of precipitation through the barrier and diminish the rate of seepage through the bottom of the stabilized pile. This barrier would also inhibit the emanation of radon, ensuring compliance with the EPA standards.

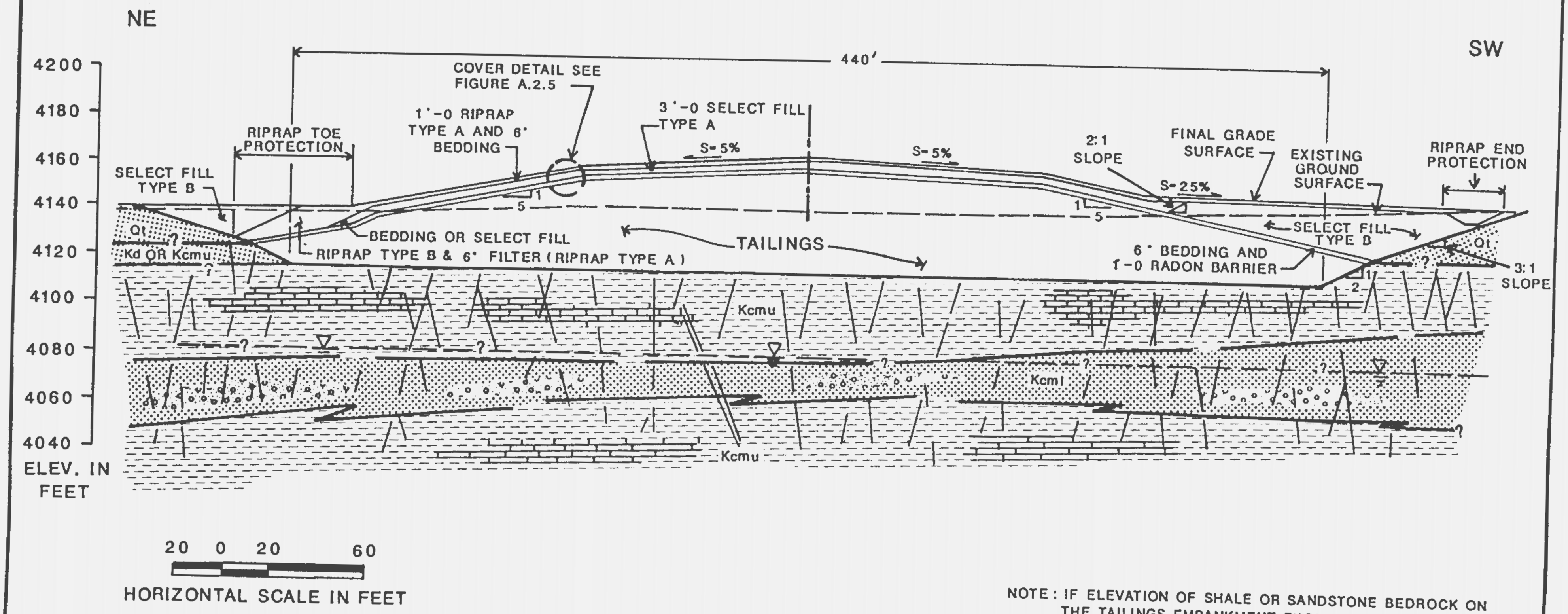
The stabilized tailings pile would be surrounded by a below-grade, tapered rock apron. The rock apron would be keyed to bedrock to protect against gully intrusion on the northeast and west sides of the pile. The apron would be seven feet wide and 10 feet deep along these sides. The remainder of the apron would be three feet wide and would extend four feet below the base of the pile. The roughly square tailings pile would cover eight acres, measuring 600 feet along each side. The pile would rise a maximum of 33 feet, averaging 14 feet, above the surrounding terrain.

All buildings and facilities on the site would be decontaminated and left intact after remedial action. The area of the existing tailings pile would be restored with uncontaminated fill from the disposal site excavation, graded to promote surface drainage, and revegetated. All other areas at the site disturbed by the remedial action would be backfilled with uncontaminated fill from the disposal site excavation and graded to promote surface drainage.

The disposal site would extend outside of the designated site boundary by six acres. The final restricted area would cover nine acres and be enclosed by a fence. Forty-five acres of the 48-acre designated site would then be released for any use consistent with existing land use controls following completion of remedial action. The conceptual design is subject to change during the final design process.

A.2.3 MAJOR CONSTRUCTION ACTIVITIES

The major feature of the proposed action is consolidation and relocation of all tailings and other contaminated materials to an area 600 feet south of the existing tailings pile. There the tailings would



LEGEND

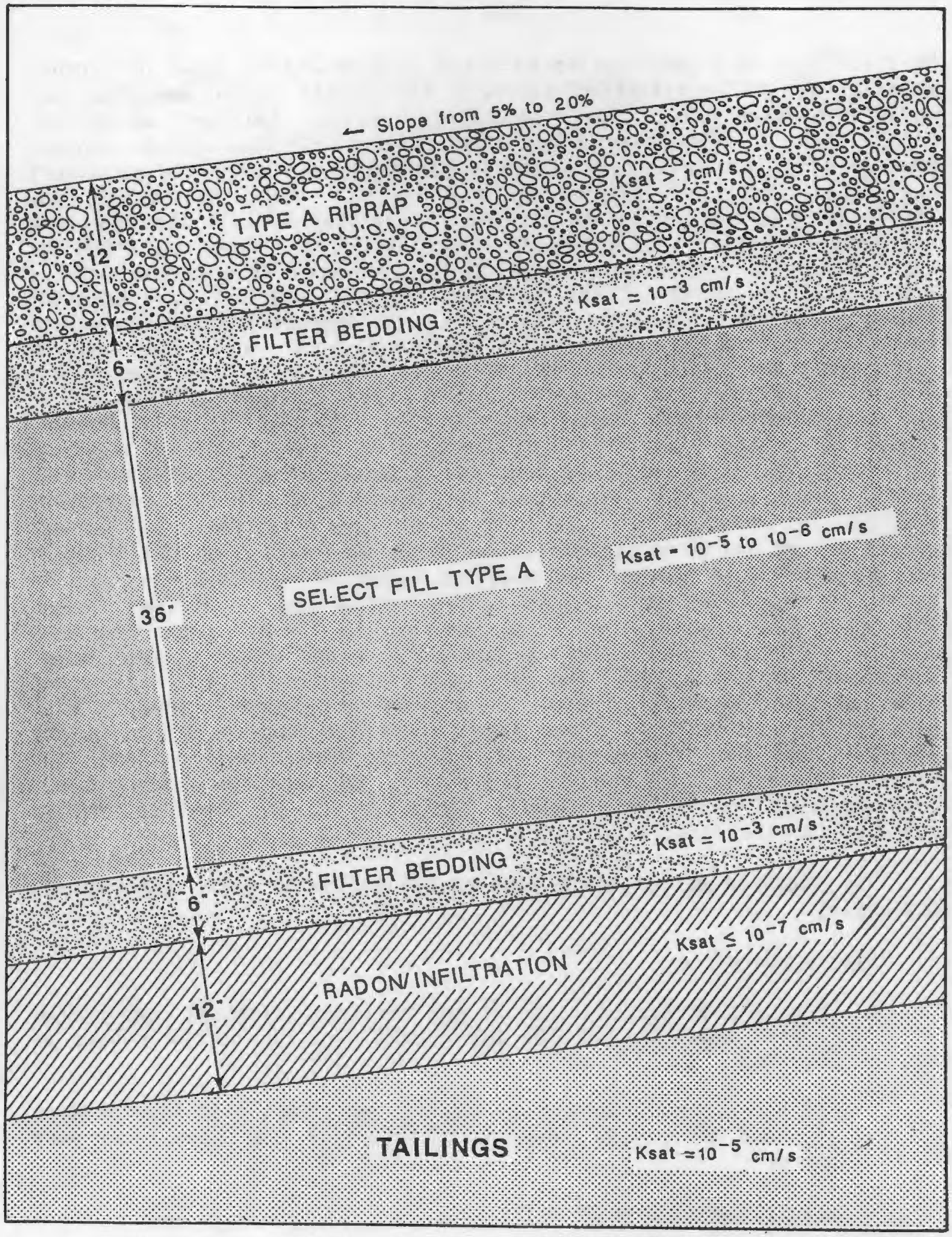
Qt	TERRACE SEDIMENTS
Kd	DAKOTA SANDSTONE
Kcmu	CEDAR MOUNTAIN FORMATION UPPER-MIDDLE UNIT
Kcml	CEDAR MOUNTAIN FORMATION LOWER-MIDDLE UNIT
⨳	FRACTURES
—⊽—	POTENTIOMETRIC SURFACE

▨	SAND AND SILT OR SILTSTONE AND SANDSTONE
☰	SHALE OR MUDSTONE
▦	LIMESTONE
⁘	CONGLOMERATE

NOTE: IF ELEVATION OF SHALE OR SANDSTONE BEDROCK ON THE TAILINGS EMBANKMENT EXCAVATION SIDESLOPES IS LOWER THAN ELEVATION 4124 FEET, THE RADON BARRIER, BEDDING, FILTER, AND RIPRAP LAYERS SHALL BE EXTENDED TO MEET BEDROCK BY OVER EXCAVATION AND CONTINUATION ALONG THE 5:1 SLOPE SHOWN.

FIGURE A.2.4

DIAGRAMMATIC CROSS SECTION OF PROPOSED DISPOSAL CELL AND FOUNDATION GREEN RIVER, UTAH, TAILINGS SITE



NOTE: Ksat-SATURATED HYDRAULIC CONDUCTIVITY; cm/s-CENTIMETER PER SECOND; SEE FIGURE A.2.4 FOR LOCATION OF THIS DETAIL IN RELATION TO THE DISPOSAL CELL.

FIGURE A.2.5
DISPOSAL CELL COVER SYSTEM
GREEN RIVER, UTAH, TAILINGS SITE

be stabilized in a below-grade pile and covered with a layer of earthen material (radon/infiltration barrier) to inhibit radon emanation and water infiltration. The radon/infiltration barrier would be constructed of silty clay taken from a local alluvial borrow source, amended with sodium bentonite (three percent), and compacted to assure that the hydraulic conductivity (K) is 10^{-7} cm/s to inhibit the infiltration of precipitation through the barrier and diminish the rate of seepage through the bottom of the pile. The earthen material for the radon/infiltration barrier would be excavated from borrow site 1, 3.5 road miles north of the tailings site (Figure A.2.6). Material from this borrow site would also be used to upgrade the temporary haul roads and to construct the filter bedding layers. One filter bedding layer would be placed over the radon/ infiltration barrier to inhibit water infiltration. A three-foot-thick layer of select fill would be placed over this filter layer to protect the radon/infiltration barrier from frost action. The fill would be obtained from stockpiled areas of uncontaminated fill excavated from the disposal area. A second filter bedding layer would be placed over the layer of select fill to prevent erosion and promote surface runoff of precipitation. Sufficient quantities of uncontaminated fill would be available from the disposal site excavation to provide the required amount of material necessary to construct the select fill layer. This second layer would be covered with rock (the erosion protection barrier) to inhibit water and wind erosion, inhibit penetration by burrowing animals and prevent human intrusion. The rock would be obtained from borrow site 2, five road miles west of the tailings site. Rock from this borrow site would also be used to construct the rock apron. For the purpose of evaluating impacts and for conceptual design, specific borrow sites for radon/infiltration and erosion protection materials were identified; however, other borrow sites may be identified during the final design and used for the remedial action.

The proposed action would require the following major construction activities:

Site preparation

- Upgrading of access roads at the tailings, disposal, and borrow sites. Upgrading of the haul roads for the borrow sites, as required.
- Reinforcement of the bridge over Brown's Wash near the tailings site and the bridge over the tributary to the Green River near borrow site 2.
- Relocation of on-site utilities.
- Preliminary earthmoving and clearing and grubbing in order to facilitate construction of temporary drainage facilities and minimize the extent of fencing required to enclose the site.
- Construction of a decontamination pad, equipment storage area, and contractor facilities, and erection of a security fence around these areas.

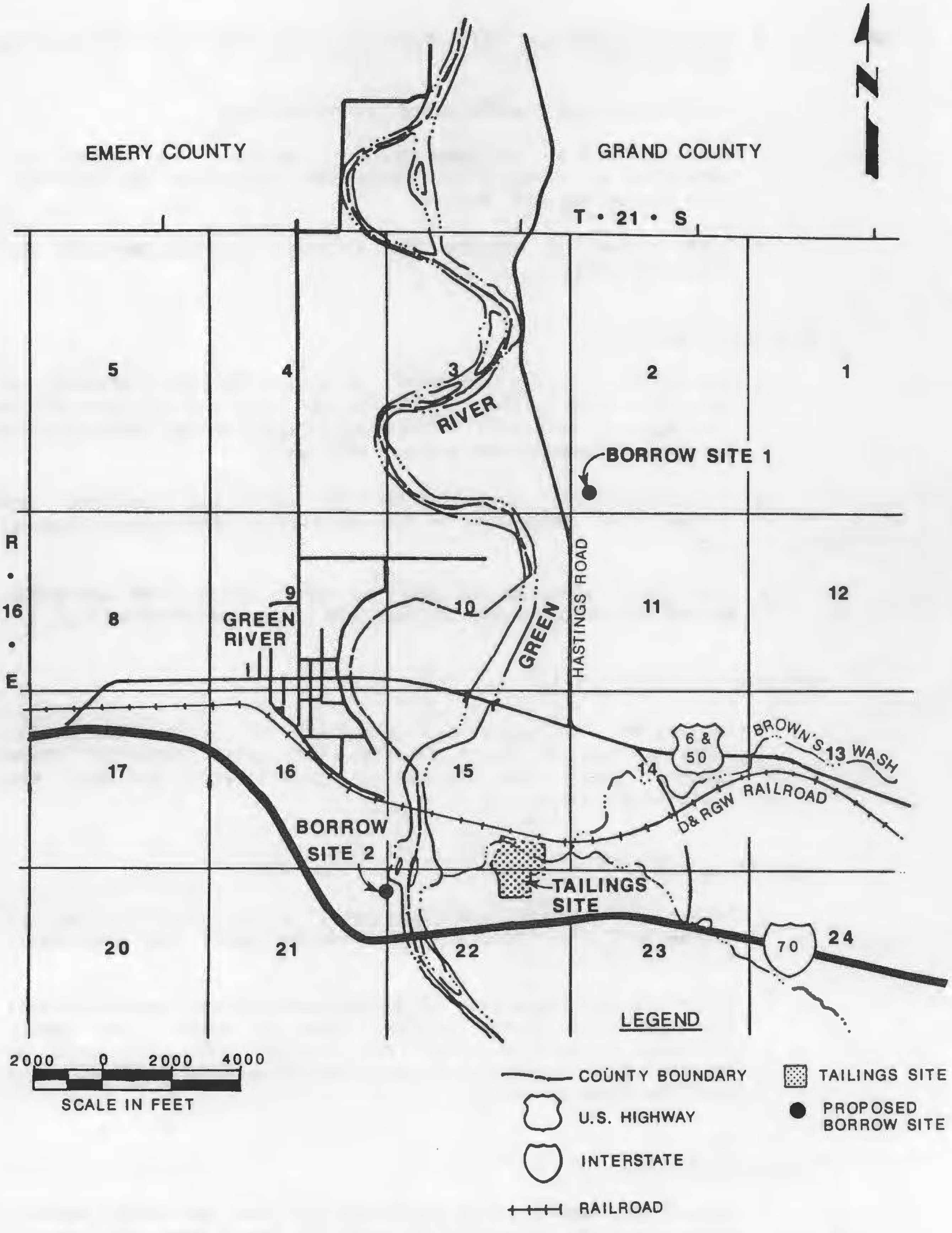


FIGURE A.2.6 LOCATIONS OF PROPOSED BORROW SITES FOR THE GREEN RIVER, UTAH, TAILINGS SITE

- Decontamination of all buildings and facilities within the tailings site.

- Construction of a waste-water retention pond.

- Construction of drainage control measures to direct all generated waste-water and storm-water runoff to the retention pond during remedial action.

- Installation of erosion and sediment control measures for disturbed areas.

Tailings relocation

- Excavation of the disposal area, including placement of excavated material in a stockpile for later use in constructing the layer of select fill for frost protection and for restoring the Brown's Wash floodplain and mill yard.

- Relocation and consolidation of all the tailings and contaminated materials in the partially below-grade disposal site.

- Even distribution of contaminated debris and grubbed vegetation within the consolidated tailings and contaminated materials.

Radon/infiltration barrier

- Excavation, haulage, and placement of a one-foot-thick, compacted earthen cover amended with sodium bentonite (three percent) over the relocated, consolidated tailings and contaminated materials.

Layer of select fill

- Excavation, haulage, and placement of a six-inch-thick layer of coarse sand and gravel (filter bedding layer) over the radon/ infiltration barrier.

- Placement and compaction of a three-foot-thick layer of select fill over the filter bedding layer to protect the radon/ infiltration barrier from frost action (the fill would be obtained from stockpiled areas of uncontaminated fill excavated from the disposal area).

Erosion protection

- Excavation, haulage, and placement of a six-inch-thick layer of coarse sand and gravel (filter bedding layer) over the layer of select fill.

- Excavation, haulage, and placement of a one-foot-thick layer of rock over the filter and bedding layer on the pile topslope and sideslopes.

- Excavation, haulage, and placement of a below-grade, tapered rock apron around the base of the stabilized tailings pile.

Site restoration

- Backfilling and grading for drainage control of disturbed areas in the floodplain of Brown's Wash and in the mill yard.

- Revegetation of restored areas in the Brown's Wash floodplain.

- Construction of a security fence around the stabilized tailings pile.

A remedial action schedule for the proposed action is shown in Figure A.2.7.

A.2.4 MAJOR DESIGN CONSIDERATIONS

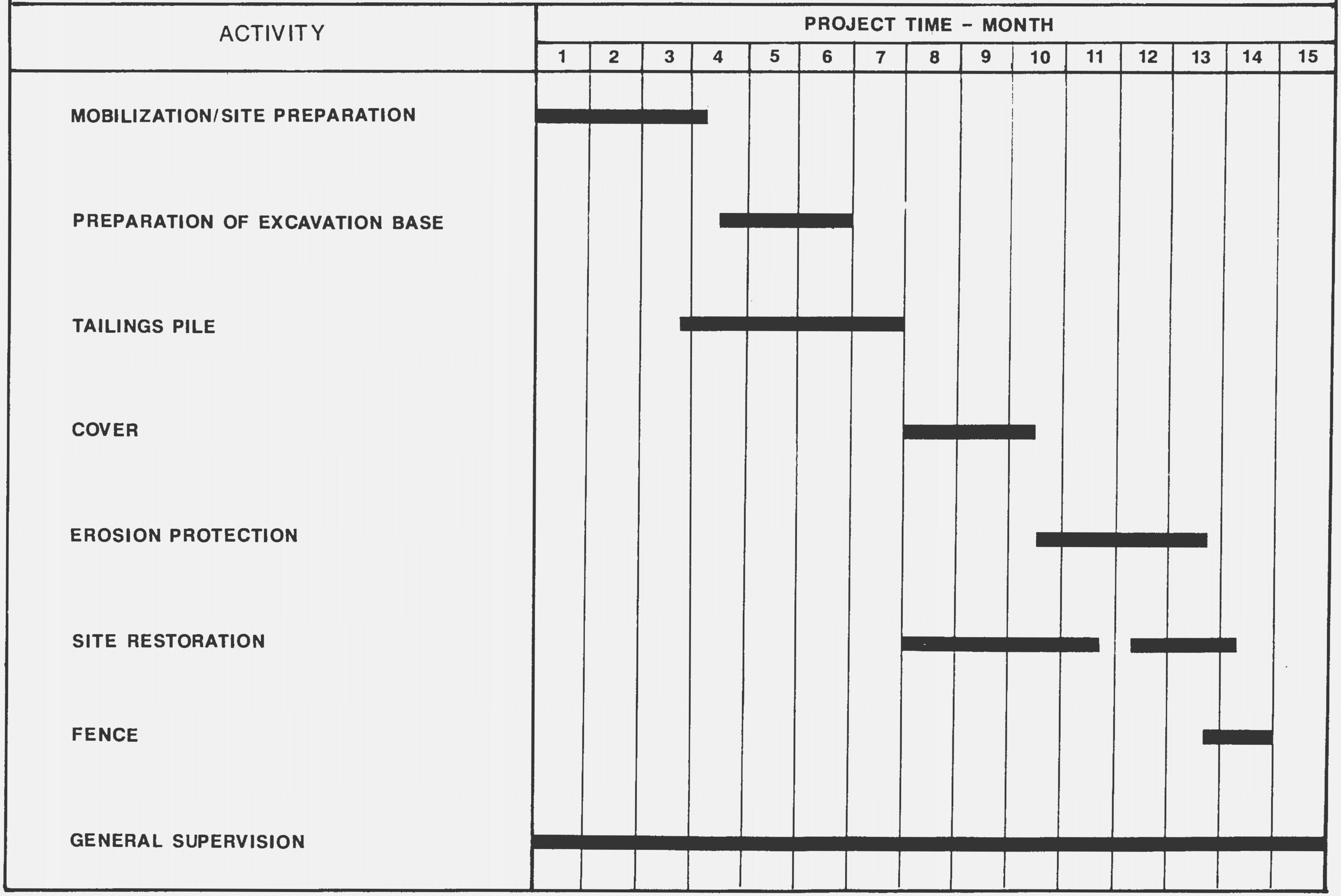
The conceptual design for the proposed action was controlled by existing conditions at the tailings and disposal sites and by the development of a cost-effective cover system. The availability of borrow materials of adequate quality and quantity was instrumental in the development of a cost effective cover system.

Location and configuration

The configuration of the final stabilized pile was primarily controlled by three factors: (1) the potential depth of below-grade disposal; (2) the proximity to the small, on-site gullies and the exposed Mancos Shale bluff above the existing pile; and (3) the size of rock required for erosion protection. The surface area of the stabilized pile would be minimized while maintaining gentle (10 horizontal to one vertical) sideslopes; thus, the below-grade disposal capacity would be maximized, eliminating the need to obtain restoration material from off-site borrow sources and minimizing the amount of cover material required. In addition, the size of the rock erosion protection required to resist erosion from sheet flow off the pile would be minimized.

The location of the stabilized tailings pile would provide considerable setback from the face of the bluff above Brown's Wash and the steep gullies that direct flows toward Brown's Wash northeast of the disposal site. All existing buildings and facilities would be decontaminated and left intact and released for unrestricted use consistent with existing land controls. Therefore, the stabilized pile would be outside of the mill yard.

FIGURE A.2.7 REMEDIAL ACTION SCHEDULE FOR THE PROPOSED ACTION, GREEN RIVER, UTAH, TAILINGS SITE



Radon control

Data on the distribution of radium in the tailings and other contaminated materials and the physical properties of the locally available earthen material were used in the RAECOM model (NRC, 1984) to estimate the thickness of the radon barrier necessary to control radon emanation to meet the EPA standard. According to this analysis, radon emanation could be controlled to meet the standard by using the following techniques:

- Decontamination of the site by excavating and placing lesser contaminated materials (i.e., windblown tailings, contaminated alluvium) on top of the relocated tailings.

- Placement of a one-foot-thick, compacted earthen cover amended with sodium bentonite (three percent) over the consolidated tailings and contaminated materials.

Long-term stability

The tailings pile has been designed to withstand the effects of several natural events as discussed below.

Water and wind erosion. The Probable Maximum Precipitation (PMP) for the Green River site was determined to be 8.5 inches of rain in one hour resulting in a maximum intensity of 56.1 inches per hour (DOE, 1988b; NOAA, 1977). This design PMP intensity would generate sheet flow rates of 0.48 cubic feet per second per foot (cfs/ft) of slope width on the 10-percent sideslopes of the stabilized pile and 0.13 cfs/ft on the five-percent topslope. The rock erosion protection required to withstand erosion from sheet flow during this PMP event is shown in Table A.2.1.

To protect the base of the stabilized pile against erosion from sheet flow, a below-grade, tapered rock apron tied into the rock erosion protection barrier on the pile sideslopes and extending to bedrock, where required, would be constructed around the base of the pile. The rock erosion protection required for this apron is shown in Table A.2.1.

High winds in the Green River area would have the potential to erode the stabilized pile. However, the rock erosion protection barrier would protect the stabilized pile from wind erosion since the erosive forces of high winds would be much less than those caused by the PMP runoff.

Flood protection and geomorphology. Since the stabilized pile would not be within the floodplain of a Probable Maximum Flood (PMF) in Brown's Wash, protection from the occurrence of floods would not be required. High flows in Brown's Wash have the potential to erode the exposed Mancos Shale bluff north of the disposal area. However, the stabilized pile would be about 600 feet south of the PMP floodplain's

Table A.2.1 Rock erosion protection requirements for the proposed action, Green River, Utah, tailings site

Design feature	PMP runoff rate (cfs/ft)[a]	Mean diameter of rock (inches)	Thickness of design feature (feet)
Filter layer[b]			
sand bedding	Not applicable	Coarse sand	0.5
gravel filter	Not applicable	Not available[c]	0.5
Erosion protection barrier			
topslope	0.13	1.5	1.5
sideslopes	0.48	2.5	1.5
Below-grade rock apron	2600 cfs	10.0	7.0

[a] PMP = Probable Maximum Precipitation; cfs/ft = cubic feet per second per foot.
[b] On topslope and sideslopes.
[c] To be determined during the final design.

southern boundary and over 400 feet higher than the elevation of the exposed bluff (see Appendix F, Floodplain Assessment).

The stabilized pile would require protection from flows resulting from local thunderstorms occurring over the 110-acre area draining toward the site; 2600 cubic feet per second (cfs) would flow from this area during a PMP event. Of primary concern are the gullies that drain the disposal area to the west and northeast; these gullies have the potential to erode toward and undercut the stabilized pile. The below-grade, tapered rock apron around the pile would be designed to withstand the erosive forces of the PMP discharge (2600 cfs) flowing against the stabilized pile. The rock (Table A.2.1) would be sized to resist the highest velocity that could occur even if the gullies were to migrate to the pile. In order to prevent undercutting, the apron would extend into the bedrock. In the disposal area, bedrock is below the surface at depths ranging from four to 15 feet (Figure A.2.5). In addition, the stabilized pile would be set back over 100 feet from the steep gullies that drain the site to the northeast.

Slope stability and seismic risk. Seismic loading conditions were evaluated by applying the horizontal bedrock acceleration of 0.21g (expressed as percent of gravity) from a floating earthquake of 6.2 on the Richter scale. The factors of safety for the designed slopes under both static and seismic loading (DOE, 1988b) exceed the generally accepted limits of 1.5 and 1.0, respectively (COE, 1970). With the use of relatively flat (10 horizontal to one vertical) sideslopes, the stabilized pile would be stable under all loading conditions.

The Green River tailings contain only cohesionless sand tailings. The tailings would be compacted to greater than 70 percent relative density, and no groundwater would be present in the final stabilized pile. Due to the absence of saturated, loose tailings, the potential for seismically induced liquefaction of the tailings would be nonexistent (DOE, 1988b). The below-grade disposal would involve removing weak soils down to the foundation bedrock (Figure A.2.4). Groundwater at the site is deep in the bedrock; therefore, there would be no potential for liquefaction of the foundation bedrock during a seismic event.

Differential settlement. Total and differential settlements are only important if significant settlement occurs after construction is completed. Since the tailings are sands that behave elastically, no significant settlement would occur following completion of construction.

Frost heave and solifluction. There is a chance that during the disposal cell design life the radon/infiltration barrier under saturated conditions could be subjected to frost heave. An additional 0.5 foot of sand and 3.0 feet of compacted select fill would be placed over the radon/infiltration barrier; these added layers, in conjunction with the 1.5 feet of filter bedding and erosion protection materials would place the radon/infiltration barrier below the calculated site-specific frost penetration depth of 30 to 36 inches. This would prevent freezing of the radon/infiltration barrier, thus ensuring its integrity during the design life of the disposal cell. If the radon/infiltration barrier freezing study determines that the freeze-thaw cycle does not affect the density or hydraulic conductivity, this layer will be removed.

Penetration by plants and animals. The use of a sufficiently thick cover system (six feet thick) would inhibit penetration of the stabilized pile by plants and animals.

Groundwater and surface-water protection

Water in the unconsolidated Brown's Wash alluvium and the upper portion of the Cedar Mountain Formation has been contaminated by the natural dewatering of the tailings during and immediately after the uranium milling and, to a much lesser degree, by infiltration and percolation of precipitation through the existing tailings pile. Currently, contaminated water is discharged from the alluvium at the surface in Brown's Wash 500 feet west of the tailings pile where a conglomeratic sandstone of the Dakota Sandstone crops out.

The stabilized tailings pile would be sloped to promote the drainage of precipitation off the pile, and the low hydraulic conductivity of the radon/infiltration barrier would inhibit the infiltration of precipitation through the pile. The radon/infiltration barrier will be constructed of silty clay taken from a local alluvial borrow source, amended with sodium bentonite (three percent), and then compacted to assure that the hydraulic conductivity (K) is 10^{-7} cm/s to inhibit the infiltration of precipitation through the barrier and diminish the rate of seepage through the bottom of the pile.

The surface water in Brown's Wash was sampled where the backwater from the Green River and water from Brown's Wash mix downstream from the existing tailings pile. Results indicate that contamination of the Green River from surface water is minimal (see Section B.1.2, Surface-Water Quality, Appendix B); however, a limited potential for contamination exists. The tailings would be relocated to a higher elevation and out of the Brown's Wash floodplain. Stabilization of the tailings with an effective cover system would prevent further erosion of the contaminated tailings. This would also prevent contaminants from entering Brown's Wash via surface-water runoff and would eliminate the potential for any future contamination of the Green River from stream flow in the wash.

A.2.5 CONSTRUCTION ESTIMATES

Preliminary estimates of equipment and personnel requirements; fuel, energy, and water consumptions; major earthwork volumes; and construction costs for the proposed action are summarized in Tables A.2.2 through A.2.8. Estimates of equipment, personnel, and consumables are based on a 14-month schedule since one of the 15 months required for the proposed action would entail site closure and finalization of administrative details.

Table A.2.2 Equipment requirements for the proposed action, Green River, Utah, tailings site

Type of equipment	Pieces of equipment per month of remedial action														Total equipment-months per type of equipment
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Pickup truck	1	2	2	1	1	2	2	2	3	2	3	3	2	2	28
10-cy dump truck	2	4	3	1	1	2	3	2	2	2	3	3	3	0	31
20-cy bottom-dump truck	0	0	0	0	0	0	0	2	10	1	2	3	1	0	19
Crane	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Flatbed truck	1	1	1	0	0	0	0	0	0	0	0	0	0	0	3
Backhoe	2	1	1	0	0	0	0	0	0	0	0	0	0	0	4
Grader	1	1	1	1	1	2	3	3	4	2	1	1	2	1	24
Scraper	0	0	1	4	6	7	7	5	5	3	1	1	1	1	42
Front-end loader	1	2	1	1	1	2	3	2	2	2	2	3	2	0	24
D6 bulldozer	1	2	1	1	0	0	0	0	0	0	1	2	1	1	10
D8 bulldozer	0	0	1	2	1	3	3	2	3	1	2	2	2	0	22
Large compactor	0	1	1	1	1	2	3	3	4	2	1	1	2	1	23
Small compactor	1	1	1	0	0	0	0	0	0	0	0	0	0	0	3
Water truck	1	1	1	1	1	2	3	3	4	2	1	1	2	1	24
Total pieces of equipment per month of remedial action	11	17	15	13	13	22	27	24	37	17	17	20	18	7	258[a]

[a] Average pieces of equipment per month is 18 pieces (258 total equipment-months for 14 months).

Table A.2.3 Personnel requirements for the proposed action, Green River, Utah, tailings 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	
Truck drivers	5	8	7	3	2	6	8	9	19	7	9	10	8	2	103
Equipment operators	6	9	8	10	11	16	19	15	18	10	8	10	10	5	155
Operator supervisors	2	2	2	2	2	3	3	3	4	2	2	2	2	1	32
Laborers	2	2	2	2	2	3	3	3	4	4	4	4	4	4	43
Mechanics	8	8	8	7	7	8	9	9	10	8	8	8	8	2	108
General supervision and field services	14	14	14	14	14	14	14	14	14	14	14	14	14	14	196
Total man-months per month of remedial action	37	43	41	38	38	50	56	53	69	45	45	48	46	28	637

[a] Personnel requirements based on one eight-hour shift per day, five days per week. Peak employment is 69 personnel. Average employment is 46 employees (637 total man-months for 14 months).

Table A.2.4 Fuel consumption summary for the proposed action, Green River, Utah, tailings site

Type of equipment	Gallons consumed
Pickup truck	4,500
10-cy dump truck	11,000
20-cy bottom-dump truck	13,000
Crane	300
Flatbed truck	400
Backhoe	600
Grader	11,000
Scraper	60,000
Front-end loader	10,000
D6 bulldozer	3,000
D8 bulldozer	23,000
Large compactor	25,000
Small compactor	400
Water truck	7,000
Total consumption	170,000

Table A.2.5 Energy consumption summary for the proposed action, Green River, Utah, tailings site

Facility	Kilowatt-hours consumed
Field offices	41,000
Change/shower trailer	94,000
Laundry	47,000
Total consumption	182,000

Table A.2.6 Water consumption summary for the proposed action, Green River, Utah, tailings site

Activity/facility	Gallons consumed
Compaction	
o Disposal area	300,000
o Tailings	870,000
o Contaminated materials	270,000
o Radon/infiltration barrier	870,000
o Layer of select fill	130,000
o Site restoration	160,000
Compaction subtotal	2,600,000
Drinking/laundry/showers	170,000
Decontamination	65,000
Dust control	970,000
Total consumption	3,800,000

Table A.2.7 Summary of major earthwork volumes for the proposed action, Green River, Utah, tailings site

Activity	Estimated in-place cubic yards
SITE PREPARATION	
o Temporary roads	
1. Subbase	2,200
2. Gravel	1,100
o Waste-water retention pond	
1. Excavate	11,600
2. Construct pond berms	1,900
o Drainage facilities	
1. Excavate	300
2. Construct berms	7,500
o Initial earthmoving, contaminated materials	32,700
TAILINGS RELOCATION/PILE CONSTRUCTION	
o Excavate and stockpile disposal area	240,000
o Excavate, haul, and place tailings	114,000
o Excavate, haul, and place contaminated materials	71,200
o Off-pile cut	8,000
o Off-pile fill	2,000
RADON/INFILTRATION BARRIER	
o Excavate	66,000
o Haul, spread, and compact	19,000
LAYER OF SELECT FILL	
o Relocate from stockpile area, compact, and place	16,000
EROSION PROTECTION BARRIER	
o Haul and place filter and bedding layer	7,000
o Excavate and screen	50,000
o Haul and place erosion protection barrier	19,000
o Excavate, haul, and place rock apron	9,000
SITE RESTORATION	
o Restore floodplain	150,000
o Backfill excavations	13,000
o Restore mill yard and fence	50,000

Table A.2.8 Summary of construction costs for the proposed action, Green River, Utah, tailings site[a]

Activity	Estimated cost in 1987 dollars
Site preparation	590,000
Tailings relocation	670,000
Cover system[b]	1,140,000
Decontamination	110,000
Site restoration	280,000
Fencing	160,000
Total	2,950,000

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

- o Property acquisition.
- o Engineering design.
- o Construction management (except field supervision).
- o Overall project management.
- o Long-term surveillance and maintenance.

[b] Includes costs of:

- o Radon/infiltration barrier
- o Layer of compacted fill
- o Erosion protection barrier
- o Two filter bedding layers
- o Off-pile erosion protection

A.3 STABILIZATION IN PLACE ALTERNATIVE

A.3.1 FINAL CONDITIONS

The stabilization in place alternative would involve consolidation of all of the tailings and contaminated materials at the existing tailings pile location. The stabilized tailings pile would have the same shape as the existing tailings pile, and the other final conditions (e.g., radon/infiltration barrier, layer of select fill, erosion protection barrier, filter bedding layer, and fencing) would be identical or similar to those for the proposed action.

Two permanent features that would be different for the stabilization in place alternative are the rock apron around the stabilized pile and the placement of riprap on portions of Brown's Wash to prevent bank erosion toward the stabilized pile. In addition, the stabilization in place design does not incorporate features associated with the excavation at the disposal area. Material for the layer of select fill would be obtained from the borrow source for the radon/infiltration material rather than from stockpiled uncontaminated fill. The stabilized pile would cover eight acres and would average five feet above the surrounding terrain to the east and west. The pile would rise 18 feet above Brown's Wash and would tie into the bluff overlooking the site. The final restricted area would cover nine acres.

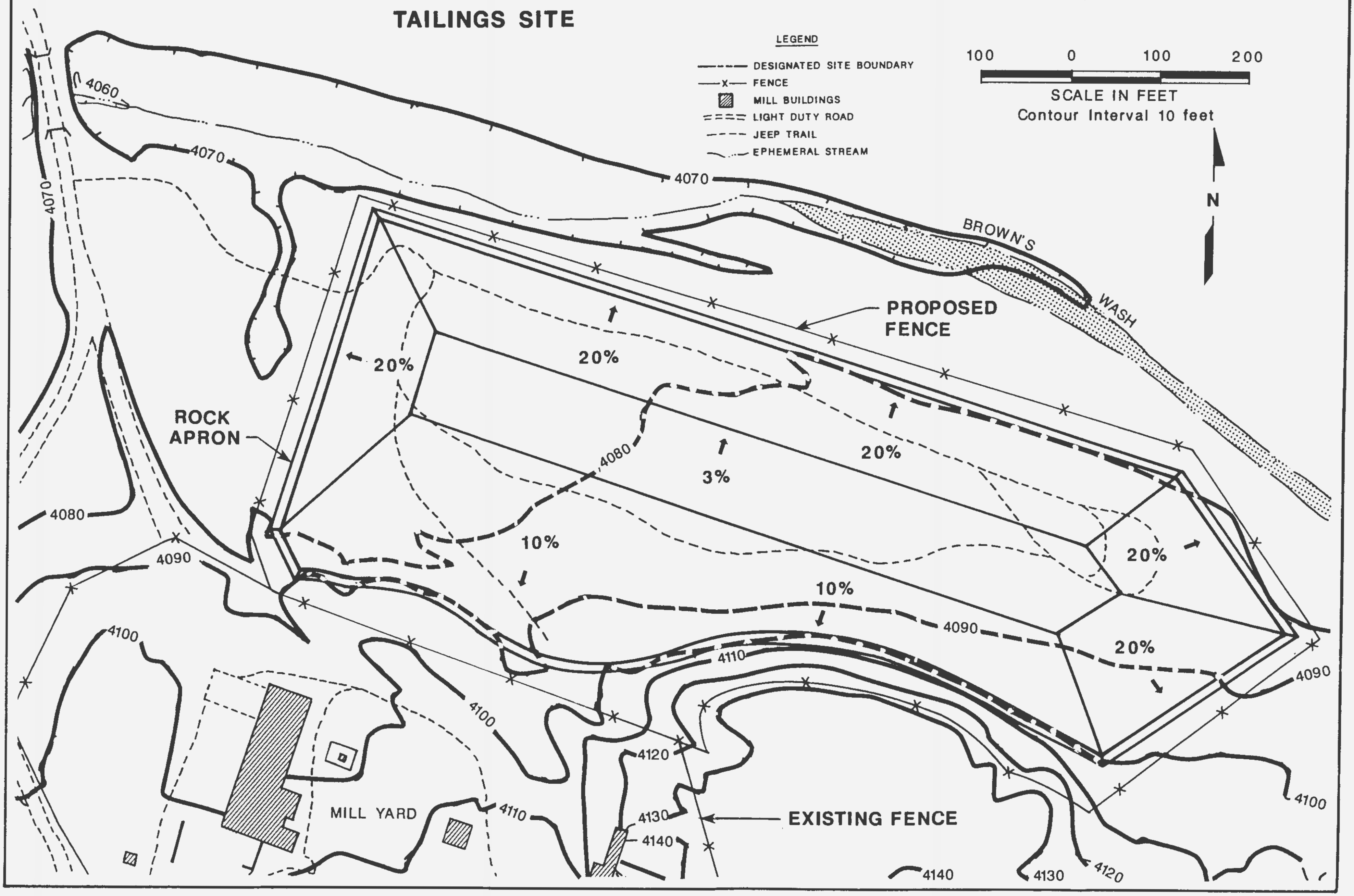
As with the proposed action, all buildings and facilities on the site would be decontaminated and remain intact after remedial action. Thirty-nine acres of the 48-acre site would be released for any use consistent with existing land use controls.

Figures A.3.1 and A.3.2 show the proposed stabilized pile configuration and typical cross sections, respectively, for the stabilization in place alternative.

A.3.2 MAJOR CONSTRUCTION ACTIVITIES

The major feature of the stabilization in place alternative is consolidation of the tailings and contaminated materials at the existing tailings pile location. This alternative would require essentially the same major construction activities as the proposed action (see Section A.2.3) except that the tailings would not be relocated and the associated disposal area excavation and site restoration would not be required. Unless noted otherwise, the same borrow source areas defined for the proposed action would provide the necessary materials for the cover system and embankment protection. Material for the layer of select fill would be obtained from the borrow source for the radon/infiltration barrier material rather than from stockpiled contaminated fill. In addition, riprap would be placed on portions of Brown's Wash to prevent bank erosion, and the erosion protection barrier and perimeter apron on the pile sideslopes would be designed to withstand the erosive forces resulting from the occurrence of a PMF in Brown's Wash. A remedial action schedule for the stabilization in place alternative is shown in Figure A.3.3.

FIGURE A.3.1 PROPOSED STABILIZED PILE CONFIGURATION FOR THE STABILIZATION IN PLACE ALTERNATIVE, GREEN RIVER, UTAH, TAILINGS SITE



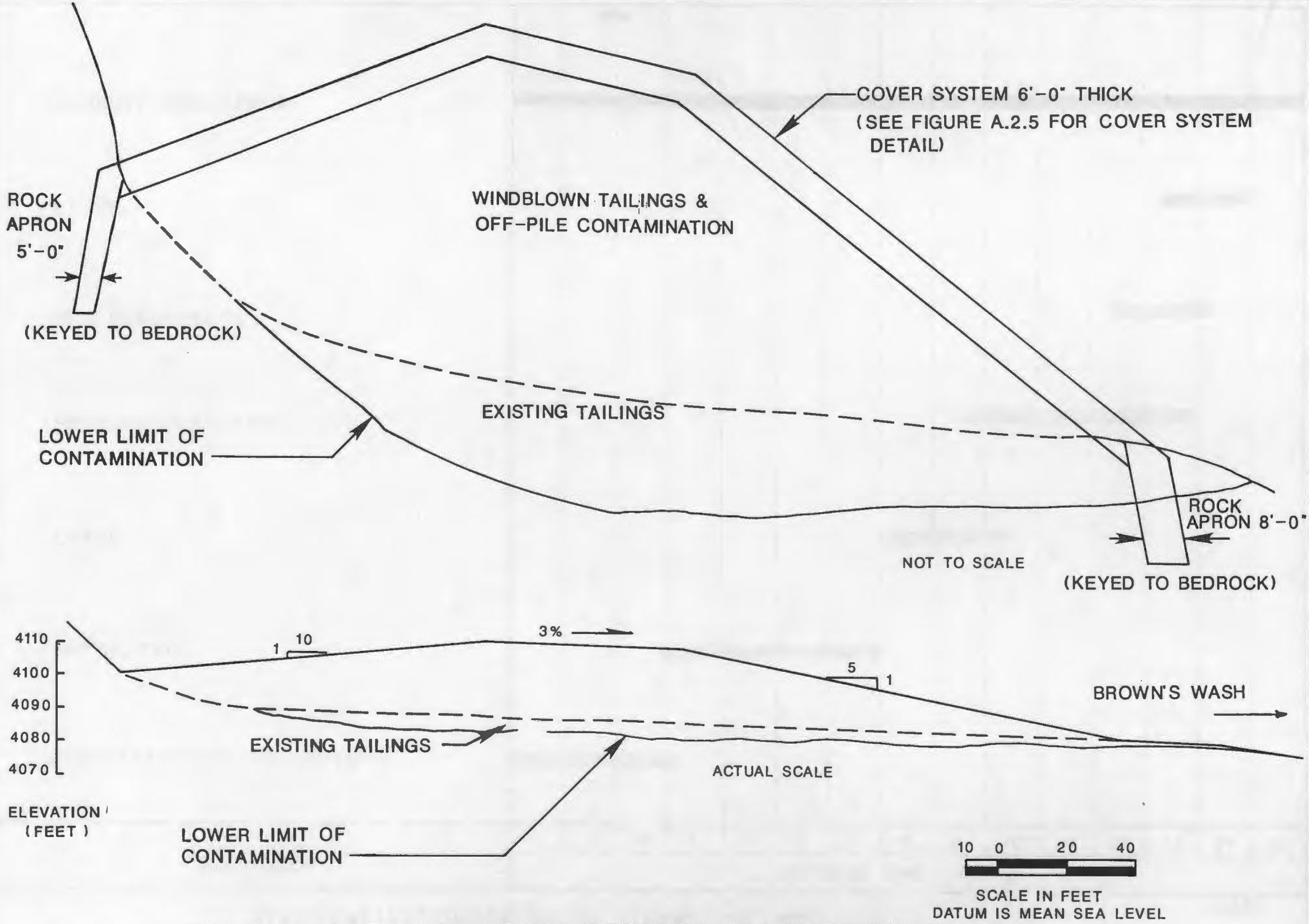
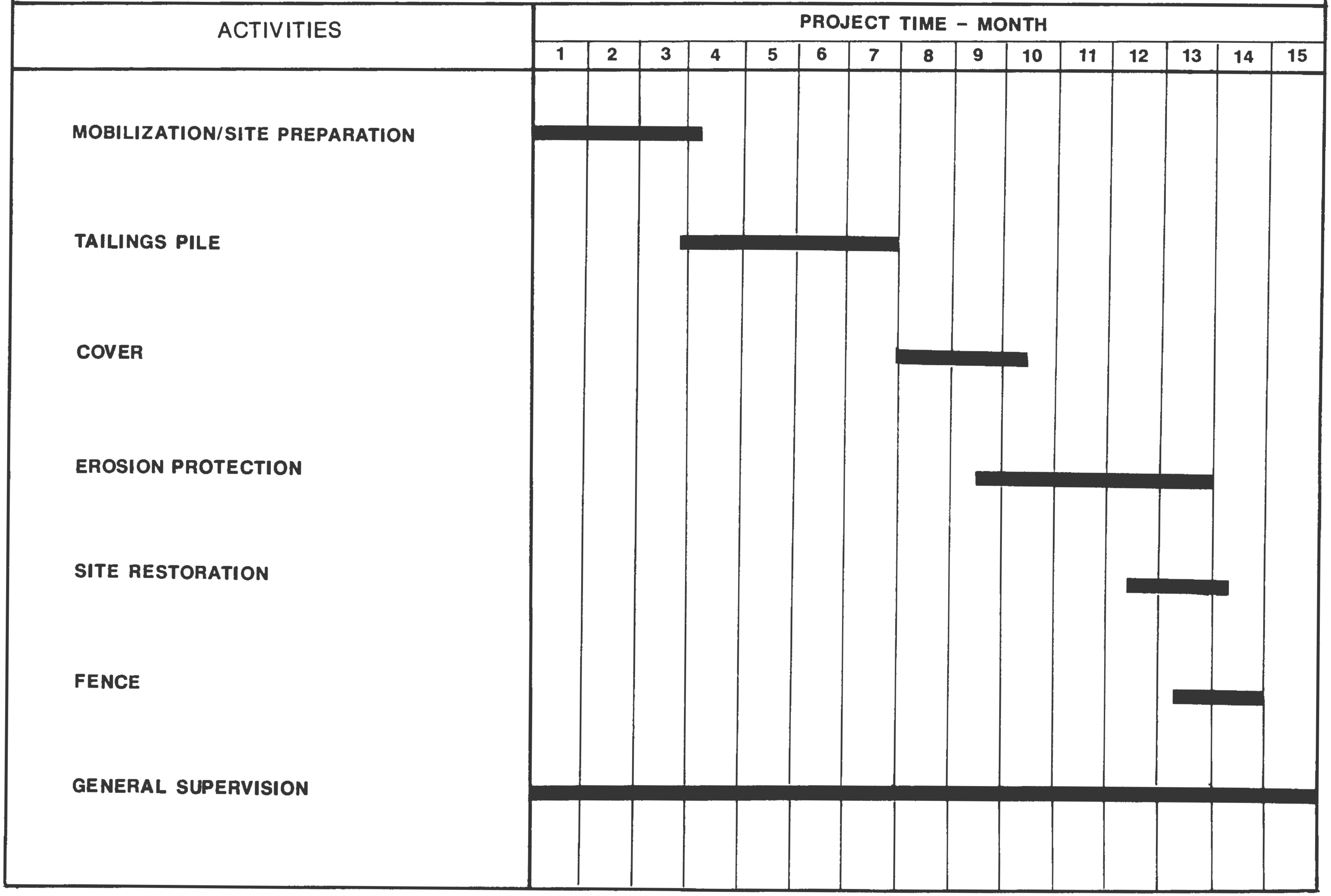


FIGURE A.3.2 TYPICAL CROSS SECTIONS, STABILIZATION IN PLACE ALTERNATIVE, GREEN RIVER, UTAH, TAILINGS SITE

FIGURE A.3.3 REMEDIAL ACTION SCHEDULE FOR THE STABILIZATION IN PLACE ALTERNATIVE, GREEN RIVER, UTAH, TAILINGS SITE



A.3.3 MAJOR DESIGN CONSIDERATIONS

Introduction

The conceptual design for the stabilization in place alternative was based on the assumption that the tailings and contaminated materials would be stabilized at the existing tailings pile location. As in the proposed action, the tailings would be covered with a layer of contaminated materials that would, in turn, be covered with a radon/infiltration barrier, a filler and bedding layer, a layer of select fill to protect the radon/infiltration barrier from frost action, and an erosion protection barrier including a filter and bedding layer.

The location and configuration of the stabilized pile for this alternative were dictated by the present position and configuration of the tailings pile. Since the stabilized pile would be placed in the same layering sequence as in the proposed action, the discussion of radon control for the proposed action in Section A.2.4 would be applicable.

Most of the design considerations for the stabilization in place alternative were the same or very similar to those for the proposed action. The major differences between the design considerations for the proposed action and this alternative are discussed below.

Long-term stability

Water and wind erosion. The tailings would be stabilized in the floodplain of Brown's Wash; therefore, additional erosion protection measures would be required to protect the tailings and contaminated materials from the occurrence of a PMF in the wash. A four-foot-thick layer of 15-inch rock would be required over the entire pile. The rock apron would be extended to the approximate depth of scour in order to prevent undercutting of the tailings pile. In addition, an apron of 11-inch-diameter rock would extend along the southern perimeter of the pile and tie into bedrock.

Flood protection and geomorphology. As discussed in previous sections, measures would be taken to prevent erosion of the stabilized pile due to flooding in Brown's Wash. Since there is a potential for the channel of Brown's Wash to migrate toward the tailings pile, the erosion protection would be designed to resist the impact of direct flow from Brown's Wash. In order to prevent the formation of gullies and encroachment on the pile along the steep slopes southeast of the pile, a rock apron would be constructed around the entire pile perimeter that would extend into the bedrock surface underlying the site.

Slope stability and seismic risk. Seismic loading conditions were evaluated by applying the horizontal bedrock acceleration of 0.21g (expressed as percent of gravity) resulting from a floating earthquake of 6.2 on the Richter scale. The factors of safety for the designed slopes under both static and seismic loading (DOE, 1988b) exceed the generally accepted limits of 1.5 and 1.0, respectively (COE, 1970). With the use of relatively flat (five horizontal to one vertical) sideslopes, the pile would be stable under all loading conditions.

The Green River tailings contain only cohesionless sand tailings in a loose, dry condition. Due to the absence of saturated tailings, the potential for seismically induced liquefaction is nonexistent. However, there is a potential for seismically induced liquefaction of the soils beneath and adjacent to the existing tailings pile. This potential would be evaluated during the final design of the remedial action, and, if necessary, appropriate mitigative measures would be incorporated into the final design.

Groundwater protection

The stabilized tailings pile would be sloped to promote the drainage of precipitation off the pile, and the low hydraulic conductivity of the radon/infiltration barrier would inhibit the infiltration of precipitation through the pile. These features would minimize the continuation of groundwater contamination from the tailings.

REFERENCES FOR APPENDIX A

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APPENDIX B

HYDROLOGY

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B.1 SURFACE WATER HYDROLOGY

B.1.1 GREEN RIVER TAILINGS SITE

The Green River tailings pile and millsite are on a slope between an abandoned upper river terrace and the southern edge of the modern floodplain of the Green River and its local tributary, Brown's Wash. Brown's Wash, an intermittent stream which drains to the Green River, borders the site on the north. The Green River flows southward approximately 0.5 mile west of the tailings pile. The tailings pile and proposed disposal site are 40 to 100 feet above and 3000 feet east of the channel of the Green River. Regional drainage characteristics are shown in Figure B.1.1.

The elevation of the tailings pile varies from 4078 to 4090 feet above mean sea level (MSL). The streambed of Brown's Wash, at the base of the tailings pile, is about 4066 feet above MSL. The streambed elevation of the Green River is approximately 4040 feet above MSL near its confluence with Brown's Wash.

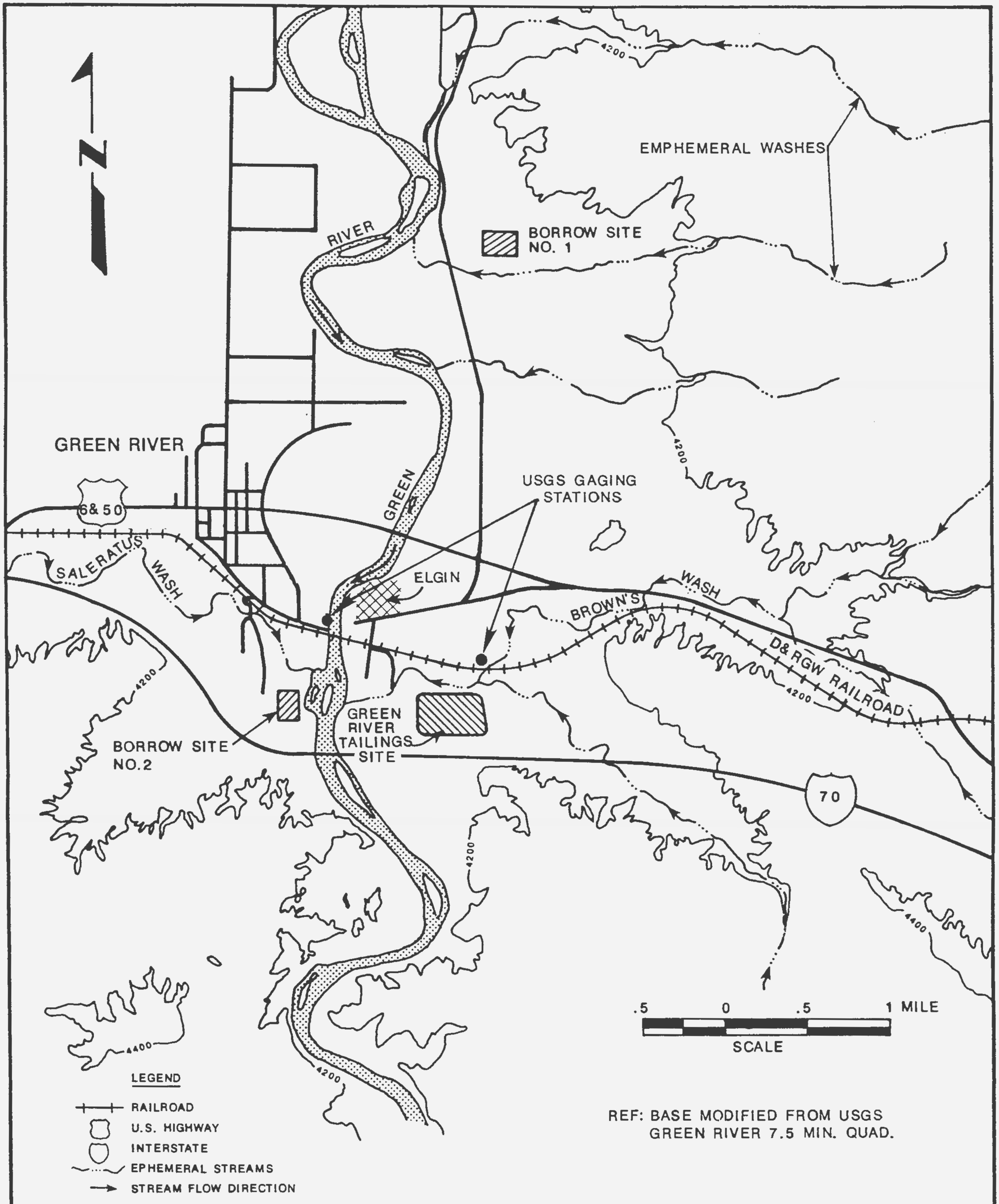
Surface water flows north of the site are diverted from Brown's Wash and the tailings by an eight-foot railroad track embankment approximately 300 feet from the point where the main branch of the wash flows adjacent to the tailings pile. Flows from the mill yard are directed northwest to Brown's Wash and eventually to the Green River, approximately 0.5 mile west of the site. The southeastern portion of the mill yard is bordered by a man-made ditch, six feet deep and approximately 400 feet long.

The proposed disposal area southeast of the mill yard is drained to the southwest and the northeast by several small gullies. Small drainage ditches adjacent to the mill yard access road direct flow to Brown's Wash west of the site area. The site area drainage features are shown in Figure B.1.2. An area of approximately 110 acres drains to the site area. The watershed is bisected by the U.S. Interstate 70 highway embankment.

B.1.2 MAJOR DRAINAGE FEATURES

B.1.2.1 <u>The Green River</u>

The Green River (near the town of Green River, Utah) has a drainage area of about 40,590 square miles and drains southward and southwestward away from the site area. The river joins the Colorado River about 100 miles downstream of the site. Major tributaries of the Green River are the Yampa and White Rivers of Colorado and the Duchesne and Price Rivers of Utah, all of which flow into the Green River above the site, and the San Rafael River, which joins the Green River about 20 miles downstream of the site.



REF: BASE MODIFIED FROM USGS GREEN RIVER 7.5 MIN. QUAD.

FIGURE B.1.1 REGIONAL DRAINAGE CHARACTERISTICS GREEN RIVER, UTAH, TAILINGS SITE

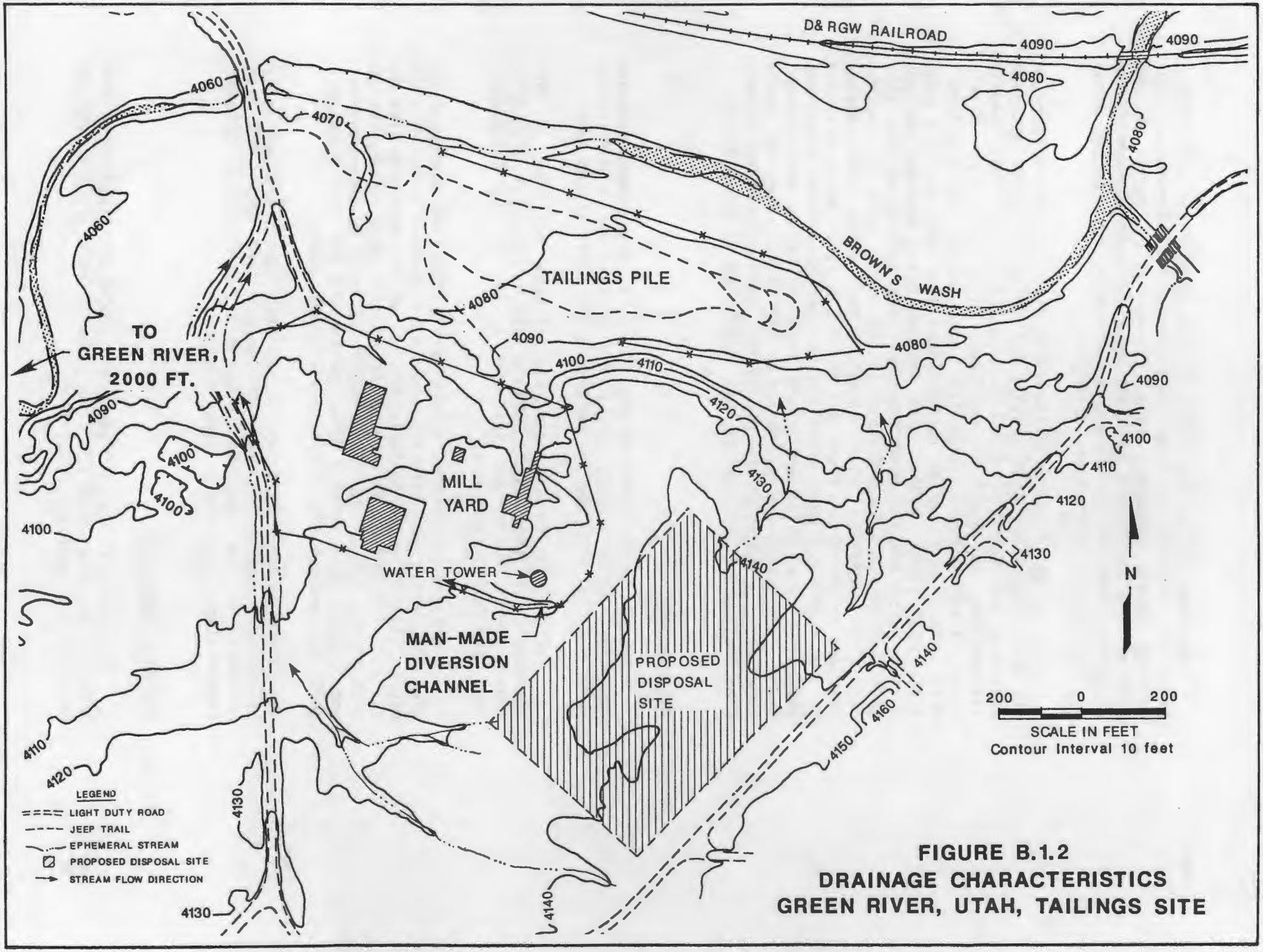


FIGURE B.1.2
DRAINAGE CHARACTERISTICS
GREEN RIVER, UTAH, TAILINGS SITE

Upstream of the confluence of the Green River and Brown's Wash, the Green River flows in a broad, flat floodplain containing gentle meander loops. Seven miles north of the confluence with Brown's Wash and continuing downstream of the confluence the terrain is characterized by flat upland areas (bluffs) separated by steep valleys.

The volume of water in the Green River in the vicinity of the site fluctuates both monthly and annually due to upstream diversion and storage. A U.S. Geological Survey (USGS) gaging station (No. 09315000) on the Green River near Green River, Utah, is approximately 3200 feet upstream of the confluence with Brown's Wash. Flow records have been kept at this gage since 1895 (USGS, 1986). The maximum peak, average maximum monthly, and average mean monthly flows determined for this gage are 68,100, 24,480, and 18,580 cubic feet per second (cfs), respectively USGS (1986). Two other USGS gaging stations on the Green River are about 213 river miles upstream of the confluence with Brown's Wash near Greendale, Utah, and about 130 river miles upstream of the confluence near Jensen, Utah. Information on basin areas and flow rates at these locations, in addition to the gaging station on Brown's Wash (see Section B.1.2.2, below), are summarized in Table B.1.1.

B.1.2.2 Brown's Wash

Brown's Wash, north of the site, has a drainage area of approximately 85 square miles and changes in elevation by about 820 feet from the headwaters to the mouth of the wash.

Several smaller springs and streams converge at the headwaters of the wash. Terrain along the wash gradually slopes until it reaches the Book Cliffs to the northeast. Here, the terrain steepens.

A culvert is located approximately 950 feet northeast of the site, under the railroad crossing (Figure B.1.1). A USGS gaging station was previously located on the upstream side of the culvert. Flows were recorded at this gage from 1949 to 1968 (Table B.1.1). The maximum peak, average maximum monthly, and average mean monthly flows determined for this gage were 5620, 69, and 3.6 cfs, respectively (USGS, 1986).

There is also a series of culverts (which are partially filled with sediment) under the access road about 750 feet northeast of the site that intercepts flows from an unnamed intermittent tributary to Brown's Wash.

B.1.2.3 Flooding potential

Analyses of the 100-year and 500-year floods and the Probable Maximum Flood (PMF) for Brown's Wash are provided in Appendix F, Floodplain Assessment.

Table B.1.1 Recorded streamflows for Brown's Wash and the Green River, Utah[a]

Station name	Basin area (mi^2)	Period of record	Maximum peak flow (cfs)	Average maximum monthly (cfs)	Average mean monthly (cfs)
Brown's Wash near Green River, Utah	85	1949 - 1968	5,620 (8/19/59)	69 (August)	36 (August)
Green River at Green River, Utah	40,590	1895 - 1985	68,100 (6/27/17)	24,480 (June)	18,580 (June)
Green River at Greendale, Utah	5,090	1951 - 1985	19,600 (6/12/57)	5,319 (June)	3,347 (June)
Green River near Jensen, Utah	5,400	1904 - 1985	40,000 (5/18/84)	19,488 (May)	12,438 (May)

[a] mi^2 = square miles; cfs = cubic feet per second.

Ref. USGS, 1986.

The Green River

An estimate of peak discharge flow of about 140,000 cfs was calculated for the Green River (Crippen and Bue, 1977). This discharge would overflow the present river banks. However, because the overbank areas are broad and flat, the overland flow would not approach either the present tailings pile or the proposed disposal area.

Brown's Wash

Significant flooding has occured in Brown's Wash, and such floods have undercut the stream bank and eroded tailings at the site. In 1959 and 1968, approximately 6000 cfs of water flowed past the existing tailings pile (FBDU, 1981). During the 1968 flood, the maximum flow depth was about 10 feet, and flood waters caused considerable streambed erosion, undercutting of the bank, erosion of the tailings (due to failure of the bank), and inundation of sections of the existing pile.

B.1.3 PROPOSED BORROW SITES

B.1.3.1 Borrow site 1

Proposed borrow site 1 is about three miles north of the existing tailings site on the east side of the Green River. The proposed borrow area is within the floodplain of the Green River and is north of an unnamed ephemeral stream that flows west into the river 2.6 miles upstream of the U.S. Highway 6&50 (U.S. 6&50) bridge over the Green River (see Figure B.1.1). The borrow site is 2340 feet east of a large meander in the Green River floodplain. The ephemeral stream 1300 feet south of the proposed borrow site drains the area east and south of the site and has a total drainage area of 750 acres. Flows are rarely encountered and no historical flow data are available for this stream. The proposed borrow area is in flat terrain with a drainage area of 100 acres. Data on the Green River, discussed in the previous section, are applicable to this site as well.

B.1.3.2 Borrow site 2

Proposed borrow site 2 is 1560 feet west of the Green River (see Figure B.1.1). In this area, the Green River is characterized by large, broad floodplains, and braided islands. The total drainage area for the borrow area is 1120 acres. Saleratus Wash, a large ephemeral stream, is 1700 feet north of the borrow site and flows east into the Green River one mile downstream of the U.S. 6&50 bridge. No historical flow data are available for Saleratus Wash. The discussions of surface-water characteristics and historical flows for the Green River are also applicable to this site.

B.1.3.3 Flooding potential

Both borrow areas would be subject to flooding from surface runoff, ephemeral flows, and Green River flows. However, a flood at either site would result only in a temporary delay in the excavation of borrow materials until ponded floodwaters evaporated, were percolated into the ground, or were removed by pumping and debris was removed.

B.1.4 SURFACE-WATER QUALITY

Surface-water samples were collected at four locations (locations 526, 709, 710, and 711) in Brown's Wash in 1982 (DOE, 1983) and in 1986. In 1986, surface-water samples were collected at two locations (801 and 802) in the Green River. Location 801 above the confluence with Brown's Wash is at the same location as USGS gaging station No. 09315000 (see Figure B.1.1); additional water-quality data for this location were compiled from the USGS records for this station

(USGS, 1967-1985). Location 802 is below the confluence of Brown's Wash. The sample locations are indicated in Figure B.1.3 and are described in Table B.1.2. Concentrations of major and trace element constituents analyzed for these samples (including the USGS data for location 801 for the months of June and September) are provided in Table B.1.3.

Surface-water quality for Brown's Wash is dependent on the quantity of flow in the wash. Concentrations of dissolved constituents are inversely proportional to the quantity of water in the channel. A comparison of analytical results of samples taken upstream and downstream of the tailings pile shows that concentrations of constituents increase only slightly if at all downstream of the existing tailings pile with the exception of gross alpha activity, which increases by 50 picocuries per liter (pCi/l). There was no measurable increase in uranium concentrations. Flow in Brown's Wash increases as it approaches the Green River and concentrations of dissolved constituents are diluted by a factor of 10^5 to 10^6 once they mix with the Green River.

B.1.4.1 The Green River

From USGS (1967-1985) data for gaging station No. 09315000 (location 801), the average flow rate for the Green River in June is 16,666 cfs, over four times the average flow rate for June (Table B.1.4). Flow rate in the Green River is seasonally dependent and concentrations of dissolved constituents in the river are inversely proportional to flow rate. In June, when flow rates are high, concentrations are low as indicated by total dissolved solids (TDS = 311 milligrams per liter, or mg/l), uranium (U = 0.0017 mg/l), and other constituents listed in Tables B.1.3 through B.1.6. Conversely, in September (when flow rates are lower), concentrations of dissolved constituents are higher, often by as much as a factor of four (TDS = 649 mg/l and U = 0.0044 mg/l; see Tables B.1.3 through B.1.6).

The impact of tailings seepage on the quality of water in the Green River is minimal as indicated in Table B.1.7. In September, 1986, surface-water samples were collected from locations 801 and 802. TDS concentrations at these two locations were 612 mg/l (location 801) and 614 mg/l (location 802); uranium concentrations were 0.0029 mg/l (location 801) and 0.0026 mg/l (location 802). These concentrations compare favorably with analyses from location 526 from September, 1986. At this location, dissolved concentrations of TDS and uranium were 791 mg/l and 0.0045 mg/l, respectively. Similar relationships can be seen for other constituents as well (see Tables B.1.3 and B.1.7).

B.1.4.2 Brown's Wash

Analyses of surface-water samples taken from four locations in Brown's Wash (Figure B.1.3) indicate that concentrations of dissolved solids are dependent on season and the

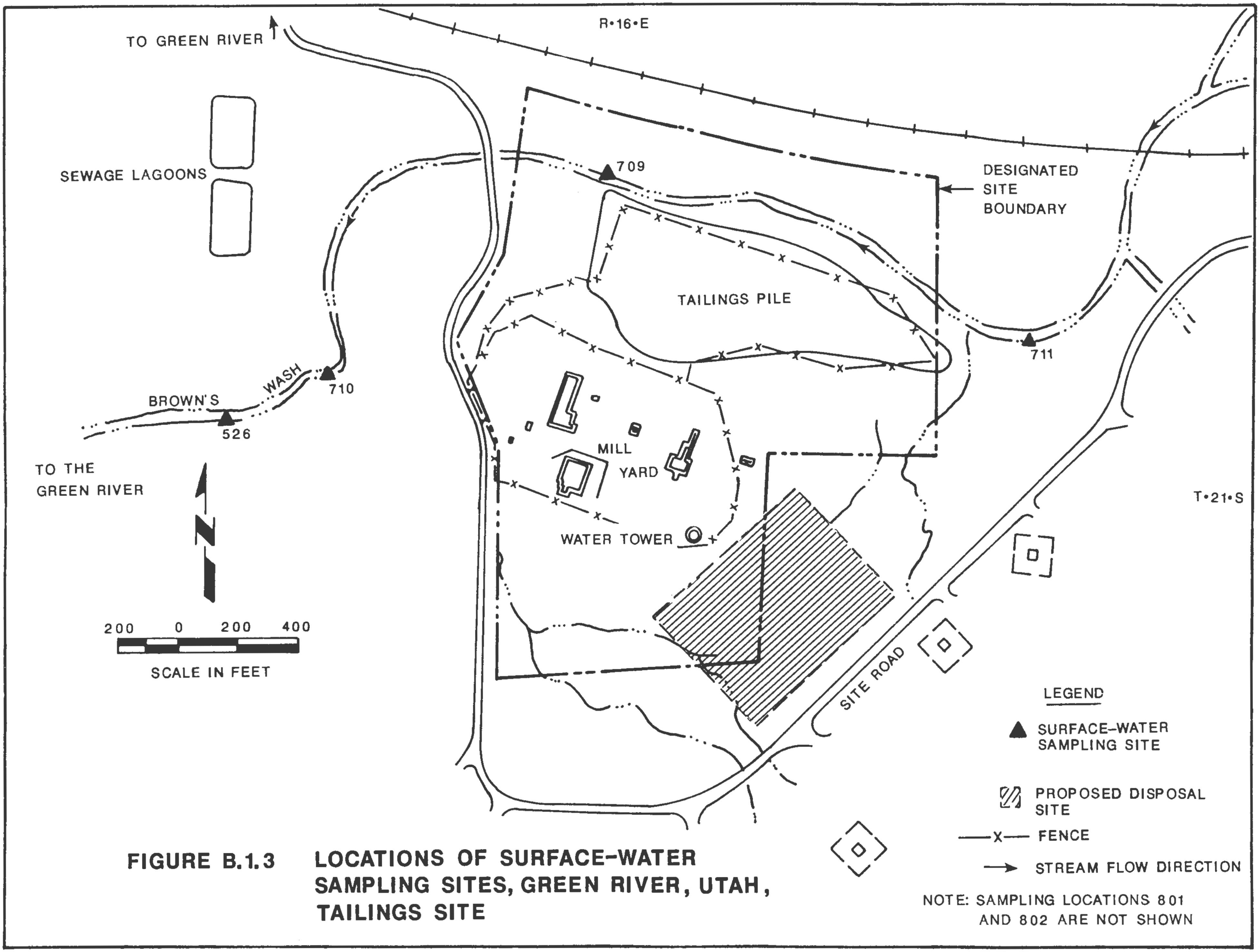


FIGURE B.1.3 LOCATIONS OF SURFACE-WATER SAMPLING SITES, GREEN RIVER, UTAH, TAILINGS SITE

Table B.1.2 Descriptions of surface-water samples, Green River, Utah, tailings site[a]

Sample location	Description of location	Number of samples
526	Brown's Wash, west (downstream) of the tailings pile and mill yard and south of the sewage lagoons.	3[b]
709	Brown's Wash, west (downstream) of the tailings pile.	3[b]
710	Brown's Wash between sites 526 and 709, west (downstream) of the tailings pile and mill yard, and approximately 400 feet east (upstream) of sampling site 526.	2[b]
711	Brown's Wash, approximately 350 feet east (upstream) of the tailings.	1[b]
801	The Green River, upstream of confluence with Brown's Wash, downstream of the town of Green River; same as USGS station No. 09315000 (Green River at Green River, Utah).	1[c,d]
802	The Green River, downstream of confluence with Brown's Wash.	1[c,d]

[a] Surface-water sampling locations, except for sites 801 and 802, are shown on Figure B.1.3.

[b] Sampling period between 1982 and 1986.

[c] Sampling period 1986.

[d] Does not include samples taken by the U.S. Geological Survey; however, U.S. Geological Survey water-quality data are included in Table B.1.3.

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site

		LOCATION ID - SAMPLE ID AND LOG DATE					
		526-S1 11/23/82	526-S1 09/01/83	526-S1 06/05/86		526-01 09/08/86	526-02 09/08/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	507.	-	115.		208.	208.
ALUMINUM	MG/L	0.005	0.20	0.3		0.2	0.2
AMMONIUM	MG/L	-	-	0.5		< 0.1	< 0.1
ANTIMONY	MG/L	-	-	< 0.003		< 0.003	< 0.003
ARSENIC	MG/L	< 0.005	< 0.01	< 0.01		< 0.01	< 0.01
BALANCE	%	-	-	-		-0.13	-0.30
BARIUM	MG/L	< 0.050	< 0.093	0.2		0.2	0.2
BICARBONATE	MG/L	619.	-	-		-	-
BORON	MG/L	-	-	0.2		0.3	0.3
CADMIUM	MG/L	< 0.005	< 0.0005	< 0.001		< 0.001	< 0.001
CALCIUM	MG/L	400.	325.00	44.2		68.0	68.0
CHLORIDE	MG/L	600.	239.00	10.		35.	35.
CHROMIUM	MG/L	< 0.005	0.03	0.03		0.04	0.04
COBALT	MG/L	-	0.02	< 0.05		< 0.05	< 0.05
CONDUCTANCE	UMHO/CM	12300.	320.00	370.		950.	950.
COPPER	MG/L	0.005	-	0.03		0.02	0.02
DISCHARGE	CFS	-	-	-		-	-
FLUORIDE	MG/L	< 1.	-	0.2		0.6	0.6
GROSS ALPHA	PCI/L	1000.	-	4.2	2.8	-	-
GROSS BETA	PCI/L	-	-	7.4	2.4	-	-
IRON	MG/L	< 0.05	0.06	0.03		0.07	0.07
LEAD	MG/L	< 0.005	0.009	< 0.01		< 0.01	< 0.01
MAGNESIUM	MG/L	616.	200.00	16.5		36.8	36.8
MANGANESE	MG/L	-	0.44	0.01		0.25	0.25
MERCURY	MG/L	< 0.002	-	< 0.0002		< 0.0002	< 0.0002
MOLYBDENUM	MG/L	< 0.05	< 0.02	0.18		0.11	0.11
NICKEL	MG/L	-	< 0.02	0.06		< 0.04	< 0.04
NITRATE	MG/L	2090.	-	0.7		3.	3.
NITRITE	MG/L	-	-	< 0.1		< 0.1	< 0.1
NO2 & NO3	MG/L	-	-	-		-	-
ORG. CARBON	MG/L	-	-	28.		-	-
PB-210	PCI/L	-	-	0.5	0.8	-	-
PH	SU	6.92	7.30	7.85		7.60	7.60
PHOSPHATE	MG/L	-	-	< 0.1		< 0.1	< 0.1
PO-210	PCI/L	-	-	0.	0.5	-	-
POTASSIUM	MG/L	20.	11.00	2.5		4.71	4.71
RA-226	PCI/L	< 2.	-	0.2	0.2	-	-
RA-228	PCI/L	-	-	0.1	0.9	-	-
REDOX PUTENT	MVOLTS	-	360.00	-		-	-
SELENIUM	MG/L	0.030	< 0.01	< 0.005		0.020	0.020
SILCON	MG/L	-	0.80	-		-	-
SILICA	MG/L	5.1	-	4.		5.	5.
SILVER	MG/L	-	0.04	< 0.01		< 0.01	< 0.01
SODIUM	MG/L	2600.	710.00	35.2		130.	130.
STRONTIUM	MG/L	-	5.43	0.4		1.1	1.1
SULFATE	MG/L	5684.	2730.00	137.		339.	341.
TEMPERATURE	C - DEGREE	9.	-	24.		23.	23.
TH-230	PCI/L	< 67.	-	2.2	1.3	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		526-S1 11/23/82	526-S1 09/01/83	526-S1 06/05/86	526-01 09/08/86	526-02 09/08/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	< 0.005	< 0.005	< 0.005
TOTAL SOLIDS	MG/L	10700.	-	318.	787.	790.
URANIUM	MG/L	1.3	0.024	0.0029	0.0011	0.0038
VANADIUM	MG/L	< 0.05	0.04	0.1	0.22	0.22
ZINC	MG/L	-	-	< 0.005	0.008	0.008

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE					
		526-03 09/08/86	526-04 09/08/86	526-05 09/08/86	526-01 03/12/87		527-S1 09/01/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	208.	208.	208.	96.		-
ALUMINUM	MG/L	0.2	0.2	0.2	0.1		< 0.20
AMMONIUM	MG/L	< 0.1	< 0.1	< 0.1	0.4		-
ANTIMONY	MG/L	< 0.003	< 0.003	< 0.003	-		-
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	-		< 0.01
BALANCE	%	-0.72	-0.30	-0.21	-		-
BARIUM	MG/L	0.2	0.2	0.2	-		< 0.071
BICARBONATE	MG/L	-	-	-	-		-
BORON	MG/L	0.3	0.3	0.3	0.3		-
CADMIUM	MG/L	< 0.001	< 0.001	< 0.001	-		< 0.0005
CALCIUM	MG/L	68.0	68.0	68.0	92.3		70.00
CHLORIDE	MG/L	35.	35.	35.	48.		53.00
CHROMIUM	MG/L	0.04	0.04	0.04	0.03		< 0.01
COBALT	MG/L	< 0.05	< 0.05	< 0.05	-		< 0.02
CONDUCTANCE	UMHO/CM	950.	950.	950.	1125.		1400.00
COPPER	MG/L	0.02	0.02	0.02	-		-
DISCHARGE	CFS	-	-	-	-		-
FLUORIDE	MG/L	0.6	0.6	0.6	0.4		-
GROSS ALPHA	PCI/L	-	-	-	30.	11.	-
GROSS BETA	PCI/L	-	-	-	18.	5.	-
IRON	MG/L	0.07	0.07	0.07	< 0.03		0.01
LEAD	MG/L	< 0.01	< 0.01	< 0.01	-		< 0.005
MAGNESIUM	MG/L	36.8	36.8	36.8	63.6		44.00
MANGANESE	MG/L	0.25	0.25	0.25	0.05		0.01
MERCURY	MG/L	< 0.0002	< 0.0002	< 0.0002	-		-
MOLYBDENUM	MG/L	0.11	0.11	0.11	< 0.1		< 0.02
NICKEL	MG/L	< 0.04	< 0.04	< 0.04	-		< 0.02
NITRATE	MG/L	3.	3.	3.	44.		-
NITRITE	MG/L	< 0.1	< 0.1	< 0.1	-		-
NO2 & NO3	MG/L	-	-	-	-		-
ORG. CARBON	MG/L	-	-	-	-		-
PB-210	PCI/L	-	-	-	-		-
PH	SU	7.60	7.60	7.60	8.39		9.50
PHOSPHATE	MG/L	< 0.1	< 0.1	< 0.1	-		-
PO-210	PCI/L	-	-	-	-		-
POTASSIUM	MG/L	4.71	4.71	4.71	4.04		8.70
RA-226	PCI/L	-	-	-	0.1	0.3	-
RA-228	PCI/L	-	-	-	-		-
REDOX POTENT	MVOLTS	-	-	-	-		230.00
SELENIUM	MG/L	0.020	0.020	0.020	0.002		< 0.01
SILCON	MG/L	-	-	-	-		6.50
SILICA	MG/L	5.	5.	5.	-		-
SILVER	MG/L	< 0.01	< 0.01	< 0.01	-		< 0.01
SODIUM	MG/L	130.	130.	130.	268.		160.00
STRONTIUM	MG/L	1.1	1.1	1.1	-		0.975
SULFATE	MG/L	346.	341.	340.	791.		437.00
TEMPERATURE	C - DEGREE	23.	23.	23.	7.0		-
TH-230	PCI/L	-	-	-	0.0	0.3	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		526-03 09/08/86	526-04 09/08/86	526-05 09/08/86	526-01 03/12/87	527-S1 09/01/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	< 0.005	< 0.005	< 0.005	-	-
TOTAL SOLIDS	MG/L	799.	795.	782.	1650.	-
URANIUM	MG/L	0.0058	0.0061	0.0059	0.0265	0.004
VANADIUM	MG/L	0.22	0.22	0.22	-	< 0.02
ZINC	MG/L	0.008	0.008	0.008	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE				
		529-S1 09/01/83	530-S1 09/01/83	531-S1 09/01/83	532-S1 09/01/83	533-S1 09/01/83
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.20
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	< 0.044	< 0.045	< 0.045	< 0.046	0.027
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
CALCIUM	MG/L	32.70	33.80	33.60	35.20	157.00
CHLORIDE	MG/L	10.50	12.60	9.50	11.50	51.00
CHROMIUM	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	0.02
COBALT	MG/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
CONDUCTANCE	UMHO/CM	400.00	390.00	400.00	370.00	270.00
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	-	-	-	-	-
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.02	0.03	< 0.01	0.02	< 0.01
LEAD	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
MAGNESIUM	MG/L	15.00	15.00	15.00	16.00	73.00
MANGANESE	MG/L	0.01	0.01	< 0.01	< 0.01	1.00
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
NICKEL	MG/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.70	7.80	8.00	7.60	7.20
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	1.10	4.50	1.90	1.80	4.00
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	420.00	390.00	410.00	230.00	340.00
SELENIUM	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SILCON	MG/L	4.20	4.20	4.20	4.20	8.50
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SODIUM	MG/L	35.00	36.00	33.00	37.00	160.00
STRONTIUM	MG/L	0.339	0.349	0.346	0.357	1.16
SULFATE	MG/L	70.00	84.00	95.00	112.00	525.00
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		529-S1 09/01/83	530-S1 09/01/83	531-S1 09/01/83	532-S1 09/01/83	533-S1 09/01/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	0.0016	0.0017	0.0016	0.0017	0.0094
VANADIUM	MG/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		550-S1 09/01/83	551-S1 09/01/83	601-S1 09/01/83	603-S1 09/01/83	709-S1 06/30/82
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	< 0.20	< 0.20	< 0.20	< 0.20	< 0.10
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.010
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	0.048	0.046	0.076	0.053	0.28
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.010
CALCIUM	MG/L	35.70	34.40	45.10	39.30	1500.
CHLORIDE	MG/L	10.50	9.50	13.00	10.50	5.
CHROMIUM	MG/L	< 0.01	< 0.01	0.03	0.02	< 0.010
COBALT	MG/L	0.02	< 0.02	< 0.02	< 0.02	-
CONDUCTANCE	UMHO/CM	440.00	400.00	600.00	450.00	3460.
COPPER	MG/L	-	-	-	-	< 0.025
DISCHARGE	CFS	-	-	-	-	-
FLUORIDE	MG/L	-	-	-	-	< 1.
GROSS ALPHA	PCI/L	-	-	-	-	150.
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.02	< 0.01	0.02	0.01	< 0.05
LEAD	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.010
MAGNESIUM	MG/L	16.00	16.00	23.00	17.00	144.
MANGANESE	MG/L	< 0.01	< 0.01	0.01	0.01	-
MERCURY	MG/L	-	-	-	-	< 0.002
MOLYBDENUM	MG/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.05
NICKEL	MG/L	0.03	< 0.02	< 0.02	< 0.02	-
NITRATE	MG/L	-	-	-	-	< 1.
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.30	7.40	7.80	7.60	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	1.60	1.40	3.50	1.50	22.
RA-226	PCI/L	-	-	-	-	3.
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	370.00	320.00	340.00	290.00	-
SELENIUM	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	0.036
SILCON	MG/L	4.20	4.20	3.90	4.20	-
SILICA	MG/L	-	-	-	-	13.7
SILVER	MG/L	0.01	< 0.01	< 0.01	< 0.01	< 0.010
SODIUM	MG/L	37.00	34.00	44.00	37.00	565.
STRONTIUM	MG/L	0.341	0.349	0.525	0.387	-
SULFATE	MG/L	105.00	100.00	113.00	84.00	8000.
TEMPERATURE	C - DEGREE	-	-	-	-	20.
TH-230	PCI/L	-	-	-	-	< 67.

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		550-S1 09/01/83	551-S1 09/01/83	601-S1 09/01/83	603-S1 09/01/83	709-S1 06/30/82
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	0.0016	0.0018	0.0017	0.0017	0.005
VANADIUM	MG/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.050
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		709-S1 11/23/82	709-S1 06/05/86	709-01 02/24/87	710-S1 11/23/82	710-S1 06/05/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	559.	300.	347.	384.	119.
ALUMINUM	MG/L	0.019	-	< 0.1	0.007	0.3
AMMONIUM	MG/L	-	4.5	8.5	-	< 0.1
ANTIMONY	MG/L	-	-	-	-	< 0.003
ARSENIC	MG/L	< 0.005	< 0.01	-	< 0.005	< 0.01
BALANCE	%	-	-0.03	-	-	0.28
BARIUM	MG/L	< 0.050	-	-	-	0.3
BICARBONATE	MG/L	682.	-	-	468.	-
BORON	MG/L	-	-	0.10	-	0.2
CADMIUM	MG/L	< 0.005	-	-	-	< 0.001
CALCIUM	MG/L	476.	538.	368.	385.	52.9
CHLORIDE	MG/L	692.	761.	404.	725.	20.
CHROMIUM	MG/L	< 0.005	-	0.03	-	0.04
COBALT	MG/L	-	-	-	-	0.05
CONDUCTANCE	UMHO/CM	11200.	7500.	3500.	10500.	500.
COPPER	MG/L	0.005	-	-	-	0.03
DISCHARGE	CFS	-	-	-	-	-
FLUORIDE	MG/L	< 1.0	0.9	0.57	< 1.	0.3
GROSS ALPHA	PCI/L	600.	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	< 0.05	0.22	0.06	-	0.05
LEAD	MG/L	< 0.005	-	-	-	< 0.01
MAGNESIUM	MG/L	595.	639.	356.	583.	23.1
MANGANESE	MG/L	-	0.54	0.10	-	0.02
MERCURY	MG/L	< 0.002	-	-	-	< 0.0002
MOLYBDENUM	MG/L	0.07	0.27	< 0.1	(0.05	0.11
NICKEL	MG/L	-	-	-	-	0.03
NITRATE	MG/L	62.	3.	4.4	120.	4.9
NITRITE	MG/L	-	-	-	-	< 0.1
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	6.93	8.68	7.89	7.07	7.76
PHOSPHATE	MG/L	-	-	-	-	< 0.1
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	22.0	44.3	16.7	20.	2.74
RA-226	PCI/L	< 2.	-	-	< 2.	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.020	< 0.005	0.45	0.020	< 0.005
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	6.1	-	-	-	4.
SILVER	MG/L	< 0.005	-	-	-	< 0.01
SODIUM	MG/L	3110.	4280.	2420.	2600.	51.5
STRONTIUM	MG/L	-	-	-	-	6.4
SULFATE	MG/L	9655.	11500.	6520.	7140.	189.
TEMPERATURE	C - DEGREE	10.	34.	3.	6.	21.
TH-230	PCI/L	< 67.	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		709-S1 11/23/82	709-S1 06/05/86	709-01 02/24/87	710-S1 11/23/82	710-S1 06/05/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	< 0.005
TOTAL SOLIDS	MG/L	14900.	19100.	10900.	11700.	477.
URANIUM	MG/L	0.368	0.235	0.0339	0.264	0.0119
VANADIUM	MG/L	< 0.050	-	-	< 0.05	0.1
ZINC	MG/L	-	-	-	-	< 0.005

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE					
		710-01 02/24/87		710-02 02/24/87	710-03 02/24/87	710-04 02/24/87	710-05 02/24/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	376.		376.	376.	376.	376.
ALUMINUM	MG/L	< 0.1		< 0.1	< 0.1	< 0.1	< 0.1
AMMONIUM	MG/L	8.4		6.5	6.5	6.4	6.4
ANTIMONY	MG/L	-		-	-	-	-
ARSENIC	MG/L	-		-	-	-	-
BALANCE	%	-		-	-	-	-
BARIUM	MG/L	-		-	-	-	-
BICARBONATE	MG/L	-		-	-	-	-
BORON	MG/L	0.25		0.28	0.29	0.27	0.30
CADMIUM	MG/L	-		-	-	-	-
CALCIUM	MG/L	400.		400.	401.	400.	401.
CHLORIDE	MG/L	524.		524.	523.	525.	524.
CHROMIUM	MG/L	0.04		0.04	0.05	0.04	0.04
COBALT	MG/L	-		-	-	-	-
CONDUCTANCE	UMHO/CM	4000.		4000.	4000.	4000.	4000.
COPPER	MG/L	-		-	-	-	-
DISCHARGE	CFS	-		-	-	-	-
FLUORIDE	MG/L	0.43		0.43	0.43	0.43	0.43
GROSS ALPHA	PCI/L	420.	100.	-	-	-	-
GROSS BETA	PCI/L	270.	40.	-	-	-	-
IRON	MG/L	0.08		0.06	0.06	0.07	0.06
LEAD	MG/L	-		-	-	-	-
MAGNESIUM	MG/L	464.		464.	464.	465.	464.
MANGANESE	MG/L	0.02		0.04	0.05	0.05	0.05
MERCURY	MG/L	-		-	-	-	-
MOLYBDENUM	MG/L	< 0.1		< 0.1	< 0.1	< 0.1	< 0.1
NICKEL	MG/L	-		-	-	-	-
NITRATE	MG/L	708.		709.	709.	707.	707.
NITRITE	MG/L	-		-	-	-	-
NO2 & NO3	MG/L	-		-	-	-	-
ORG. CARBON	MG/L	-		-	-	-	-
PB-210	PCI/L	-		-	-	-	-
PH	SU	8.43		8.43	8.43	8.43	8.43
PHOSPHATE	MG/L	-		-	-	-	-
PO-210	PCI/L	-		-	-	-	-
POTASSIUM	MG/L	20.1		20.1	20.1	20.2	20.1
RA-226	PCI/L	2.2	1.2	-	-	-	-
RA-228	PCI/L	-		-	-	-	-
REDOX POTENT	MVOLTS	-		-	-	-	-
SELENIUM	MG/L	0.49		0.49	0.49	0.49	0.49
SILCON	MG/L	-		-	-	-	-
SILICA	MG/L	-		-	-	-	-
SILVER	MG/L	-		-	-	-	-
SODIUM	MG/L	2480.		2480.	2480.	2480.	2480.
STRONTIUM	MG/L	-		-	-	-	-
SULFATE	MG/L	6820.		6820.	6820.	6820.	6820.
TEMPERATURE	C - DEGREE	5.0		5.0	5.0	5.0	5.0
TH-230	PCI/L	-		-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		710-01 02/24/87	710-02 02/24/87	710-03 02/24/87	710-04 02/24/87	710-05 02/24/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	12400.	12400.	12400.	12400.	12400.
URANIUM	MG/L	0.988	0.677	0.647	0.634	0.677
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE				
		711-S1 06/30/82	801-S1 06/01/50	801-S1 06/11/50	801-S1 06/21/50	801-S1 09/01/50
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	< 0.10	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	0.010	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	0.36	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	< 0.010	-	-	-	-
CALCIUM	MG/L	1720.	-	50.	-	-
CHLORIDE	MG/L	6.0	-	8.	-	-
CHROMIUM	MG/L	< 0.010	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	3520.	462.	428.	404.	858.0
COPPER	MG/L	< 0.025	-	-	-	-
DISCHARGE	CFS	-	28100.	26700.	24200.	2140.0
FLUORIDE	MG/L	< 1.	-	-	-	-
GROSS ALPHA	PCI/L	100.	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	< 0.05	-	-	-	-
LEAD	MG/L	< 0.010	-	-	-	-
MAGNESIUM	MG/L	155.	-	13.	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	< 0.002	-	-	-	-
MOLYBDENUM	MG/L	< 0.05	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	< 1.	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.7	7.8	7.6	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	21.	-	-	-	-
RA-226	PCI/L	< 2.	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	0.034	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	16.1	-	11.	-	-
SILVER	MG/L	< 0.010	-	-	-	-
SODIUM	MG/L	559.	-	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	2110.	-	59.	-	-
TEMPERATURE	C - DEGREE	20.	-	-	-	-
TH-230	PCI/L	< 67.	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		711-S1 06/30/82	801-S1 06/01/50	801-S1 06/11/50	801-S1 06/21/50	801-S1 09/01/50
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	0.005	-	-	-	-
VANADIUM	MG/L	< 0.050	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/11/50	801-S1 09/21/50	801-S1 06/01/51	801-S1 06/05/51	801-S1 06/11/51
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	82.0	-	50.	-	48.
CHLORIDE	MG/L	42.0	-	10.	-	10.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1030.0	1030.0	428.	-	490.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	2330.0	3040.0	26100.	29600.	16600.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	33.0	-	13.	-	15.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.7	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	14.	-	11.
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	100.0	-	22.	-	26.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	290.0	-	66.	-	82.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/11/50	801-S1 09/21/50	801-S1 06/01/51	801-S1 06/05/51	801-S1 06/11/51
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/19/51	801-S1 06/21/51	801-S1 09/01/51	801-S1 09/11/51	801-S1 09/21/51
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	48.	74.0	68.0	71.0
CHLORIDE	MG/L	-	9.	28.0	34.0	36.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	420.	838.0	845.0	914.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	18600.	23400.	4130.0	2710.0	2120.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	13.	28.0	29.0	33.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	3.5
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	11.	11.0	9.2	8.6
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	23.	73.0	80.0	85.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	64.	230.0	240.0	270.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/19/51	801-S1 06/21/51	801-S1 09/01/51	801-S1 09/11/51	801-S1 09/21/51
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	801-S1 06/01/52 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/07/52 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/11/52 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/13/52 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/21/52 PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	50.	-	44.	-	50.
CHLORIDE	MG/L	8.	-	7.	-	13.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	456.	-	390.	-	493.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	35800.	37700.	37200.	43300.	18300.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	14.	-	11.	-	15.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.2	-	3.5	-	3.2
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	12.	-	11.	-	11.
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	25.	-	20.	-	30.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	72.	-	52.	-	86.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/52	801-S1 06/07/52	801-S1 06/11/52	801-S1 06/13/52	801-S1 06/21/52
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/23/52	801-S1 06/26/52	801-S1 09/01/52	801-S1 09/02/52	801-S1 09/08/52
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	89.0	-	-
CHLORIDE	MG/L	-	-	42.0	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	-	1010.0	-	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	18600.	16900.	3900.0	4640.0	3400.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	38.0	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	7.7	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	13.0	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	87.0	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	290.0	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/23/52	801-S1 06/26/52	801-S1 09/01/52	801-S1 09/02/52	801-S1 09/08/52
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/11/52	801-S1 09/14/52	801-S1 09/21/52	801-S1 09/24/52	801-S1 06/01/53
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	87.0	-	87.0	-	-
CHLORIDE	MG/L	-	-	-	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1070.0	-	1060.0	-	472.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	2920.0	2930.0	2470.0	2520.0	16200.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	40.0	-	41.0	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	-	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/11/52	801-S1 09/14/52	801-S1 09/21/52	801-S1 09/24/52	801-S1 06/01/53
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/08/53	801-S1 06/11/53	801-S1 06/16/53	801-S1 06/21/53	801-S1 06/22/53
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	-	-	-
CHLORIDE	MG/L	-	-	-	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	419.	-	391.	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	16400.	22400.	24200.	20300.	25500.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	-	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	-	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/08/53	801-S1 06/11/53	801-S1 06/16/53	801-S1 06/21/53	801-S1 06/22/53
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/29/53	801-S1 09/01/53	801-S1 09/04/53	801-S1 09/11/53	801-S1 09/21/53
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	80.0	-	72.0	76.0
CHLORIDE	MG/L	-	43.0	-	47.0	52.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	1000.0	-	1040.0	1110.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	14500.	1780.0	1840.0	1420.0	1200.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	36.0	-	38.0	40.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	4.2	-	4.1	4.1
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	12.0	-	9.7	8.6
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	-	110.0	120.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	300.0	-	320.0	350.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/29/53	801-S1 09/01/53	801-S1 09/04/53	801-S1 09/11/53	801-S1 09/21/53
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/54	801-S1 06/02/54	801-S1 06/07/54	801-S1 06/11/54	801-S1 06/21/54
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	50.	-	-	51.0	52.0
CHLORIDE	MG/L	-	-	-	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	472.0	-	-	557.0	571.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	8660.0	11100.0	7340.0	5300.0	5180.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	12.0	-	-	16.0	15.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.0	-	-	8.1	8.0
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	30.0	-	-	43.0	46.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	-	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/54	801-S1 06/02/54	801-S1 06/07/54	801-S1 06/11/54	801-S1 06/21/54
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/01/54	801-S1 09/07/54	801-S1 09/11/54	801-S1 09/21/54	801-S1 06/01/55
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	90.0	-	110.0	95.0	47.0
CHLORIDE	MG/L	-	-	-	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	985.0	-	1150.0	1080.0	436.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	1990.0	2520.0	2240.0	2540.0	10200.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	24.0	-	28.0	27.0	9.2
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	-	-	7.8
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	90.0	-	110.0	110.0	28.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	-	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/01/54	801-S1 09/07/54	801-S1 09/11/54	801-S1 09/21/54	801-S1 06/01/55
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE 801-S1 06/02/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/11/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/20/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/21/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/01/55 PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	45.0	-	44.0	89.0
CHLORIDE	MG/L	-	-	-	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	426.0	-	428.0	994.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	10600.0	12200.0	13400.0	10600.0	1540.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	10.0	-	9.6	22.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.7	-	7.7	7.8
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	29.0	-	29.0	98.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	-	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/02/55	801-S1 06/11/55	801-S1 06/20/55	801-S1 06/21/55	801-S1 09/01/55
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	801-S1 09/03/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/04/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/11/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/14/55 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/21/55 PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	150.0	89.0	77.0	-	77.0
CHLORIDE	MG/L	-	-	-	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1360.0	994.0	970.0	-	1050.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	1720.0	1540.0	1020.0	1080.0	980.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	28.0	22.0	24.0	-	30.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.7	7.8	7.7	-	7.9
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	110.0	98.0	99.0	-	110.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	-	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/03/55	801-S1 09/04/55	801-S1 09/11/55	801-S1 09/14/55	801-S1 09/21/55
PARAMETER	UNIT OF MEASURF	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/56	801-S1 06/08/56	801-S1 06/11/56	801-S1 06/14/56	801-S1 06/21/56
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	44.0	-	37.0	-	51.0
CHLORIDE	MG/L	10.0	-	9.0	-	9.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	393.0	-	347.0	-	416.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	28600.0	28500.0	21100.0	27100.0	11200.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	11.0	-	11.0	-	11.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.8	-	7.5	-	7.8
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	2.0	-	2.0	-	1.9
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	13.0	-	12.0	-	12.0
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	22.0	-	19.0	-	23.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	59.0	-	51.0	-	72.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/56	801-S1 06/08/56	801-S1 06/11/56	801-S1 06/14/56	801-S1 06/21/56
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/22/56	801-S1 09/01/56	801-S1 09/11/56	801-S1 09/21/56	801-S1 06/01/57
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	0.011	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	64.0	65.	69.	42.0
CHLORIDE	MG/L	-	35.0	40.	43.	9.8
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	751.0	803.	871.	406.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	15200.0	1460.0	1170.	1020.	26300.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	23.0	25.	28.	12.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.8	7.8	7.7	7.3
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	2.8	2.8	3.	3.3
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	9.3	9.	7.5	13.0
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	69.0	76.	85.	25.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	180.0	200.	230.	69.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/22/56	801-S1 09/01/56	801-S1 09/11/56	801-S1 09/21/56	801-S1 06/01/57
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/03/57	801-S1 06/10/57	801-S1 06/11/57	801-S1 06/17/57	801-S1 06/21/57
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	41.0	-	42.0
CHLORIDE	MG/L	-	-	9.5	-	8.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	-	387.0	-	392.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	20100.0	37100.0	41000.0	41200.0	27100.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	10.0	-	10.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	7.4	-	7.3
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	3.4	-	2.2
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	12.0	-	13.0
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	24.0	-	24.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	63.0	-	67.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/03/57	801-S1 06/10/57	801-S1 06/11/57	801-S1 06/17/57	801-S1 06/21/57
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/24/57	801-S1 09/09/57	801-S1 09/16/57	801-S1 09/18/57	801-S1 06/01/58
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	0.018	-	-	0.07
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	66.	67.	-	43.0
CHLORIDE	MG/L	-	30.	36.	-	10.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	836.	882.	-	411.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	26400.0	3160.	2610.	2610.0	19700.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	32.	29.	-	12.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.5	7.3	-	8.0
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	3.8	2.6	-	1.8
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILICON	MG/L	-	-	-	-	-
SILICA	MG/L	-	11.	9.1	-	11.0
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	73.	83.	-	27.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	240.	260.	-	76.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE 801-S1 06/24/57 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/09/57 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/16/57 PARAMETER VALUE+/-UNCERTAINTY	801-S1 09/18/57 PARAMETER VALUE+/-UNCERTAINTY	801-S1 06/01/58 PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/01/58	801-S1 09/13/58	801-S1 09/15/58	801-S1 06/01/59	801-S1 06/05/59
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	60.0	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.017	0.019	0.017	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	73.	190.0	73.	41.0	-
CHLORIDE	MG/L	49.	38.0	49.	11.0	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1070.	1700.0	1070.	397.0	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	1570.	2180.	1570.	12800.0	8750.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	34.	48.	34.	11.0	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.6	7.4	7.6	7.5	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.6	5.2	3.6	2.1	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	8.6	11.	8.6	12.0	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	110.	150.	110.	26.0	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	330.	760.	330.	71.0	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/01/58	801-S1 09/13/58	801-S1 09/15/58	801-S1 06/01/59	801-S1 06/05/59
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/15/59	801-S1 06/25/59	801-S1 09/01/59	801-S1 09/08/59	801-S1 09/17/59
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	0.016	-	0.032
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	73.	-	210.
CHLORIDE	MG/L	-	-	44.	-	38.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	-	954.	-	1570.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	15900.0	14600.0	1720.	1380.0	2090.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	26.	-	33.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	7.6	-	7.3
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	4.3	-	5.4
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	9.1	-	13.
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	99.	-	120.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	270.	-	690.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/15/59	801-S1 06/25/59	801-S1 09/01/59	801-S1 09/08/59	801-S1 09/17/59
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/19/59	801-S1 09/23/59	801-S1 09/24/59	801-S1 06/01/60	801-S1 06/05/60
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.016	-	-	0.08	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	73.0	-	-	40.0	-
CHLORIDE	MG/L	44.	-	-	10.0	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	954.	-	-	381.0	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	1720.	1820.0	1670.0	11500.0	11600.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	26.	-	-	10.0	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.6	-	-	7.7	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	4.3	-	-	1.7	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	9.1	-	-	11.0	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	99.	-	-	25.0	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	270.	-	-	68.0	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/19/59	801-S1 09/23/59	801-S1 09/24/59	801-S1 06/01/60	801-S1 06/05/60
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/14/60	801-S1 09/01/60	801-S1 09/03/60	801-S1 09/04/60	801-S1 09/19/60
PARAMETER	UNIT OF MEASURE	PARAMETER VALUF+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	0.012	0.042	-	0.014
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	79.	160.	79.	110.
CHLORIDE	MG/L	-	62.	37.	-	54.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	937.	1620.	-	1520.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	14200.0	978.	1170.	978.	1070.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	26.	46.	26.	40.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.9	7.9	-	7.9
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	3.8	8.2	-	5.1
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	8.4	13.	8.4	5.9
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	98.	170.	98.	190.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	250.	700.	-	580.
TEMPERATURE	C - DEGRFE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/14/60	801-S1 09/01/60	801-S1 09/03/60	801-S1 09/04/60	801-S1 09/19/60
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/25/60	801-S1 06/01/61	801-S1 09/01/61	801-S1 09/18/61	801-S1 09/21/61
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.019	0.06	0.017	0.012	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	93.	40.0	82.	140.	82.
CHLORIDE	MG/L	67.	12.0	42.	30.	30.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1210.	363.0	994.	1400.	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	960.	9110.0	2880.	3550.	2880.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	32.	8.5	28.	56.	28.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.	7.9	7.6	7.4	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.8	1.8	5.	6.3	6.3
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	9.6	13.0	11.	11.	11.
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	140.	27.0	92.	95.	92.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	390.	54.0	300.	600.	600.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/25/60	801-S1 06/01/61	801-S1 09/01/61	801-S1 09/18/61	801-S1 09/21/61
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/62	801-S1 06/16/62	801-S1 06/29/62	801-S1 09/01/62	801-S1 09/22/62
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	0.08	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	36.0	-	-
CHLORIDE	MG/L	13.0	10.0	8.5	-	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	486.0	395.0	345.0	861.	2010.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	16100.0	20100.0	20200.0	1510.	2950.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	9.7	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.7	7.9	8.1	7.7	7.2
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	1.5	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	10.0	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	32.0	24.0	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	89.0	67.0	66.0	-	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/62	801-S1 06/16/62	801-S1 06/29/62	801-S1 09/01/62	801-S1 09/22/62
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/63	801-S1 06/11/63	801-S1 06/22/63	801-S1 06/26/63	801-S1 09/01/63
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	-	-	-
CHLORIDE	MG/L	20.0	-	-	-	59.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	490.0	-	-	-	1380.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	5210.0	5810.0	5140.0	3240.0	2080.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	-	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.6	-	-	-	7.9
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	44.0	-	-	-	160.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	110.0	-	-	-	460.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/01/63	801-S1 06/11/63	801-S1 06/22/63	801-S1 06/26/63	801-S1 09/01/63
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/02/63	801-S1 09/06/63	801-S1 09/07/63	801-S1 09/11/63	801-S1 09/18/63
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	-	-	-
CHLORIDE	MG/L	-	-	48.	60.	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	-	-	1550.	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	1690.	1410.0	1780.	1160.	1190.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	-	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	7.5	7.5	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	180.	160.	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	750.	570.	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/02/63	801-S1 09/06/63	801-S1 09/07/63	801-S1 09/11/63	801-S1 09/18/63
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/22/63	801-S1 09/23/63	801-S1 09/24/63	801-S1 06/01/64	801-S1 09/01/64
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	-	-	-
CHLORIDE	MG/L	-	64.	-	14.0	40.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	1280.	-	457.0	887.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	1080.	1220.	1940.0	12200.0	2350.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	-	-	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.5	-	7.8	8.
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	160.	-	30.0	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	410.	-	-	250.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/22/63	801-S1 09/23/63	801-S1 09/24/63	801-S1 06/01/64	801-S1 09/01/64
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/07/64	801-S1 09/16/64	801-S1 06/01/65	801-S1 06/12/65	801-S1 06/20/65
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	-	48.0	60.0	45.0
CHLORIDE	MG/L	-	-	11.0	18.0	12.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	-	424.0	571.0	439.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	2750.	2330.	14500.0	27800.0	20700.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	-	13.0	17.0	14.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	-	8.2	7.6	7.9
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	-	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	24.0	39.0	26.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	-	73.0	130.0	92.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/07/64	801-S1 09/16/64	801-S1 06/01/65	801-S1 06/12/65	801-S1 06/20/65
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/01/65	801-S1 09/05/65	801-S1 09/13/65	801-S1 06/01/66	801-S1 06/12/66
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	71.	85.	59.	48.0	55.0
CHLORIDE	MG/L	42.	53.	43.	10.0	19.0
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	964.	1220.	997.	537.0	697.0
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	2090.	2730.	3610.	7400.0	4350.0
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	46.	34.	18.0	25.0
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.9	7.7	8.4	7.5	7.7
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	-	-	9.6	9.1
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	97.	120.	100.	34.0	52.0
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	260.	380.	280.	120.0	180.0
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/01/65	801-S1 09/05/65	801-S1 09/13/65	801-S1 06/01/66	801-S1 06/12/66
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/18/66	801-S1 09/01/66	801-S1 09/02/66	801-S1 09/04/66	801-S1 09/13/66
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	130.	130.	74.	-
CHLORIDE	MG/L	-	27.	31.	41.	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	1380.	1320.	1020.	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	4760.0	3390.	2750.	2530.	2240.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	51.	50.	40.	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	7.5	7.8	8.1	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILICON	MG/L	-	-	-	-	-
SILICA	MG/L	-	10.	8.2	7.1	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	130.	110.	90.	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	540.	520.	300.	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/18/66	801-S1 09/01/66	801-S1 09/02/66	801-S1 09/04/66	801-S1 09/13/66
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/24/66	801-S1 09/29/66	801-S1 06/01/67	801-S1 06/15/67	801-S1 06/20/67
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	72.	77.	58.	66.	120.
CHLORIDE	MG/L	38.	44.	14.	17.	17.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	977.	1010.	568.	652.	945.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	3020.	2380.	18700.	18400.	18300.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	39.	37.	18.	19.	18.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.8	7.6	7.7	7.7	7.5
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	7.0	6.4	10.	-	13.
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	87.	97.	43.	52.	80.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	300.	310.	140.	180.	360.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/24/66	801-S1 09/29/66	801-S1 06/01/67	801-S1 06/15/67	801-S1 06/20/67
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/21/67	801-S1 06/25/67	801-S1 09/01/67	801-S1 09/07/67	801-S1 09/11/67
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	67.	50.	89.	94.	90.
CHLORIDE	MG/L	14.	11.	36.	64.	10.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	605.	478.	1030.	1140.	1070.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	20600.	19500.	4010.	3400.	3940.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	16.	15.	34.	40.	36.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.6	7.7	7.9	8.	8.
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	9.5	8.	6.4	7.3	7.
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	45.	33.	99.	130.	87.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	160.	110.	340.	400.	360.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/21/67	801-S1 06/25/67	801-S1 09/01/67	801-S1 09/07/67	801-S1 09/11/67
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/12/67	801-S1 06/01/68	801-S1 06/05/68	801-S1 06/08/68	801-S1 06/13/68
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.18	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	84.	56.	50.	-	40.
CHLORIDE	MG/L	34.	11.	8.6	-	8.9
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1040.	493.	445.	-	362.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	3970.	21400.	26800.	28700.	19800.
FLUORIDE	MG/L	0.4	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	36.	16.	14.	-	13.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	6.1	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.7	7.9	7.7	-	7.7
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.8	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	5.9	11.	9.6	-	9.3
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	93.	-	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	350.	84.	80.	-	62.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/12/67	801-S1 06/01/68	801-S1 06/05/68	801-S1 06/08/68	801-S1 06/13/68
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	290.	270.	-	220.
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/14/68	801-S1 06/26/68	801-S1 09/01/68	801-S1 09/16/68	801-S1 06/01/69
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.08	-	-	0.13	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	38.	42.	77.	72.	42.
CHLORIDE	MG/L	10.	9.3	33.	28.	13.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	408.	382.	971.	928.	457.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	17900.	14400.	4040.	4000.	14000.
FLUORIDE	MG/L	0.4	-	-	0.4	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	17.	12.	35.	37.	17.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	1.7	-	-	0.7	-
NITRITE	MG/L	0.01	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.9	7.7	7.6	8.	7.9
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	1.7	-	-	2.9	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	9.3	8.9	6.	53.	8.3
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	27.	-	-	85.	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	88.	76.	310.	310.	100.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/14/68	801-S1 06/26/68	801-S1 09/01/68	801-S1 09/16/68	801-S1 06/01/69
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	260.	230.	-	640.	290.
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE 801-S1 06/08/69	801-S1 06/10/69	801-S1 06/18/69	801-S1 06/19/69	801-S1 06/20/69
		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	51.	43.	68.	-	51.
CHLORIDE	MG/L	17.	13.	42.	-	18.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	572.	529.	937.	-	588.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	9020.	9550.	12100.	13500.	12500.
FLUORIDE	MG/L	-	0.5	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	20.	21.	32.	-	22.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.8	7.9	7.8	-	7.9
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	1.8	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	8.6	8.5	10.	-	9.2
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	38.	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	140.	120.	270.	-	150.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/08/69	801-S1 06/10/69	801-S1 06/18/69	801-S1 06/19/69	801-S1 06/20/69
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	360.	320.	610.	-	370.
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/24/69	801-S1 09/01/69	801-S1 09/09/69	801-S1 09/11/69	801-S1 09/15/69
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	61.	80.	75.	91.	82.
CHLORIDE	MG/L	18.	31.	35.	36.	32.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	667.	981.	924.	1090.	981.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	11800.	3400.	5120.	5070.	3940.
FLUORIDE	MG/L	-	-	-	-	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	22.	41.	34.	35.	34.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.9	7.6	7.6	7.7	7.8
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	-	-	-	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILICON	MG/L	-	-	-	-	-
SILICA	MG/L	9.	5.6	4.8	7.2	6.8
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	-	-	-	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	190.	300.	280.	320.	300.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/24/69	801-S1 09/01/69	801-S1 09/09/69	801-S1 09/11/69	801-S1 09/15/69
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	440.	640.	630.	700.	660.
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/17/69	801-S1 09/23/69	801-S1 06/12/70	801-S1 06/16/70	801-S1 09/09/70
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	0.09	0.12
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	90.	77.	-	54.	72.
CHLORIDE	MG/L	32.	32.	-	16.	27.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1050.	957.	-	508.	879.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	4240.	4340.	22300.	18500.	3130.
FLUORIDE	MG/L	0.4	-	-	0.2	0.4
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	35.	36.	-	34.	35.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	4.9	-	-	-	3.7
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.1	7.8	-	8.	8.5
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.9	-	-	2.2	3.2
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	6.1	6.2	-	9.4	5.3
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	93.	88.	-	40.	83.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	330.	300.	-	98.	260.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/17/69	801-S1 09/23/69	801-S1 06/12/70	801-S1 06/16/70	801-S1 09/09/70
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	710.	640.	-	450.	640.
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/08/71	801-S1 09/08/71	801-S1 06/15/72	801-S1 09/03/72	801-S1 09/13/72
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.02	0.21	0.08	-	0.22
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	31.	78.	36.	-	79.
CHLORIDE	MG/L	7.8	30.	11.	-	47.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	380.	880.	590.	-	1030.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	14800.	3610.	17000.	2400.	2090.
FLUORIDE	MG/L	-	0.4	0.1	-	0.4
GROSS ALPHA	PCI/L	-	-	2.3	-	4.9
GROSS BETA	PCI/L	-	-	4.8	-	12.
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	11.	31.	12.	-	34.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	0.37	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	0.23	0.35	-	-	0.1
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.9	8.	7.4	-	8.1
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	1.6	3.7	4.3	-	5.6
RA-226	PCI/L	-	-	0.06	-	< 0.1
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	7.1	8.5	-	6.2
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	27.	89.	26.	-	96.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	77.	270.	88.	-	300.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/08/71	801-S1 09/09/71	801-S1 06/15/72	801-S1 09/03/72	801-S1 09/13/72
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	220.	610.	250.	-	680.
URANIUM	MG/L	-	-	0.0014	-	0.0048
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/12/73	801-S1 09/11/73	801-S1 06/24/74	801-S1 09/23/74	801-S1 06/16/75
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.14	0.18	0.1	0.18	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	37.	78.	33.	69.	36.
CHLORIDE	MG/L	10.	30.	8.3	30.	8.
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	435.	950.	362.	900.	370.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	20900.	4770.	13400.	-	-
FLUORIDE	MG/L	1.1	0.3	0.1	0.3	0.2
GROSS ALPHA	PCI/L	-	-	0.0036	9.0	-
GROSS BETA	PCI/L	4.2	5.9	3.6	7.3	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	14.	33.	11.	29.	11.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	0.25	0.68	0.2	0.35	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.8	8.4	7.8	7.8	8.
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	2.	3.3	2.	4.	1.7
RA-226	PCI/L	0.06	-	0.05	0.09	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	9.8	7.3	8.8	5.2	8.4
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	76.	25.	77.	25.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	86.	290.	77.0	250.	78.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/12/73	801-S1 09/11/73	801-S1 06/24/74	801-S1 09/23/74	801-S1 06/16/75
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	250.	-	220.	560.	230.
URANIUM	MG/L	0.0045	0.0043	0.001	0.0038	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/23/75	801-S1 09/15/75	801-S1 09/24/75	801-S1 06/21/76	801-S1 06/24/76
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	79.	-	49.	-
CHLORIDE	MG/L	-	34.	-	14.	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	1060.	-	550.	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	20600.	3610.	2360.	9000.	8400.
FLUORIDE	MG/L	-	0.3	-	0.3	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	45.	-	18.	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	8.2	-	8.2	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	4.	-	2.	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	5.3	-	8.	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	95.	-	42.	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	350.	-	150.	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 06/23/75	801-S1 09/15/75	801-S1 09/24/75	801-S1 06/21/76	801-S1 06/24/76
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	720.	-	360.	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/23/76	801-S1 06/27/77	801-S1 09/21/77	801-S1 09/28/77	801-S1 06/21/78
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	-	53.	-	74.	-
CHLORIDE	MG/L	-	22.	-	32.	-
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	-	650.	-	890.	-
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	3290.	2950.	2560.	2040.	20700.
FLUORIDE	MG/L	-	0.2	-	0.3	-
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	-	23.	-	33.	-
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	-	8.4	-	8.6	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	-	2.9	-	2.9	-
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	-	4.5	-	5.2	-
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	-	56.	-	88.	-
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	-	170.	-	280.	-
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/23/76	801-S1 06/27/77	801-S1 09/21/77	801-S1 09/28/77	801-S1 06/21/78
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	410.	-	630.	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/26/78	801-S1 06/22/79	801-S1 09/06/79	801-S1 09/19/79	801-S1 06/25/80
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	0.240	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.23	-	0.21	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	79.	-	57.	63.	29.
CHLORIDE	MG/L	36.	-	29.	28.	7.4
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	950.	-	840.	895.	330.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	2860.	14400.	2530.	2300.	14100.
FLUORIDE	MG/L	0.4	-	0.4	0.3	0.2
GROSS ALPHA	PCI/L	-	-	-	8.2	-
GROSS BETA	PCI/L	-	-	-	5.3	-
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	33.	-	33.	33.0	12.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	-	-	-	-	0.01
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.2	-	8.5	8.1	7.6
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	3.4	-	3.5	2.9	1.5
RA-226	PCI/L	-	-	-	0.10	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	5.8	-	6.7	5.2	8.7
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	97.	-	92.	92.	21.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	320.	-	250.	270.	70.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/26/78	801-S1 06/22/79	801-S1 09/06/79	801-S1 09/19/79	801-S1 06/25/80
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	680.	-	580.	620.	210.
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/17/80	801-S1 06/25/81	801-S1 09/22/81	801-S1 06/25/82	801-S1 06/23/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	-	-	-
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	-
ARSENIC	MG/L	-	-	-	-	-
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	-	-	-
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	-	-	-	-	-
CADMIUM	MG/L	-	-	-	-	-
CALCIUM	MG/L	85.	51.	67.	29.	38.
CHLORIDE	MG/L	36.	21.	28.	6.2	9.3
CHROMIUM	MG/L	-	-	-	-	-
COBALT	MG/L	-	-	-	-	-
CONDUCTANCE	UMHO/CM	1130.	570.	795.	321.	400.
COPPER	MG/L	-	-	-	-	-
DISCHARGE	CFS	2820.	3000.	3560.	15300.	39900.
FLUORIDE	MG/L	0.4	0.2	0.4	0.2	0.2
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	7.3	-	4.8
IRON	MG/L	-	-	-	-	-
LEAD	MG/L	-	-	-	-	-
MAGNESIUM	MG/L	40.	20.	29.	10.	15.
MANGANESE	MG/L	-	-	-	-	-
MERCURY	MG/L	-	-	-	-	-
MOLYBDENUM	MG/L	-	-	-	-	-
NICKEL	MG/L	-	-	-	-	-
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	0.29	0.03	0.1	< 0.1	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.1	7.9	7.8	-	8.2
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	5.	1.8	3.3	0.6	2.
RA-226	PCI/L	-	-	0.13	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	-	-	-
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	7.7	7.3	5.	8.6	8.1
SILVER	MG/L	-	-	-	-	-
SODIUM	MG/L	110.	51.	73.	19.	29.
STRONTIUM	MG/L	-	-	-	-	-
SULFATE	MG/L	410.	170.	250.	60.	98.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/17/80	801-S1 06/25/81	801-S1 09/22/81	801-S1 06/25/82	801-S1 06/23/83
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	800.	390.	550.	200.	-
URANIUM	MG/L	-	-	0.0049	-	0.0028
VANADIUM	MG/L	-	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/06/83	801-S1 06/25/84	801-S1 09/25/84	801-S1 06/20/85	801-S1 09/04/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	-	-	-	-	-
ALUMINUM	MG/L	-	-	0.010	-	< 0.010
AMMONIUM	MG/L	-	-	-	-	-
ANTIMONY	MG/L	-	-	-	-	0.810
ARSENIC	MG/L	-	-	0.002	-	0.002
BALANCE	%	-	-	-	-	-
BARIUM	MG/L	-	-	0.120	-	0.12
BICARBONATE	MG/L	-	-	-	-	-
BORON	MG/L	0.17	0.05	-	0.06	-
CADMIUM	MG/L	-	-	< 0.001	-	< 0.001
CALCIUM	MG/L	65.	34.	64.	35.	71.
CHLORIDE	MG/L	24.	6.9	21.	8.5	28.
CHROMIUM	MG/L	-	-	0.001	-	< 0.001
COBALT	MG/L	-	-	< 0.003	-	< 0.003
CONDUCTANCE	UMHO/CM	830.	370.	820.	-	-
COPPER	MG/L	-	-	0.003	-	0.006
DISCHARGE	CFS	6160.	21100.	6300.	-	-
FLUORIDE	MG/L	0.3	0.2	0.3	0.2	0.3
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	-	-	0.042	-	< 0.003
LEAD	MG/L	-	-	< 0.001	-	< 0.001
MAGNESIUM	MG/L	29.	14.	32.	15.	35.
MANGANESE	MG/L	-	-	< 0.001	-	0.006
MERCURY	MG/L	-	-	< 0.0001	-	< 0.0001
MOLYBDENUM	MG/L	-	-	< 0.01	-	< 0.010
NICKEL	MG/L	-	-	< 0.001	-	0.002
NITRATE	MG/L	-	-	-	-	-
NITRITE	MG/L	-	-	-	-	-
NO2 & NO3	MG/L	0.14	0.16	0.23	0.18	< 0.10
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	8.2	8.2	8.2	-	-
PHOSPHATE	MG/L	-	-	-	-	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	2.9	1.8	2.8	1.4	3.4
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
REDOX POTENT	MVOLTS	-	-	-	-	-
SELENIUM	MG/L	-	-	0.002	-	0.002
SILCON	MG/L	-	-	-	-	-
SILICA	MG/L	8.3	9.2	8.8	9.4	5.6
SILVER	MG/L	-	-	< 0.001	-	< 0.001
SODIUM	MG/L	70.	22.	75.	27.	82.
STRONTIUM	MG/L	-	-	0.8	-	-
SULFATE	MG/L	210.	79.	230.	96.	270.
TEMPERATURE	C - DEGREE	-	-	-	-	-
TH-230	PCI/L	-	-	-	-	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-S1 09/06/83	801-S1 06/25/84	801-S1 09/25/84	801-S1 06/20/85	801-S1 09/04/85
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	-	-	-	-	-
URANIUM	MG/L	-	-	-	-	-
VANADIUM	MG/L	-	-	< 0.006	-	0.006
ZINC	MG/L	-	-	0.034	-	0.008

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE 801-01 09/08/86 PARAMETER VALUE	+/-UNCERTAINTY	801-01 03/12/87 PARAMETER VALUE	+/-UNCERTAINTY	801-01 10/01/87 PARAMETER VALUE	+/-UNCERTAINTY	801-01 01/07/88 PARAMETER VALUE	+/-UNCERTAINTY	802-01 09/08/86 PARAMETER VALUE	+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	191.		42.		172.		183.		199.	
ALUMINUM	MG/L	0.2		0.2		< 0.1		0.1		0.2	
AMMONIUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
ANTIMONY	MG/L	< 0.003		-		-		-		< 0.003	
ARSENIC	MG/L	< 0.01		-		< 0.01		< 0.01		< 0.01	
BALANCE	%	0.02		-		-		-		-0.74	
BARIUM	MG/L	0.2		-		-		-		0.2	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	0.2		0.1		0.2		0.19		0.2	
CADMIUM	MG/L	< 0.001		-		-		-		< 0.001	
CALCIUM	MG/L	64.0		56.3		68.		69.6		64.0	
CHLORIDE	MG/L	28.		27.5		23.6		25.		28.	
CHROMIUM	MG/L	< 0.01		0.03		< 0.01		0.07		< 0.01	
COBALT	MG/L	< 0.05		-		-		-		< 0.05	
CONDUCTANCE	UMHO/CM	750.		480.		710.		436.		850.	
COPPER	MG/L	0.03		-		-		-		0.03	
DISCHARGE	CFS	-		-		-		-		-	
FLUORIDE	MG/L	0.5		0.28		0.1		0.27		0.5	
GROSS ALPHA	PCI/L	-		19.	6.	0.0	3.9	4.1	2.9	-	
GROSS BETA	PCI/L	-		9.5	2.5	0.0	3.3	4.3	1.9	-	
IRON	MG/L	< 0.03		0.06		< 0.03		0.35		< 0.03	
LEAD	MG/L	< 0.01		-		-		-		< 0.01	
MAGNESIUM	MG/L	36.7		30.8		36.		30.3		36.7	
MANGANESE	MG/L	0.02		0.01		< 0.01		0.02		0.02	
MERCURY	MG/L	< 0.0002		-		-		-		< 0.0002	
MOLYBDENUM	MG/L	0.18		< 0.1		< 0.01		0.03		0.18	
NICKEL	MG/L	< 0.04		-		-		-		< 0.04	
NITRATE	MG/L	3.		2.2		< 1.0		0.9		3.	
NITRITE	MG/L	< 0.1		-		-		-		< 0.1	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		9.		46.6		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	8.10		8.18		8.1		7.9		8.12	
PHOSPHATE	MG/L	< 0.1		-		-		-		< 0.1	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	3.77		2.52		2.49		2.55		3.77	
RA-226	PCI/L	-		0.0	0.2	0.2	0.1	0.	0.1	-	
RA-228	PCI/L	-		-		2.1	1.2	0.	0.8	-	
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.005		0.003		< 0.005		< 0.005		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	4.		-		-		-		4.	
SILVER	MG/L	< 0.01		-		-		-		< 0.01	
SODIUM	MG/L	97.5		70.0		77.		64.3		97.5	
STRONTIUM	MG/L	1.0		-		-		-		1.0	
SULFATE	MG/L	284.		330.		258.		239.		284.	
TEMPERATURE	C - DEGREE	22.		8.0		22.0		0.1		22.	
TH-230	PCI/L	-		1.0	0.7	-		-		-	

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		801-01 09/08/86	801-01 03/12/87	801-01 10/01/87	801-01 01/07/88	802-01 09/08/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	< 0.005	-	-	-	< 0.005
TOTAL SOLIDS	MG/L	612.	750.	670.	577.	611.
URANIUM	MG/L	0.0079	0.0025	0.003	0.0042	0.0036
VANADIUM	MG/L	0.24	-	< 0.01	0.02	0.25
ZINC	MG/L	< 0.005	-	0.20	0.02	< 0.005

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE					
		802-02 09/08/86	802-03 09/08/86	802-04 09/08/86	802-05 09/08/86	802-01 03/12/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	199.	199.	199.	199.	288.	
ALUMINUM	MG/L	0.2	0.2	0.2	0.2	0.1	
AMMONIUM	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	
ANTIMONY	MG/L	< 0.003	< 0.003	< 0.003	< 0.003	-	
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	-	
BALANCE	%	-0.74	-0.74	-0.74	-0.74	-	
BARIUM	MG/L	0.2	0.2	0.2	0.2	-	
BICARBONATE	MG/L	-	-	-	-	-	
BORON	MG/L	0.2	0.2	0.2	0.2	0.1	
CADMIUM	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	-	
CALCIUM	MG/L	64.0	64.0	64.0	64.0	62.2	
CHLORIDE	MG/L	28.	28.	28.	28.	25.	
CHROMIUM	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	0.03	
COBALT	MG/L	< 0.05	< 0.05	< 0.05	< 0.05	-	
CONDUCTANCE	UMHO/CM	850.	850.	850.	850.	485.	
COPPER	MG/L	0.03	0.03	0.03	0.03	-	
DISCHARGE	CFS	-	-	-	-	-	
FLUORIDE	MG/L	0.5	0.5	0.5	0.5	0.28	
GROSS ALPHA	PCI/L	-	-	-	-	0.0	3.7
GROSS BETA	PCI/L	-	-	-	-	5.1	2.2
IRON	MG/L	< 0.03	< 0.03	< 0.03	< 0.03	0.03	
LEAD	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	-	
MAGNESIUM	MG/L	36.7	36.7	36.7	36.7	34.9	
MANGANESE	MG/L	0.02	0.02	0.02	0.02	0.01	
MERCURY	MG/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	-	
MOLYBDENUM	MG/L	0.18	0.18	0.18	0.18	< 0.1	
NICKEL	MG/L	< 0.04	< 0.04	< 0.04	< 0.04	-	
NITRATE	MG/L	3.	3.	3.	3.	2.1	
NITRITE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	-	
NO2 & NO3	MG/L	-	-	-	-	-	
ORG. CARBON	MG/L	-	-	-	-	-	
PB-210	PCI/L	-	-	-	-	-	
PH	SU	8.12	8.12	8.12	8.12	8.26	
PHOSPHATE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	-	
PO-210	PCI/L	-	-	-	-	-	
POTASSIUM	MG/L	3.77	3.77	3.77	3.77	2.80	
RA-226	PCI/L	-	-	-	-	0.0	0.2
RA-228	PCI/L	-	-	-	-	-	
REDOX POTENT	MVOLTS	-	-	-	-	-	
SELENIUM	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.002	
SILCON	MG/L	-	-	-	-	-	
SILICA	MG/L	4.	4.	4.	4.	-	
SILVER	MG/L	< 0.01	-	< 0.01	< 0.01	-	
SODIUM	MG/L	97.5	97.5	97.5	97.5	106.	
STRONTIUM	MG/L	1.0	1.0	1.0	1.0	-	
SULFATE	MG/L	284.	284.	284.	284.	258.	
TEMPERATURE	C - DEGREE	22.	22.	22.	22.	8.5	
TH-230	PCI/L	-	-	-	-	0.8	0.7

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		802-02 09/08/86	802-03 09/08/86	802-04 09/08/86	802-05 09/08/86	802-01 03/12/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	< 0.005	-	< 0.005	< 0.005	-
TOTAL SOLIDS	MG/L	612.	616.	618.	613.	752.
URANIUM	MG/L	0.0027	0.0031	0.0016	0.0019	0.0030
VANADIUM	MG/L	0.22	0.22	0.22	0.22	-
ZINC	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	-

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE									
		802-02 03/12/87		802-03 03/12/87		802-04 03/12/87		802-05 03/12/87		802-01 10/01/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	288.		288.		288.		288.		171.	
ALUMINUM	MG/L	0.1		0.1		0.1		0.1		< 0.1	
AMMONIUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	-		-		-		-		< 0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	0.2		0.2		0.1		0.28		0.2	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	61.6		61.5		61.6		61.7		70.	
CHLORIDE	MG/L	25.		25.		25.		25.		23.5	
CHROMIUM	MG/L	0.01		0.01		0.01		0.01		< 0.01	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	485.		485.		485.		485.		710.	
COPPER	MG/L	-		-		-		-		-	
DISCHARGE	CFS	-		-		-		-		-	
FLUORIDE	MG/L	0.28		0.28		0.28		0.28		0.2	
GROSS ALPHA	PCI/L	0.4	4.0	4.6	3.8	0.0	5.1	0.0	4.8	0.0	4.7
GROSS BETA	PCI/L	5.9	2.4	5.4	1.7	7.0	2.7	7.1	2.5	2.1	4.0
IRON	MG/L	< 0.03		< 0.03		< 0.03		< 0.03		< 0.03	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	34.6		34.6		34.6		34.6		37.	
MANGANESE	MG/L	0.01		0.01		0.01		0.01		< 0.01	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		< 0.01	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	1.6		1.6		1.6		1.5		< 1.0	
NITRITE	MG/L	-		-		-		-		-	
NO2 & NO3	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		6.	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	8.26		8.26		8.26		8.26		8.15	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	2.84		2.84		2.84		2.84		2.46	
RA-226	PCI/L	0.0	0.2	0.0	0.2	0.1	0.3	0.0	0.2	0.2	0.1
RA-228	PCI/L	-		-		-		-		0.5	0.8
REDOX POTENT	MVOLTS	-		-		-		-		-	
SELENIUM	MG/L	< 0.002		< 0.002		< 0.002		< 0.002		< 0.005	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	102.		102.		102.		103.		78.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	253.		253.		254.		254.		257.	
TEMPERATURE	C - DEGREE	8.5		8.5		8.5		8.5		21.0	
TH-230	PCI/L	1.7	0.8	0.6	0.6	0.0	0.5	0.2	0.5	-	

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE				
		802-02 03/12/87	802-03 03/12/87	802-04 03/12/87	802-05 03/12/87	802-01 10/01/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-	-	-	-	-
TOTAL SOLIDS	MG/L	748.	748.	749.	748.	650.
URANIUM	MG/L	0.0024	0.0027	0.0024	0.0038	< 0.003
VANADIUM	MG/L	-	-	-	-	< 0.01
ZINC	MG/L	-	-	-	-	< 0.005

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Continued)

		LOCATION ID - SAMPLE ID AND LOG DATE					
		802-01 01/07/88					
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	200.					
ALUMINUM	MG/L	0.1					
AMMONIUM	MG/L	0.2					
ANTIMONY	MG/L	-					
ARSENIC	MG/L	< 0.01					
BALANCE	%	-					
BARIUM	MG/L	-					
BICARBONATE	MG/L	-					
BORON	MG/L	0.21					
CADMIUM	MG/L	-					
CALCIUM	MG/L	69.3					
CHLORIDE	MG/L	24.					
CHROMIUM	MG/L	0.02					
COBALT	MG/L	-					
CONDUCTANCE	UMHO/CM	453.					
COPPER	MG/L	-					
DISCHARGE	CFS	-					
FLUORIDE	MG/L	0.26					
GROSS ALPHA	PCI/L	6.2	3.1				
GROSS BETA	PCI/L	4.3	1.8				
IRON	MG/L	0.13					
LEAD	MG/L	-					
MAGNESIUM	MG/L	30.1					
MANGANESE	MG/L	0.01					
MERCURY	MG/L	-					
MOLYBDENUM	MG/L	0.03					
NICKEL	MG/L	-					
NITRATE	MG/L	0.8					
NITRITE	MG/L	-					
NO2 & NO3	MG/L	-					
ORG. CARBON	MG/L	41.8					
PB-210	PCI/L	-					
PH	SU	8.1					
PHOSPHATE	MG/L	-					
PO-210	PCI/L	-					
POTASSIUM	MG/L	2.34					
RA-226	PCI/L	0.1	0.2				
RA-228	PCI/L	0.	0.9				
REDOX POTENT	MVOLTS	-					
SELENIUM	MG/L	< 0.005					
SILCON	MG/L	-					
SILICA	MG/L	-					
SILVER	MG/L	-					
SODIUM	MG/L	64.2					
STRONTIUM	MG/L	-					
SULFATE	MG/L	239.					
TEMPERATURE	C - DEGREE	0.1					
TH-230	PCI/L	-					

Table B.1.3 Concentrations of major and trace constituents in surface waters, Green River, Utah, tailings site (Concluded)

		LOCATION ID - SAMPLE ID AND LOG DATE
		802-01 01/07/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY
TIN	MG/L	-
TOTAL SOLIDS	MG/L	602.
URANIUM	MG/L	0.0038
VANADIUM	MG/L	0.02
ZINC	MG/L	0.009

MAPPER INPUT FILE: GRN01*UDPSWQ100128

Table B.1.4 Relationship of flow rate to concentration of total dissolved solids and dissolved uranium in the Green River at sampling location 801 in June and September, 1967, through 1985, Green River, Utah, tailings site[a]

	June			September		
	Q (cfs)	TDS (mg/l)	U (mg/l)	Q (cfs)	TDS (mg/l)	U mg/l
x[b]	16,666	311	0.0017	3650	649	0.0044
s[c]	7,033	103	0.0008	1112	60	0.0005
n[d]	35	22	4	29	18	4

[a] cfs = cubic feet per second; mg/l = milligrams per liter; TDS = total dissolved solids; Q = streamflow; and U = uranium.

[b] Arithmetic mean of available records.

[c] Standard deviation of sample population.

[d] Number of records (some months include more than one record).

Ref. USGS, 1967-1985.

Table B.1.5 Statistical summary for chemical constituents and flow rate of the Green River at location 801 for June, 1967, through 1985, Green River, Utah, tailings site

Parameter (units)[a]	Sample size	Sample mean	Sample standard deviation	Expected range of population mean[b]
Flow rate (cfs)	35	16,666	7033	16,666 ± 2425
Boron (mg/l)	7	0.077	0.039	0.077 ± 0.036
Calcium (mg/l)	29	47.93	17.90	47.93 ± 6.81
Chloride (mg/l)	30	13.27	6.94	13.27 ± 2.59
Conductance (μmho/cm)	29	514	157	514 ± 60
Fluoride (mg/l)	15	0.29	0.25	0.29 ± 0.14
Gross beta (pCi/l)	4	4.35	0.57	4.35 ± 0.91
Magnesium (mg/l)	30	17.07	5.67	17.07 ± 2.12
NO_2 + NO_3 (mg/l)	8	0.14	0.09	0.14 ± 0.08
pH (standard units)	28	7.8	0.22	7.8 ± 0.01
Potassium (mg/l)	16	1.96	0.78	1.96 ± 0.42
Radium-226 (pCi/l)	3	0.057	0.006	0.057 ± 0.015
Silica (mg/l)	28	8.96	1.38	8.96 ± 0.54
Sodium (mg/l)	20	36.4	15.1	36.4 ± 7.1
Sulfate (mg/l)	30	123.6	65.4	123.6 ± 24.4
TDS (mg/l)	22	311	103	311 ± 46
Uranium (mg/l)	4	0.0017	0.00078	0.0017 ± 0.0012

[a] Parameters with two or fewer samples were not included in the statistical summary.

[b] Expected range of population mean assuming a normal distribution of parameter values and a 95 percent confidence level.

Ref. USGS, 1967-1985.

Table B.1.6 Statistical summary for chemical constituents and flow rate of the Green River at location 801 for September, 1967, through 1985, Green River, Utah, tailings site

Parameter (units)[a]	Sample size	Sample mean	Sample standard deviation	Expected range of population mean[b]	
Flow rate (cfs)	29	3650	1112	3650	±423
Boron (mg/l)	10	0.18	0.037	0.18	±0.027
Calcium (mg/l)	26	76.6	9.3	76.6	±3.8
Chloride (mg/l)	27	32.0	9.0	32.0	±3.6
Conductance (μmho/cm)	26	961	98	961	±40
Fluoride (mg/l)	18	0.36	0.051	0.36	±0.025
Gross beta (pCi/l)	5	7.6	2.6	7.6	±3.2
Magnesium (mg/l)	27	34.7	3.7	34.7	±1.46
Nitrate (mg/l)	4	3.85	2.3	3.85	±3.66
$NO_2 + NO_3$ (mg/l)	9	0.25	0.19	0.25	±0.15
pH (standard units)	26	8.0	0.3	8.0	±0.1
Potassium (mg/l)	18	3.58	0.75	3.58	±0.37
Radium-226 (pCi/l)	4	0.093	0.033	0.093	±0.053
Silica (mg/l)	27	8.04	9.04	8.04	±3.58
Sodium (mg/l)	22	89.5	13.2	89.5	±5.9
Sulfate (mg/l)	27	300.4	48.0	300.4	±19.0
TDS (mg/l)	18	649	60	649	±30
Uranium (mg/l)	4	0.0044	0.0005	0.0044	±0.0008

[a] Parameters with three or fewer samples were not included in the statistical summary.

[b] Expected range of population mean assuming a normal distribution of parameter values and a 95 percent confidence level.

Ref. USGS, 1967-1985.

Table B.1.7 Concentrations of selected constituents for the Green River and Brown's Wash, Green River, Utah, tailings site[a]

Constituent by sampling location[b]	Concentrations by sampling period[c]			
	June 1982	November 1982	June 1986	September 1986
TDS (mg/l)				
801			311	612
802				614[e]
526		10,700	318	791[e]
710		11,700	477	
709	---	14,900	19,100	
711	---			
Nitrate (mg/l)				
801			0.14	3
802				3[e]
526		2,090	0.7	3[e]
710		120	4.9	
709	1	62	3.0	
711	1			
Uranium (mg/l)				
801			0.0017	0.0029[e]
802				0.0026[e]
526		1.3	0.0029	0.0045[e]
710		0.264	0.0119	
709	0.005	0.368	0.235	
711	0.005			
Thorium (pCi/l)				
801		---	---	---
802				---
526		67	2.2	---
710		---	---	
709	67	67	---	
711	67			

Table B.1.7 Concentrations of selected constituents for the Green River and Brown's Wash, Green River, Utah, tailings site[a] (Concluded)

Constituent by sampling location[b]	Concentrations by sampling period[c]			
	June 1982	November 1982	June 1986	September 1986
Gross alpha (pCi/l)[d]				
801		---	---	---
802				---
526		1,000	4.2	---
710		---	---	
709	150	600	---	
711	100			

[a] mg/l = milligrams per liter; pci/l = picocuries per liter, --- = below detection limit.

[b] Location 801 is above and location 802 is below the confluence of Green River and Brown's Wash; locations for Brown's Wash (526 through 411) are arranged according to relation in the wash (downstream to upstream; see Figure B.1.3).

[c] Blank spaces indicate that data were not collected for that location during a particular sampling period.

[d] See Table B.1.3 for variance in activity.

[e] Arithmetic mean; see Table B.1.3 for actual values.

relative amount of water present in the wash. Analyses of samples collected downstream from the existing tailings pile indicate that the existing pile contributes little to the existing water-quality of the wash.

During periods of low ("base") flow (late fall to early winter), water may be present in some parts of the channel and not in others. Often, the water is stagnant. The highest concentrations of dissolved constituents are recorded at these locations and are a function of the evaporative process in these stagnant areas. At location 526, concentrations of TDS (10,700 mg/l), nitrate (2090 mg/l), thorium (67 picocuries per liter (pCi/l), and gross alpha activity (1000 pCi/l) were highest in the November, 1982, sampling period. In September, 1986, concentrations of these constituents were much lower than in November, 1982. However, they were two to three times higher than concentrations recorded in June, 1986 (Table B.1.7). Similar comparisons can be made for other sample locations in Brown's Wash (see Tables B.1.3 and B.1.7).

In June, 1982, water samples were collected at locations 709 and 711 (DOE, 1983). Water samples were collected at these two locations again in June, 1986, as well as at locations 526 and 710 (see Figure B.1.3 and Table B.1.3). In June, 1986, backwater from the Green River was mixing with the water from Brown's Wash at location 526. During this same sampling period, there was no water present at location 711, indicating that the relative amount of water present in the wash can vary annually. Dissolved concentrations at location 709 were much higher in June, 1986, than in June, 1982. However, as the water in Brown's Wash mixed with the Green River backwater (location 526), concentrations of dissolved constituents were diluted to levels comparable to those recorded for location 801 in the Green River. At location 710, between locations 526 and 709 (see Figure B.1.3), concentrations had dropped significantly to within the levels reported for location 526 (see Tables B.1.3 and B.1.7).

Results of the chemical analyses indicate that the relationship of the sample location to the existing tailings pile has little effect on the quality of water in Brown's Wash. For the June, 1982, sampling period, a comparison of the analyses indicates that concentrations are approximately the same or slightly higher upstream from the existing pile (see locations 709 and 711, Tables B.1.3 and B.1.7).

However, in June, 1986, because of the increase in surface-water flow between locations 709 and 710, water quality between these locations changes considerably. For instance, concentrations of TDS were 19,100 and 477 mg/l at locations 709 and 710, respectively. Similarly, uranium concentration at locations 709 and 710 were 0.235 and 0.0119 mg/l, respectively. At location 526, concentrations of dissolved constituents were further diluted by mixing with backwater from the Green River where the concentration of TDS was 318 mg/l and uranium concentration was 0.0029 mg/l. Other dissolved constituents were similarly diluted.

B.1.5 SURFACE-WATER USES, STANDARDS, AND CLASSIFICATIONS

In November, 1985, Brown's Wash was reconnoitered from an area adjacent to the tailings site to its confluence with the Green River. There were no signs (e.g., canals or turn-out structures) of current use of the water in Brown's Wash. Because the water in Brown's Wash originates in an area affected by the dissolution of minerals in the rocks through which the water flows, the water has little or no value. From a practical standpoint, the water in Brown's Wash has a nuisance value due to the salt it contributes to the Colorado River system.

The city of Green River presently takes water from the Green River upstream of the tailings site for municipal use. Water users inside the city limits are charged a rate of $11.50 for the first 6000 gallons per month and $1.00 for each additional 1000 gallons per month (City of Green River, 1984). Withdrawal is minimal for approximately 20 miles downstream of the confluence with Brown's Wash partly due to a change in floodplain terrain from broad and flat to steep mesas and buttes (Spadafora, 1987).

In the immediate vicinity of the city of Green River, future usage of the Green River may be significant. This is because the expected continued lack of groundwater use in the area places the burden of supplying all water needs upon surface-water withdrawal from the Green River.

The value of Green River water in the area can probably be expected to increase slightly. Increases in population, agricultural development, or mineral or energy development in the Green River area would increase the demand for Green River water. The increased demand would increase the water's value; however, the amount of increase is slight, and future demands can be met by using Green River water.

The Utah State Board of Health and Utah Water Pollution Control Board classify the Green River and its tributaries as Class 2B (protected for boating, water skiing, and similar uses, excluding recreational bathing), Class 3B (protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain), and Class 4 (protected for agricultural uses including irrigation of crops and livestock watering) waters. Water quality standards are presented in Table B.1.8.

Table B.1.8 Nominal Water Quality Standards - State of Utah

	Classes		
Constituent	2B	3B	4
Bacteriological			
(No./100 ml) 30-day geometric mean			
o Maximum total coliforms	5,000	N/A	N/A
o Maximum fecal coliforms	2,000	N/A	N/A
Physical			
Total dissolved gasses	N/A	Not to exceed 110% of saturation	N/A
Minimum DO (mg/l)[a]	5.5	5.5	N/A
Maximum temperature	N/A	27°C	N/A
Maximum temp. change	N/A	4C°	N/A
pH (standard units)	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity increase[b]	10NTU	10NTU	N/A
Chemical (Maximum mg/l)			
Arsenic, dissolved	N/A	N/A	0.1
Cadmium, dissolved	N/A	0.004[c]	0.01
Chromium, dissolved	N/A	0.10	0.10
Copper, dissolved	N/A	0.01	0.2
Cyanide	N/A	0.005	N/A
Iron, dissolved	N/A	1.0	N/A
Lead, dissolved	N/A	0.05	0.1
Mercury, total	N/A	0.00005	N/A
Phenol	N/A	0.01	N/A
Selenium, dissolved	N/A	0.05	0.05
Silver, dissolved	N/A	0.01	N/A
Zinc, dissolved	N/A	0.05	N/A
NH_3 as N (un-ionized)	N/A	0.02	N/A
Chlorine	N/A	0.01	N/A
Boron, dissolved	N/A	N/A	0.75
H_2S	N/A	0.002	N/A
TDS[d]	N/A	N/A	1200

Table B.1.8 Nominal Water Quality Standards - State of Utah (Concluded)

Constituent	Classes 2B	 3B	 4
Radiological (Maximum pCi/l)			
Gross alpha	N/A	15[e]	15[e]
Pesticides (Maximum mg/l)			
Endrin	N/A	0.004	N/A
Lindane	N/A	0.001	N/A
Methoxychlor	N/A	0.03	N/A
Toxaphene	N/A	0.005	N/A
Pollution Indicators[e]			
Gross beta	N/A	50	50
BOD[f]	5	5	5
NO_3 as N (mg/l)	4	4	N/A
PO_4 (mg/l)[g]	0.05	0.05	N/A

N/A - Not applicable; no standard.

[a] These limits are not applicable to lower water levels in deep impoundments; DO = dissolved oxygen.

[b] NTU = nephelometric turbidity units; at background levels of 100 NTUs or greater, a 10% increase limit will be used instead of the numeric values listed.

[c] Limit shall be increased threefold if $CaCO_3$ hardness in water exceeds 150 mg/l.

[d] Total dissolved solids (TDS) limit may be adjusted on a case-by-case basis.

[e] Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

[f] Biological oxygen demand.

[g] PO_4 as P(mg/l) limit for lakes and reservoirs is 0.025.

Note: The numerical standards are taken in part from Utah Water Quality Standards--Amended October 23, 1978

B.2 GROUNDWATER HYDROLOGY

The U.S. Environmental Protection Agency (EPA) has established health and environmental protection regulations to correct and prevent groundwater contamination resulting from processing activities at inactive uranium tailings sites (40 CFR Part 192). The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 designated responsibility to the DOE for assessing the tailings sites. The DOE (1988a) has determined that this assessment shall include:

- Definition of hydrogeologic characteristics of the environment, including the hydrostratigraphy, aquifer hydraulic parameters, areas of aquifer recharge and discharge, potentiometric surface, and groundwater velocity.
- Comparison of existing water quality with background water quality, the proposed EPA groundwater standards, the EPA National Drinking Water Standards, and the water quality standards for the state of Utah.
- Definition of physical and chemical characteristics of the potential contaminant source, including concentration and leachability in relation to migration of contaminants in groundwater and hydraulically connected surface water.
- Description of water resource use, including availability, current and future use, value, and alternative supplies.
- Evaluation of current and future impacts to the groundwater system resulting from uranium processing activities and remedial actions.

On January 5, 1983, the EPA promulgated final standards for the disposal and cleanup of the inactive uranium processing sites under the UMTRCA (48 FR 590). The standards became effective on March 7, 1983; however, on September 3, 1985, the groundwater provisions of the regulations (40 CFR Part 192.20(a)(2)-(3)) were remanded to the EPA by the U.S. Tenth Circuit Court of Appeals. Revised standards were issued by the EPA on September 23, 1987 (52 FR 36000). The DOE has commented on the proposed standards.

Water quality at the Green River uranium mill tailings site was characterized and compared with the EPA's proposed groundwater standards for remedial actions at inactive uranium processing sites. Until the final EPA groundwater standards are issued, the DOE will also compare the water quality with EPA primary and secondary drinking water standards, and with water quality standards for the state of Utah (Table B.2.1).

Table B.2.1 Water quality standards and maximum concentration limits, Green River, Utah, tailings site[a]

Constituent	Proposed EPA groundwater maximum concentration limits[b]	EPA National Drinking Water Standards		State of Utah Drinking Water Standards
		Primary[c]	Secondary[d]	
Inorganic Chemical				
Arsenic	0.05	0.05		0.05
Barium	1.0	1.0		1.0
Boron				0.75
Cadmium	0.010	0.010		0.010
Chloride			250	250
Chromium	0.05	0.05		0.05
Copper			1.0	1.0
Iron			0.3	0.3
Lead	0.05	0.05		0.05
Manganese			0.05	0.05
Mercury	0.002	0.002		0.002
Molybdenum	0.1			
Nitrate	44	44		44
Selenium	0.01	0.01		0.01
Silver	0.05	0.05		0.05
Sulfate			250	250
Zinc			5.0	5.0
TDS			500	500
pH (standard units)			6.5-8.5	6.5-8.5
Radionuclides				
Ra-226 and 228	5.0 pCi/l			5.0 pCi/l
U-234 and 238	30 pCi/l (0.044 mg/l)			
Gross alpha	15 pCi/l			15 pCi/l

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[a] Standards are given in mg/l except as noted.

[b] 52 FR 36000; proposed standards also include a list of hazardous organic constituents not normally associated with uranium mill tailings; see Appendix VII of 40 CFR Part 261.

[c] 40 CFR Part 141.

[d] 40 CFR Part 143.

B.3 SITE CHARACTERIZATION SUMMARY

To comply with EPA standards for remedial actions at inactive uranium processing sites (40 CFR Part 192), the DOE has characterized the hydrogeology, water quality, and water resources at the Green River, Utah, uranium mill tailings site. Major points are summarized below; a detailed discussion of the site characterization is provided in Section B.4, below.

- Four distinct hydrostratigraphic units occur within the upper 200 feet of Quaternary and Cretaceous sediments beneath the site. In decending order these are: (1) Brown's Wash alluvium (top hydrostratigraphic unit); (2) shale and limestone of the Cedar Mountain Formation (upper-middle hydrostratigraphic unit); (3) sandstone, siltstone, and conglomerate of the Cedar Mountain Formation (lower-middle hydrostratigraphic unit); and (4) Buckhorn Conglomerate Member of the Cedar Mountain Formation (bottom hydrostratigraphic unit). The Dakota Sandstone is present in some areas beneath the proposed disposal site. These four units are underlain by the Jurassic Morrison Formation.

- Average hydraulic conductivities of aquifer materials range from a low of 1.6 feet per day (ft/day) in the lower-middle shale unit to a high of 25.0 ft/day in the Brown's Wash alluvium. Average linear groundwater velocities range from 0.08 ft/day to 1.14 ft/day in the two units, respectively.

- Groundwater flow in the upper- and lower-middle hydrostratigraphic units is controlled by connected fractures and joints; strong, upward, vertical hydraulic gradients; and the dip and lateral extent of the hydrostratigraphic units.

- Groundwater flow in the Brown's Wash alluvium and the upper-middle shale unit, where it lies beneath the alluvium, is also controlled by paleo-erosion of the upper-middle unit near the present tailings pile by a meandering Brown's Wash channel, and by the subsequent deposition of the Brown's Wash alluvium.

- Background groundwater quality in the top hydrostratigraphic unit is characterized by concentrations of chromium, molybdenum, nitrate, and selenium that exceed proposed EPA maximum concentration limits (MCLs) and State of Utah Primary Drinking Water Standards (except for molybdenum, which does not have a Utah standard).

- Background groundwater quality in the upper-middle hydrostratigraphic unit is characterized by concentrations of nitrate and selenium that exceed proposed EPA MCLs and State of Utah Primary Drinking Water Standards.

- Background groundwater quality in the lower-middle hydrostratigraphic unit is characterized by concentrations of molybdenum, nitrate, selenium, uranium, and gross alpha that exceed proposed EPA MCLs and State of Utah Primary Drinking Water Standards (except for molybdenum, which does not have a Utah standard).

- Background groundwater quality in the bottom hydrostratigraphic unit is characterized by concentrations of chromium, molybdenum, and selenium that exceed proposed EPA MCLs and State of Utah Primary Drinking Water Standards (except for molybdenum, which does not have a Utah standard).

- Background groundwater quality in all four hydrostratigraphic units is characterized by concentrations of total dissolved solids (TDS), sulfate, and chloride that exceed EPA and State of Utah Secondary Drinking Water Standards.

- Groundwater in all four units is classified as Class II based on TDS (TDS greater than 1000 but less than 10,000 milligrams per liter, or mg/l).

- Groundwater may be classified as Class III; concentrations of selenium, chromium, nitrate, and uranium in background samples exceed proposed EPA MCLs for these constituents.

- Contamination by tailings seepage is limited to the Brown's Wash alluvium and the upper-middle shale unit of the Cedar Mountain Formation beneath the present tailings pile. Major contaminants introduced by tailings seepage to these units include ammonium, molybdenum, nitrate, selenium, uranium, and gross alpha.

- The tailings seepage has been neutralized by the alluvium and shale bedrock beneath the tailings (the pH of the groundwater is near 7.0). Uranium concentrations in the alluvium and shale do not exceed 2 mg/l in any of the wells, while concentrations in the tailings pore water (lysimeter samples) have been measured as high as 675 mg/l. Dilution by groundwater underflow and attenuation, probably as cation exchange in the alluvium and precipitation in the shale, have significantly lowered uranium concentrations, as well as other seepage contaminants, to well below the relatively high concentrations found in the tailings pore water.

- Of the 15 registered wells in Township 21 South, Range 16 East, only one well is on the east side of the Green River. Except for the Crystal Geyser well two miles southeast and upgradient of the Green River site, most or all of these wells are completed in shallow alluvium. The majority of these wells are currently not in use because of poor groundwater quality and the availability of better quality water from the city of Green River.

- Groundwater in the Green River area is not considered to be potable; because of the naturally poor quality and low yield of the aquifers in the area, future use of groundwater for domestic consumption is not expected.

- Dispersion modeling indicates that the predicted concentrations of constituents exiting the base of the disposal cell would meet the proposed MCLs and background levels at the toe of the disposal cell for all constituents except uranium, gross alpha, and nitrate.

- Because groundwater in the Green River area is of naturally poor quality and future use for domestic consumption is not expected, the application for alternate concentration limits for uranium, gross alpha, and nitrate may be justified.

B.4 SITE CHARACTERIZATION

B.4.1 PREVIOUS INVESTIGATIONS

Bibliographies (ONWI, 1985; La Pray and Hamblin, 1980; Buss and Geoltz, 1974; USGS, 1972, 1971-1985, 1964; Childers and Smith, 1970; Buss, 1951) were reviewed to identify geological, hydrological, and hydrogeological investigations of the Green River site and vicinity. A number of regional studies (USGS, 1964; Howard and Love, 1945; Waring and Knechtel, 1936; Reeside, 1930, 1923; La Rue, 1916) were identified; however, much of the information contained in these reports is either outdated or not sufficient to aid in characterizing the hydrogeology of the site.

Five reconnaissance studies of the Paradox Basin were conducted as part of a program to evaluate the potential for storage of nuclear waste in salt deposits (Weir et al., 1983); one of these studies (Rush et al., 1982) included the area of the Green River tailings site.

A one-time sampling effort at the Green River tailings site was conducted by Geochemistry and Environmental Chemistry Research, Inc. (GECR) (GECR, 1983). Data from this report are from sampling and analyses of groundwater and surface water from background areas, the area adjacent to the site, and the site. Soils samples were collected and archived, and have not been analyzed. Because of questionable quality assurance and control on the water sample analyses from the GECR report, the data were not used for analyses in this report.

An unpublished report by the DOE (1983) on the Green River site contains the results of drilling, groundwater sampling, and aquifer hydraulic testing of eight monitor wells; surface water sampling of Brown's Wash adjacent to and downstream of the site; and climatological data for the vicinity. Some of the data from the DOE (1983) report were used in this report.

B.4.2 CURRENT INVESTIGATIONS

Hydrogeological data, including borehole logs, well completion records, groundwater elevations, aquifer hydraulic parameters, and water-quality data, were collected at the Green River tailings site by the DOE during three drilling and testing phases from the fall of 1985 to the fall of 1987. All field and laboratory procedures and calculations were performed in accordance with the DOE's Standard Operating Procedures as contained in the Albuquerque Operations Manual (DOE, 1985). Five two-inch diameter polyvinyl chloride (PVC) monitor wells, 28 four-inch diameter PVC monitor wells, and three two-inch diameter, low-carbon, galvanized steel well points were installed to characterize the Green River tailings and proposed disposal sites. The depths of these installations range from seven to 185 feet. Twelve exploratory geotechnical boreholes were also drilled, and ranged in depth from 16.5 to 32.5 feet. Lithologic logs were obtained from these boreholes prior to their abandonment. The locations of all monitor wells, abandoned boreholes, test pits, and surface-water sampling sites included in this investigation are shown in Figure B.4.1. Following installation and development of the monitor wells, slug injection/withdrawal tests and short-duration (less than 25 hours) pumping drawdown/recovery tests were performed to estimate the hydraulic properties of the aquifer materials within the screened zones of the wells. The monitor wells were surveyed and static groundwater elevations in the wells were measured to determine vertical and horizontal hydraulic gradients and directions of groundwater flow. Table B.4.1 summarizes monitor well information for the Green River tailings site.

B.4.3 SUPPLEMENTAL DRILLING, TESTING, AND HYDROLOGICAL CHARACTERIZATION

Between August and November, 1987, a supplemental (Phase III) field program was conducted to further characterize the hydrogeology at the Green River tailings site. A total of 16 additional monitor wells and one well point were installed. The field program had three principal objectives:

- To expand and refine the existing database for groundwater quality, and the extent of existing contamination and plume movement away from the tailings pile.
- To provide further characterization of the hydrogeology beneath the proposed disposal site and provide more detailed input to the design of the proposed disposal cell.
- To obtain geochemical and hydraulic information on the foundation and aquifer material beneath the proposed disposal site. This information was used as input to infiltration and geochemical models to estimate the effects of the proposed remedial action on the groundwater system.

B.4.4 CLIMATE

The climate in the vicinity of the Green River site is arid. As is characteristic of arid climates, vegetation is sparse in the tailings site area, except locally along the Green River and to a lesser degree along Brown's Wash (see Appendix C, Flora and Fauna). Average annual precipitation at Green River, Utah, is approximately six inches; monthly averages range from 0.30 inch in January to 0.96 inch in August (Table B.4.2). The mean annual Class A pan evaporation at Green River is approximately 60 inches (NOAA, 1982). The ratio of mean annual pan evaporation to mean annual precipitation is 10 to one. This large net evaporative loss would tend to minimize infiltration and would also tend to minimize contaminant migration.

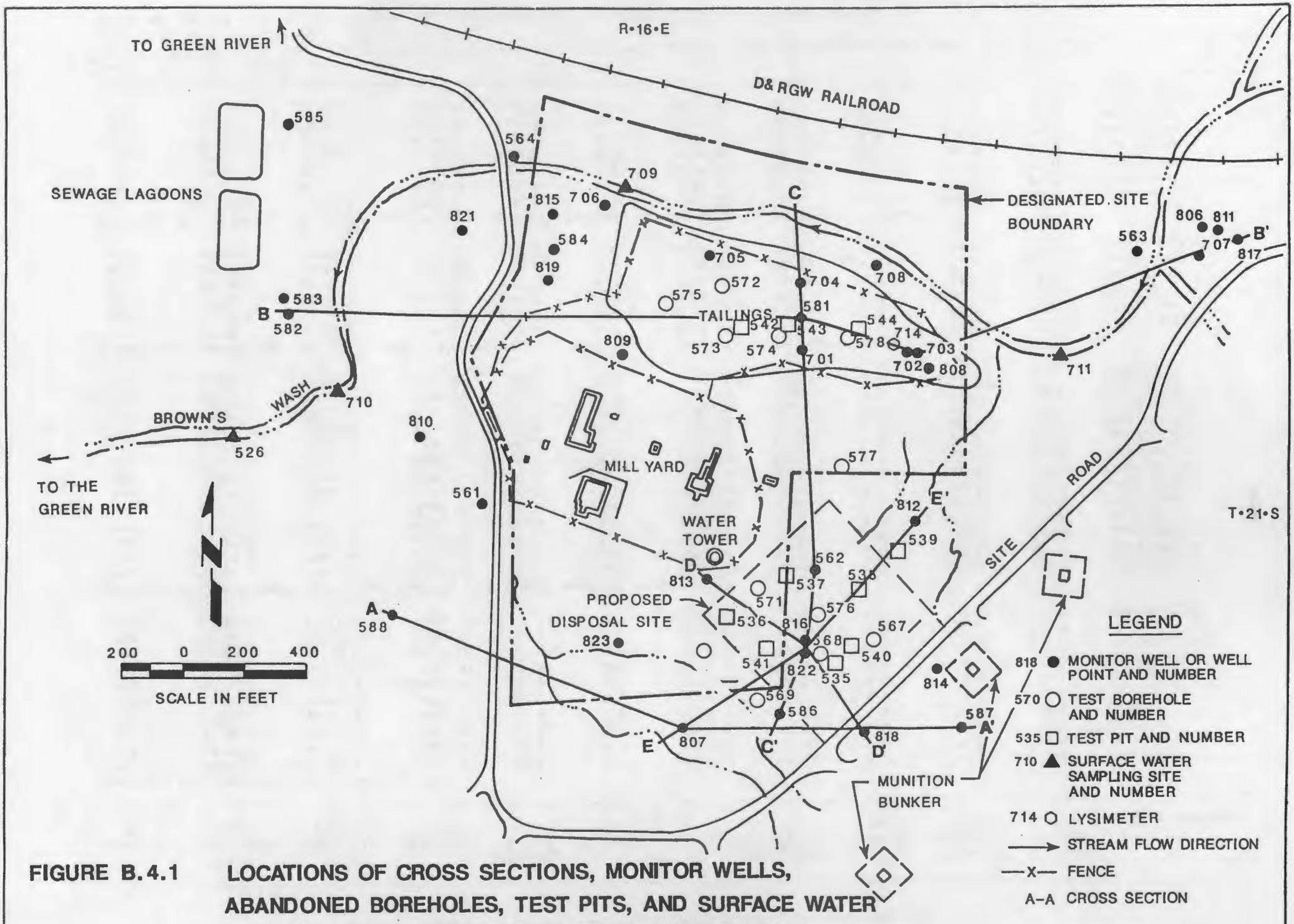


FIGURE B.4.1 LOCATIONS OF CROSS SECTIONS, MONITOR WELLS, ABANDONED BOREHOLES, TEST PITS, AND SURFACE WATER SAMPLING SITES, GREEN RIVER, UTAH, TAILINGS SITE

Table B.4.1 Monitor well data, Green River, Utah, tailings site

Location ID	North coordinate (ft)	East coordinate (ft)	Borehole			Well casing			Screened depth[a] (ft)	Interval length (ft)	Flow relationship
			Elevation (ft)	Depth[a] (ft)	Diameter (in)	Elevation (ft)	Depth[a] (ft)	Diameter (in)			
Formation of completion: Alluvium (top unit)											
563	60760.1	60003.5	4079.70	16.0	2.0	4081.10	16.0	2.0	10.0	5.0	Upgradient
564	60917.7	58100.1	4064.60	11.0	2.0	4068.10	11.0	2.0	5.0	5.0	Downgradient
702	60355.8	59295.1	4081.80	43.0	8.0	4082.60	26.0	4.0	15.0	8.0	On-site
704	60556.4	58941.0	4080.70	23.0	8.0	4082.10	23.0	4.0	15.0	8.0	On-site
705	60640.1	58665.7	4076.10	20.0	8.0	4078.30	20.0	4.0	14.0	6.0	On-site
706	60779.0	58379.2	4069.80	34.0	8.0	4070.90	18.0	4.0	8.0	6.0	Downgradient
707	60750.9	60224.0	4081.80	37.0	8.0	4083.10	16.0	4.0	9.0	6.0	Upgradient
708	60605.4	59218.6	4073.10	11.0	8.0	4074.70	11.0	4.0	7.0	4.0	Crossgradient
808	60317.9	59333.8	4082.27	25.0	8.0	4084.27	25.0	4.0	13.0	10.0	On-site
821	60689.9	57916.6	4065.32	7.0	2.0	4068.32	7.0	2.0	2.0	5.0	Downgradient
Formation of completion:[b] Shale (upper-middle unit, Cedar Mountain Formation)											
583	60462.5	57425.9	4065.60	56.5	6.0	4067.10	56.5	2.0	34.5	20.0	Downgradient
584	60654.2	58236.8	4072.10	50.0	6.0	4073.60	50.0	2.0	29.5	20.0	Downgradient
585	60925.6	57423.5	4067.60	50.0	6.0	4069.10	50.0	2.0	39.5	10.0	Downgradient
701	60330.9	58929.2	4087.00	57.0	8.0	4087.20	57.0	4.0	30.0	27.0	On-site
806	60839.6	60243.9	4082.00	67.0	8.0	4084.00	67.0	4.0	55.0	10.0	Upgradient
807	59155.2	58668.8	4139.14	100.0	8.0	4141.14	100.0	4.0	78.0	20.0	Upgradient
809	60371.1	58519.2	4080.30	70.0	8.0	4082.50	70.0	4.0	48.0	20.0	Downgradient
810	60011.6	57868.6	4098.76	80.0	8.0	4100.76	80.0	4.0	58.0	20.0	Downgradient
812	59740.3	59350.1	4142.75	59.0	8.0	4144.75	59.0	4.0	46.0	10.0	Upgradient
814	59377.7	59412.5	4143.03	60.0	8.0	4145.03	60.0	4.0	48.0	10.0	Upgradient
816	59392.3	59003.8	4141.26	60.0	8.0	4143.56	60.0	4.0	48.0	10.0	Upgradient
822	59366.8	59003.0	4140.64	35.0	8.0	4143.14	35.0	4.0	13.0	20.0	Upgradient
823	59408.0	58450.5	4132.86	30.0	8.0	4135.06	30.0	4.0	17.0	10.0	Upgradient
Formation of completion: Sandstone and conglomerate (lower-middle unit, Cedar Mountain Formation)											
561[c]	59838.7	58028.8	4108.70	143.5	6.0	4111.20	143.5	2.0	111.0	30.0	Crossgradient
562[c]	59585.9	59014.3	4143.60	130.0	6.0	4147.70	129.5	2.0	87.5	40.0	Upgradient
581	60450.2	58932.9	4083.30	85.0	8.0	4084.60	85.0	4.0	64.3	20.0	On-site
811	60818.9	60300.0	4082.83	80.0	8.0	4085.33	80.0	4.0	62.5	15.0	Upgradient
813	59622.2	58669.9	4135.10	99.5	8.0	4136.40	99.5	4.0	77.7	20.0	Upgradient
815	60738.7	58225.6	4071.53	100.0	8.0	4073.53	100.0	4.0	88.0	10.0	Downgradient
Formation of completion: Sandstone (bottom unit, Buckhorn Conglomerate Member of Cedar Mountain Formation)											
582	60427.0	57424.8	4065.50	168.5	8.0	4067.00	168.5	4.0	148.0	22.0	Downgradient
586	59171.8	58915.7	4142.40	166.5	8.0	4143.40	166.5	4.0	145.5	20.0	Upgradient
587	59177.2	59540.5	4167.90	185.0	8.0	4169.40	185.0	4.0	164.5	20.0	Upgradient
588	59445.0	57782.7	4112.20	145.0	8.0	4113.50	145.0	4.0	124.3	20.0	Upgradient
817	60794.8	60347.9	4083.31	145.0	8.0	4085.31	145.0	4.0	113.2	30.0	Upgradient
818	59145.1	59189.7	4150.58	187.0	8.0	4152.58	187.0	4.0	165.0	20.0	Upgradient
819	60583.3	58230.8	4072.70	166.0	8.0	4074.70	166.0	4.0	144.0	20.0	Downgradient

[a] Depth below land surface.

[b] Excludes monitor well 703. The bentonite seal breached in this well shortly after installation (DOE, 1983) and information from this well has been excluded from analyses.

[c] Wells 561 and 562 are screened in both the upper-middle and lower-middle hydrostratigraphic units.

Table B.4.2 Climatological data for Green River, Utah[a]

Month	Mean temperature(°F)	Precipitation (inches)
January	24.2	0.30
February	33.8	0.35
March	41.9	0.31
April	51.8	0.44
May	61.9	0.55
June	70.6	0.37
July	77.9	0.38
August	75.5	0.96
September	65.4	0.65
October	53.1	0.84
November	38.3	0.41
December	26.8	0.45
Annual	51.8	6.01

[a]Station: Green River Airport
Elevation: 4070 feet
Period: 1951 - 1972

Ref. NOAA, 1982.

Meteorological data from the Green River airport for 1975 and 1976 indicated an average wind speed of 4.2 miles per hour, with infrequent strong gusts coming from the south, southwest, north, and northwest (FBDU, 1981).

B.4.5 GEOLOGY AND HYDROSTRATIGRAPHY

B.4.5.1 Geology

The Green River site is in east-central Utah on the nose of a shallow, northward plunging anticline that is repeated by the arcuate east-northeast to west-northwest trending Little Grand Wash fault, which lies three miles to the south of the site. Bedrock exposed at the surface in the site area consists of sedimentary units of Cretaceous and Jurassic age. Rock units lying beneath the surface range in age from Jurassic to Pennsylvanian and, at depth, include the salt- and gypsum-bearing Paradox Member of the Pennsylvanian Hermosa Formation.

In descending sequence, the geologic units within 200 feet of the surface in the Green River site area are as follows:

- Brown's Wash alluvium beneath the present tailings pile, and alluvial terrace deposits beneath the proposed disposal site (Quaternary age).
- Tununk Shale Member of the Mancos Shale (Cretaceous age).
- Dakota Sandstone (Cretaceous age).
- Cedar Mountain Formation (Cretaceous age).

The Brown's Wash alluvium consists of a mixture of silt, sand, gravel, and some small cobbles. The alluvium is limited to an area that extends 300 to 400 feet on either side of Brown's Wash, and varies in thickness from zero to 35 feet. The tailings pile directly overlies the Brown's Wash alluvium. The terrace deposits consist mostly of silt and sand and are approximately 20 feet thick in the vicinity of the proposed disposal site.

The Tununk Shale Member of the Mancos Shale subcrops beneath the Brown's Wash alluvium in the eastern half of the site but is mostly eroded away by the channel of Brown's Wash in the western half of the site area. This unit is exposed in the east-central section of the site, and forms the bluff at the south end of the existing tailings pile. This shale unit forms a wedge that thins toward the south and probably disappears completely between the tailings pile and the proposed disposal site. The Tununk Shale consists of carbonaceous shale interbedded with thin beds of sandstone. South of the tailings pile, the Tununk Shale is probably between zero and 25 feet thick.

The Dakota Sandstone rests unconformably on top of the Cedar Mountain Formation. Although this unit is very thin in the site area (no more than 10 feet thick beneath the tailings pile) and is highly variable in thickness, it appears to extend both east and west of the tailings and disposal sites. The Dakota lies between unconformable contacts with either the Mancos Shale, the Brown's Wash alluvium, or the alluvial terrace deposits (top contact), and the Cedar Mountain Formation (bottom contact). In the site area, the Dakota Sandstone consists of fractured to unfractured, weathered to fresh sandstone, shale, and conglomerate. Where it has not been eroded away, the shale and dense, well-cemented sandstone and conglomerate of the Dakota Sandstone either are not saturated or only partly saturated beneath the tailings pile.

The Cedar Mountain Formation consists of mudstone, shale, limestone, sandstone, conglomerate, and occasional interbedded coal. The Cedar Mountain Formation lies unconformably beneath the Dakota Sandstone and in the site area is at least 150 feet thick. Fractured and unfractured sandstone, sandstone conglomerates, and fractured shales or limestones within the Cedar Mountain Formation are the primary water-bearing units.

B.4.5.2 Hydrostratigraphy

Figure B.4.1 shows the locations of cross sections (Figures B.4.2 through B.4.6) that show the hydrostratigraphy at the Green River tailings site. The surface topography shown on the cross sections was developed from a topographic survey of the site. Subsurface lithologic data were obtained from borehole logs, visual inspection of rock core, and correlation of subsurface data with surface geology.

Hydrological investigations have shown that horizontal and vertical fracturing occurs in the Dakota Sandstone and Cedar Mountain Formation beneath the proposed disposal site. Core samples from monitor wells 562, 807, 812, 813, 814, 816, and 818 at the disposal site (see Figure B.4.1) show that vertical and near-vertical fractures are present in the bedrock. The fractures start at the top of the bedrock section; the fracturing is uniform and consistent through the Cedar Mountain Formation at least in the upper 60 feet of bedrock. The degree of fracturing varies from moderate to intense and is typical of the fracturing observed in outcrops of the Cedar Mountain Formation in the vicinity of the disposal site. Fracturing of the bedrock beneath the present tailings pile is variable. The flowing monitor well (581), completed in the sandstone unit beneath the pile, is evidence that the confining unit for the sandstone unit at this location (the overlying shale) must be relatively impermeable. Evidence (aquifer hydraulic conductivities and water levels) suggests that joints, fractures, or minor faulting may be controlling groundwater flow in the shallow bedrock approximately along the alignment of Brown's Wash.

Within the upper 200 feet of Quaternary and Cretaceous sediments, four distinct water-bearing (hydrostratigraphic) units were defined at the Green River tailings site. These units are described as follows:

- The top hydrostratigraphic unit is the Brown's Wash alluvium. Groundwater in this unit is locally perched by the dense, well-cemented sandstone conglomerate of the Dakota Sandstone and the shale and limestone of the Cedar Mountain Formation (where these bedrock units are not fractured). Directly beneath the existing tailings pile, a paleochannel of Brown's

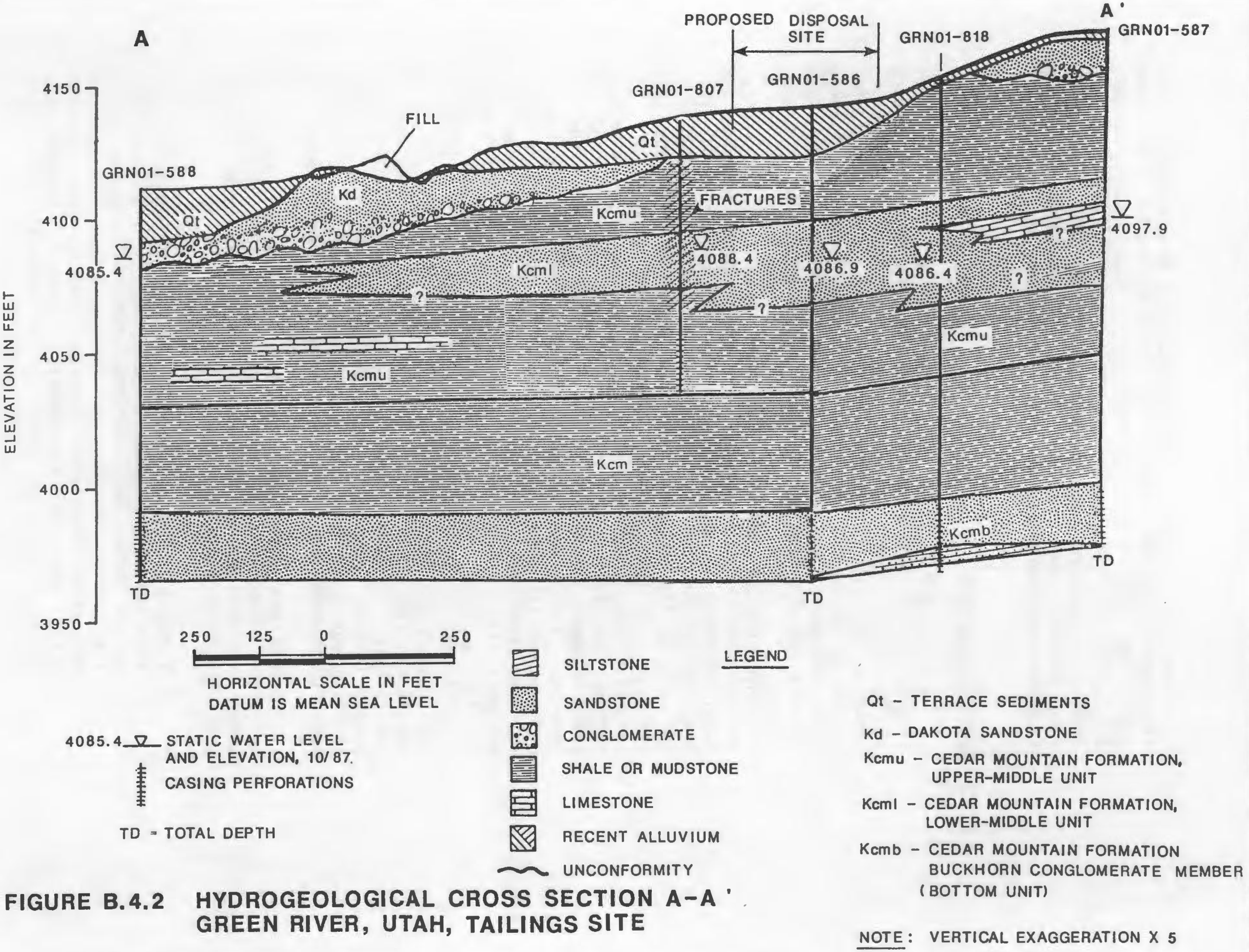


FIGURE B.4.2 HYDROGEOLOGICAL CROSS SECTION A-A '
GREEN RIVER, UTAH, TAILINGS SITE

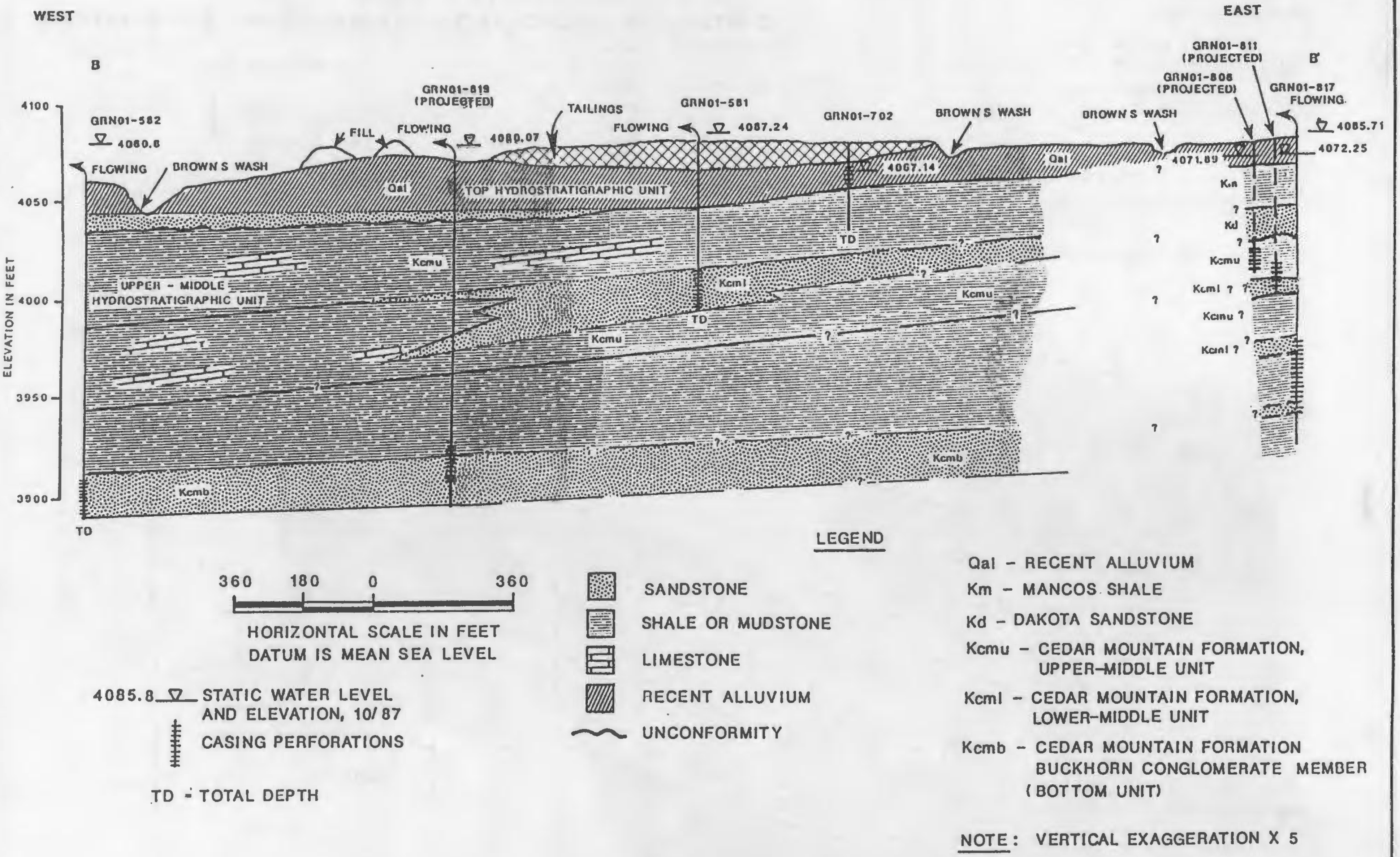


FIGURE B.4.3
HYDROGEOLOGICAL CROSS SECTION B-B'
GREEN RIVER, UTAH, TAILINGS SITE

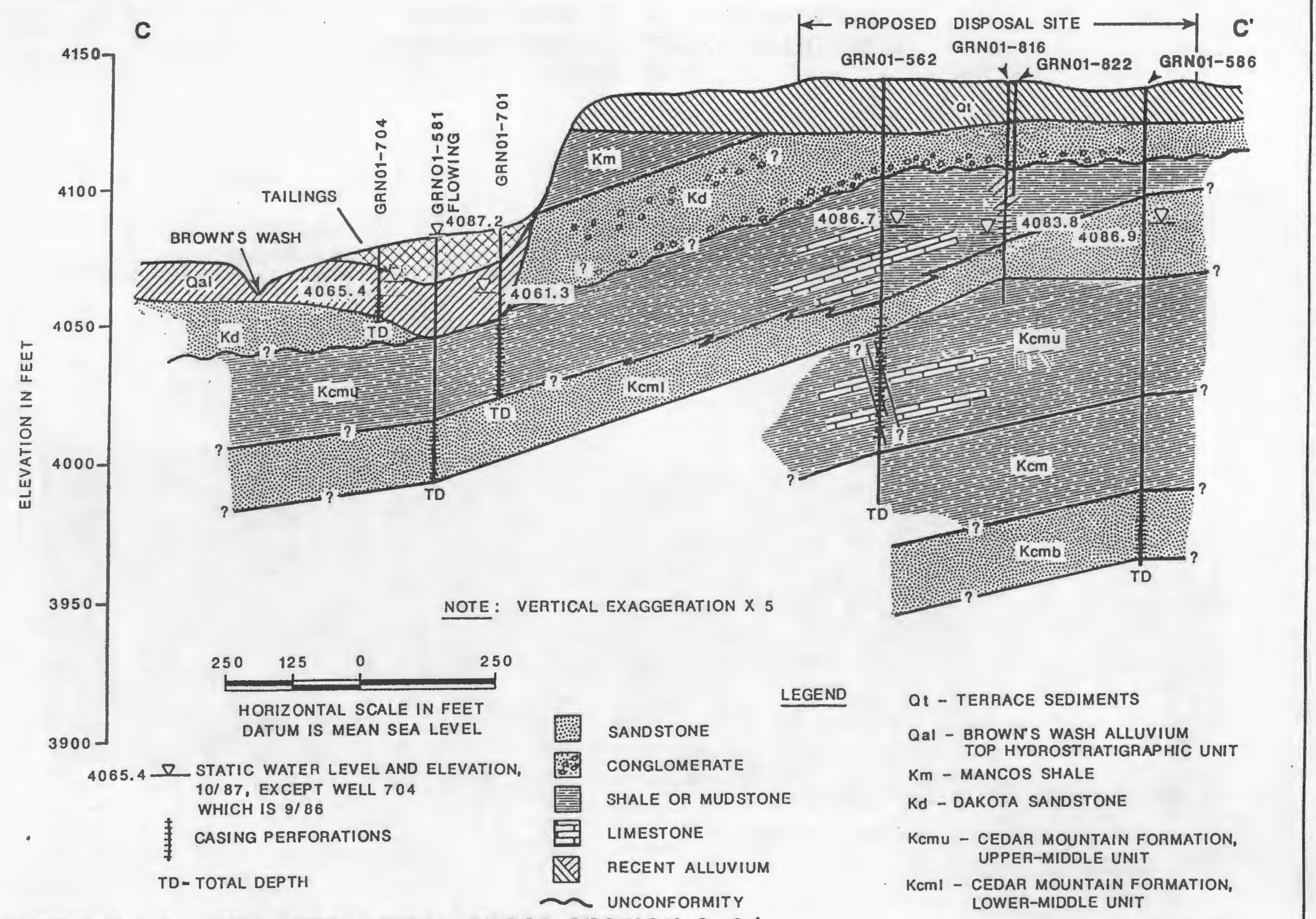


FIGURE B.4.4 HYDROGEOLOGICAL CROSS SECTION C-C' GREEN RIVER, UTAH, TAILINGS SITE

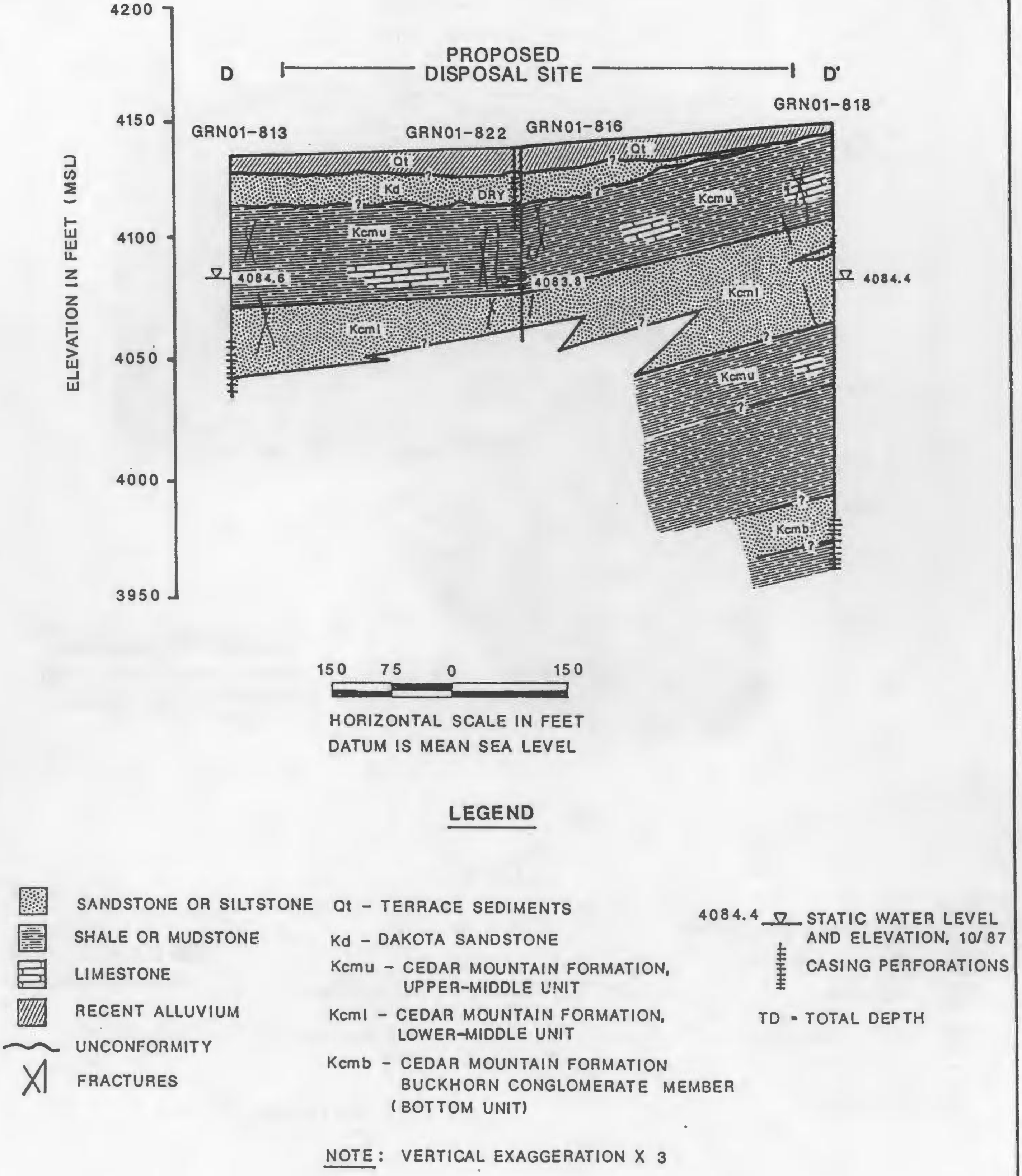
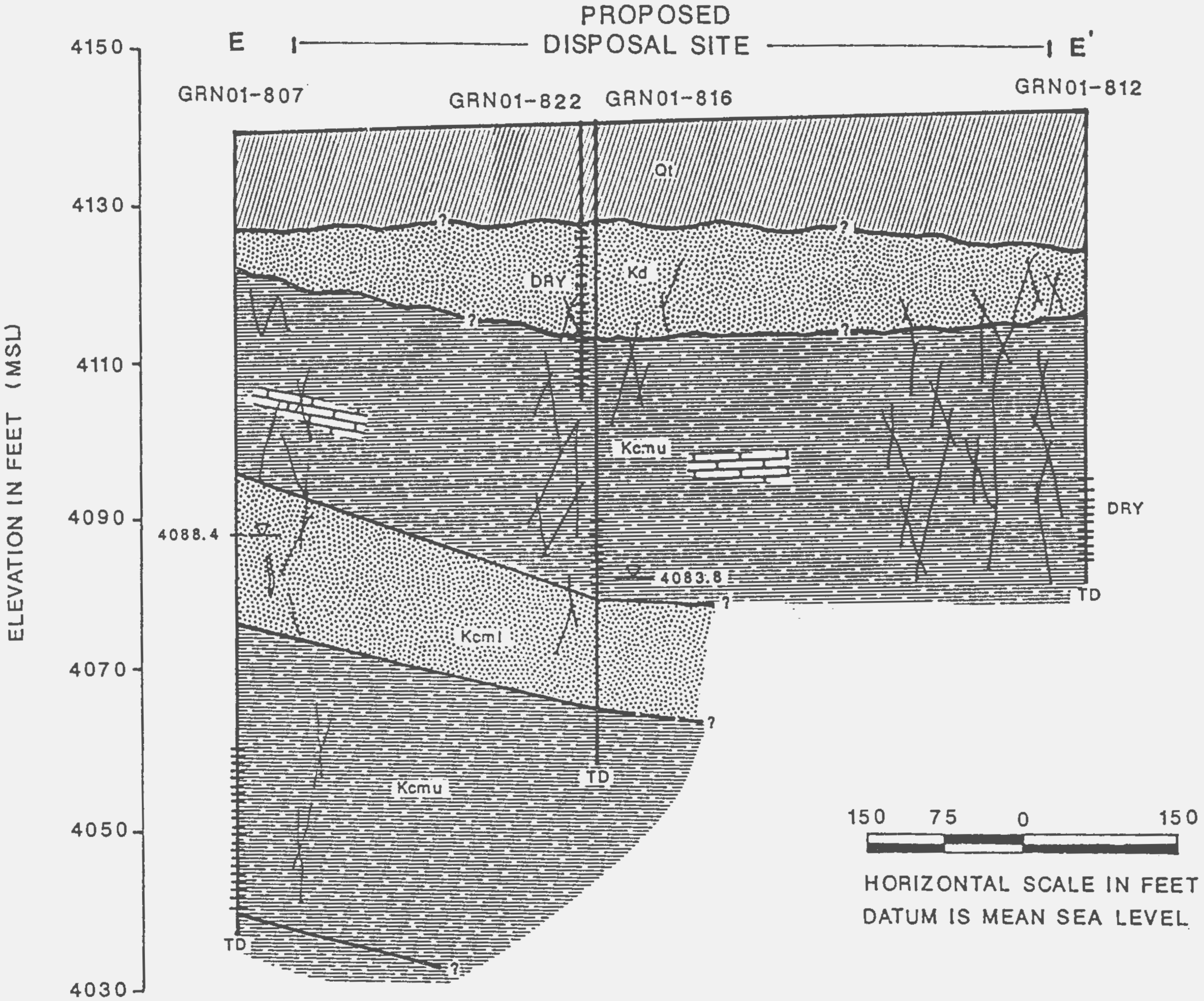


FIGURE B.4.5
HYDROGEOLOGICAL CROSS SECTION D-D'
GREEN RIVER, UTAH, TAILINGS SITE



LEGEND

- ▨ SANDSTONE OR SILTSTONE
- ▤ SHALE OR MUDSTONE
- ▦ LIMESTONE
- ▧ RECENT ALLUVIUM
- ~ UNCONFORMITY
- X FRACTURES

Qt – TERRACE SEDIMENTS

Kd – DAKOTA SANDSTONE

Kcmu – CEDAR MOUNTAIN FORMATION, UPPER-MIDDLE UNIT

Kcml – CEDAR MOUNTAIN FORMATION, LOWER-MIDDLE UNIT

4088.4 ▽ STATIC WATER LEVEL AND ELEVATION, 10/87

‡ CASING PERFORATIONS

TD = TOTAL DEPTH

NOTE: VERTICAL EXAGGERATION X 7.5

FIGURE B.4.6
HYDROGEOLOGICAL CROSS SECTION E-E '
GREEN RIVER, UTAH, TAILINGS SITE

Wash has eroded away the Dakota Sandstone, and the Brown's Wash alluvium directly overlies shale of the Cedar Mountain Formation. The Brown's Wash alluvium does not extend south of the tailings pile and is not present beneath the proposed disposal site.

- The upper-middle hydrostratigraphic unit is the alternating layers of shale, limestone, and mudstone of the Cedar Mountain Formation. This unit is continuous beneath the existing tailings pile and the proposed disposal site.
- The lower-middle hydrostratigraphic unit is a relatively thick, but laterally limited, sandstone and conglomerate channel deposit within the Cedar Mountain Formation. The lower-middle unit intertongues with the upper-middle unit and is continuous beneath the present tailings pile and the proposed disposal site.
- The bottom hydrostratigraphic unit is the Buckhorn Conglomerate Member of the Cedar Mountain Formation. This basal sandstone and sandstone conglomerate unit is 15 to 25 feet thick beneath the site area and is confined by overlying shale and mudstone. The Buckhorn conglomerate is continuous beneath the existing tailings pile and the proposed disposal site.

B.4.6 HYDRAULIC PARAMETERS

A summary of the hydraulic characteristics of the top, upper-middle, lower-middle, and bottom hydrostratigraphic units is presented in Table B.4.3. A number of methods were used to calculate values of hydraulic conductivity for the units. The methods of analyses include the following:

- Ferris-Knowles slug test analysis (Ferris and Knowles, 1963).
- Cooper, Bredehoeft, and Papadopulos slug test analysis (Cooper et al., 1967).
- Bouwer-Rice slug test analysis (Bouwer and Rice, 1967).
- Pumping drawdown analyses.
- Pumping recovery analyses.

Slug test data from monitor wells 561, 581, 582, 583, 584, 585, 586, 587, 588, 701, 704, 707, 806, 807, 811, 813, 815, and 818 were analyzed by the Ferris-Knowles method. This method is best suited for fully developed wells that are open to the full thickness of an artesian aquifer of small to moderate transmissivity (less than 50,000

Table B.4.3 Summary of aquifer hydraulic characteristics, Green River, Utah, tailings site

Monitor well number[a]	Hydrostratigraphic unit[a]	Tested interval (ft)[b]	Test method[c]	Average hydraulic conductivity (ft/day)[d]	Average transmissivity (ft^2/day)[e]	Average linear velocity (ft/day)[f]
702	Top	15-23.8	PD[g],BR[g]	32.8	289	0.92
704	Top	15-21.2	BR[g],FK,CBP	54.6	339	1.51
705	Top	14-18.6	BR[g]	16.4	75	0.55
706[h]	Top	8-12.5	BR[g]	3.3	15	NA
707	Top	9-12.6	BR[g],FK,CBP	226.3	815	2.19
808	Top	15.8-23.0	BR	11.1	79.9	0.92
583	Upper-Middle	33-53	FK,CBP	2.4	48	0.13
584	Upper-Middle	28-48	FK,CBP	2.4	48	0.12
585	Upper-Middle	28-41	FK,CBP	0.5	10	0.03
701	Upper-Middle	52-57	FK,CBP,BR[g]	17.0	85	0.71
806	Upper-Middle	55-65	FK,CBP	0.23	4.6	0.01
807	Upper-Middle	78-98	FK,CBP	0.0068	0.14	ND
561	Lower-Middle	115-145	FK,CBP	0.0055	0.17	ND
581	Lower-Middle	63-83	FK,PR	21.6	432	2.7
811	Lower-Middle	62.5-77.5	FK,CBP	0.22	3.28	0.02
813	Lower-Middle	77.7-97.7	FK,CBP,PD	4.53	90.8	0.19
815	Lower-Middle	88-98	FK,CBP	0.37	3.7	0.04
582	Bottom	146.5-166.5	FK,CBP,PR	3.6	72	0.072
586	Bottom	144.5-164.5	FK,CBP,PR	0.13	2.6	ND
587	Bottom	163-183	FK,CBP,PR	0.076	1.5	ND
588	Bottom	123-143	FK,CBP,PR	5.8	116	0.13
818	Bottom	165-185	FK,CBP	7.6	151	0.17

---

[a] See Figure B.4.1 for locations of monitor wells. Slug tests were unsuccessful for well 708 and no data are available. Well 561 is partially screened in the upper-middle unit. Wells 562 and 703 were not tested. Wells 586 and 587 were grout-contaminated at the time of testing, and hydraulic conductivity values are not representative of bottom unit. Well 807 is screened in the upper-middle unit below the lower-middle unit.

[b] Tested interval is in feet below land surface.

[c] PD is pumping drawdown (type-curve) method; PR is pumping recovery (single well) method; BR is Bouwer and Rice slug test method; FK is Ferris and Knowles slug test method; CBP is Cooper, Bredehoeft, and Papadopulos slug test method.

[d] Arithmetic average of all applied methods of analysis; wells 701, 704, and 707 have been tested twice.

[e] Average hydraulic conductivity multiplied by tested interval length.

[f] Average linear velocity calculated for silty, gravelly sand (top unit, assumed porosity of 0.30); shale and limestone (upper-middle unit, assumed porosity of 0.15); sandstone and sandstone conglomerate (lower middle unit, assumed porosity of 0.20); sandstone/conglomerate (bottom unit, assumed porosity of 0.20) (Walton, 1970). NA = not available; ND = not determined.

[g] Analyses by DOE (1983).

[h] Hydraulic conductivity at well 706 was measured shortly after drilling by DOE (1983), but the well has been dry for each sampling period thereafter.

gallons per day per foot (gpd/ft)); it is also suited to some unconfined aquifers (Ferris and Knowles, 1963). The Ferris-Knowles equation is as follows:

$$k = \frac{q(1/t)}{4\pi sL}$$

where

k = hydraulic conductivity (ft/day).

q = slugged volume (cubic ft).

t = time (days).

s = residual drawdown at time t_s (ft).

L = length of interval being tested (ft).

The values of 1/t and s are obtained from a straight-line fit through the plotted data points. These data are available from the UMTRA Project Office, Albuquerque, New Mexico.

Slug test data from monitor wells 561, 582, 583, 584, 585, 586, 587, 588, 701, 704, 707, 806, 807, 811, 813, 815, and 818 were analyzed using the Cooper, Bredehoeft, and Papadopulos (Cooper et al., 1967) method, which has requirements similar to the Ferris-Knowles method, and is as follows:

$$k = \frac{r^2}{tL}$$

where

k = hydraulic conductivity (ft/day).

r = radius of well casing (ft).

t = time for point in "matched-type curve" (days).

L = length of interval being tested (ft).

The value t is obtained by matching data points of residual drawdown versus time (log scale) to a "type curve" referenced by Cooper, Bredehoeft, and Papadopulos (Lohman, 1972).

Short-duration aquifer pumping tests were analyzed from monitor wells 581, 582, 586, 587, 588, and 813 by the single-well pumping drawdown or recovery method, formally recognized as the modified Theis nonequilibrium formula (Freeze and Cherry, 1979). The pumping drawdown or recovery formula is as follows:

$$k = \frac{264q}{sL}$$

where

k = hydraulic conductivity (gpd/ft^2).

q = average pumping rate for the duration of the test (gpm).

s = drawdown per one log cycle (ft).

L = length of interval being tested (ft).

An aquifer pumping drawdown test was conducted on alluvial well 702 (DOE, 1983). Also, slug tests were performed and analyzed from monitor wells 701, 702, 704, 705, 706, and 707 using the Bouwer-Rice method (DOE, 1983).

Assumptions inherent in the analyses of the aquifer hydraulic test data, regardless of the method of analysis, are as follows:

- The unit being tested is homogeneous and isotropic.
- The radius of the well is small in comparison to the extent of the aquifer.
- The removal of the slug and the development of initial, residual drawdown are instantaneous.
- The influence of the filter pack is negligible.

To obtain the average hydraulic conductivity values listed in Table B.4.3, values from each analysis were summed and an arithmetic mean was calculated. Wells 701, 704, and 707 were tested in 1983 and 1986. Alluvial wells 702, 705, and 706 were only tested in 1983. All other wells listed in Table B.4.3 were tested in 1986 and 1987.

Average linear velocities listed in Table B.4.3 were calculated as follows (Freeze and Cherry, 1979):

$$v = \frac{ki}{n}$$

where

v = average linear velocity (ft/day).

k = average saturated hydraulic conductivity (ft/day).

i = average hydraulic gradient (ft/ft).

n = assumed porosity of aquifer material (dimensionless).

More detailed discussions of the hydraulic characteristics of the four hydrostratigraphic units are presented in the following sections. Table B.4.4 presents static groundwater elevations in the monitor wells for four sampling periods: June, 1986; September, 1986; March, 1987; and October, 1987.

Table B.4.4 Groundwater elevations, Green River, Utah, tailings site

Well number	Elevation (top of casing)	Water elevation[a]			
		June 1986	September 1986	March 1987	October 1987
Top unit					
563	4081.1	4069.2	4070.1	4069.2	4069.6
564	4068.1	Dry	Dry	Dry	Destroyed
702	4082.6	4067.3	4068.3	4067.9	4067.1
704	4082.1	4065.2	4065.4	4065.4	Clogged
705	4078.3	4062.9	4063.3	4063.6	4062.7
706	4070.9	Dry	Dry	Dry	Dry
707	4083.1	4070.2	4070.9	4070.8	4069.7
708	4074.7	NS	4065.4	4066.7	Clogged
808	4084.3	NS	NS	NS	4068.1
821	4068.3	NS	NS	NS	Dry
Upper-middle unit					
583	4067.1	NS	4052.4	4051.0	4049.6
584	4073.6	NS	4058.8	4059.5	4058.2
585	4069.1	NS	4054.7	4055.2	4054.7
701	4087.9	4062.8	4062.7	4063.1	4061.3
806	4084.0	NS	NS	NS	4071.9
807[b]	4141.1	NS	NS	NS	4088.4
809	4082.5	NS	NS	NS	4058.6
810	4100.8	NS	NS	NS	4063.0
812	4144.8	NS	NS	NS	Dry
814	4145.0	NS	NS	NS	Dry
816	4143.6	NS	NS	NS	4083.8
822	4143.1	NS	NS	NS	Dry
823	4135.1	NS	NS	NS	Dry
Lower-middle unit					
561[b]	4111.2	4085.8	4084.3	4082.6	4081.0
562[b]	4147.7	4087.5	4088.3	4088.4	4086.7
581	4084.6	NS	Flowing(NM)	Flowing(NM)	4087.2
811	4085.3	NS	NS	NS	4072.3
813	4136.4	NS	NS	NS	4084.6
815	4073.5	NS	NS	NS	4068.5

Table B.4.4 Groundwater elevations, Green River, Utah, tailings site (Concluded)

Well number	Elevation (top of casing)	Water elevation[a] June 1986	September 1986	March 1987	October 1987
Bottom unit					
582	4067.0	NS	Flowing(NM)	Flowing(NM)	4080.8
586	4143.4	NS	4085.6	4087.6	4086.9
587	4169.4	NS	4086.3	4094.8	4097.9
588	4113.5	NS	4083.1	4086.2	4085.4
817[b]	4085.3	NS	NS	NS	4085.7
818	4152.6	NS	NS	NS	4086.4
819	4074.7	NS	NS	NS	4080.1

[a] NS = well was either not sampled or was not yet installed; NM = not measured; Destroyed = surface casing was destroyed and well could not be measured; Clogged = well sounder could not be lowered down the casing because of an obstruction in the well. The potentiometric surface in the flowing wells was measured by shutting the well in and measuring the shut in pressure and/or with a clear plastic riser hose, if possible.

[b] Monitor wells 561 and 562 partially screen the upper-middle and lower-middle units; monitor well 807 screens the upper-middle unit below the lower-middle unit; monitor well 817 probably does not screen the bottom unit (see text for explanation).

A preliminary characterization of the hydraulic properties of the Green River tailings was done. Table B.4.5 lists the results of a constant-head vertical hydraulic conductivity test on a remolded geotechnical test pit sample collected from within the tailings. Physical properties of soil samples from other boreholes within the tailings are also listed. The saturated hydraulic conductivity of the remolded tailings sample (92 percent compaction, ASTM D698) was calculated to be 5.8×10^{-4} centimeters per second (cm/s) and is considered representative of the tailings, which are a relatively uniform, well-sorted, silty sand. Complete mechanical properties and an analysis of the saturated hydraulic conductivity of the tailings are presented in Section B.5.

B.4.7 GROUNDWATER FLOW

B.4.7.1 Top hydrostratigraphic unit

Shallow, unconfined groundwater is present in Brown's Wash alluvium beneath the present tailings pile. As indicated in Figure B.4.4, this hydrostratigraphic unit is not present beneath the proposed disposal site area. The occurrence of

Table B.4.5 Permeability test results and physical properties from tailings samples, Green River, Utah, tailings site[a]

Borehole number	Sample interval (feet)	USCS class[b]	Tailings type	In-situ moisture content (percent)	Dry density (pcf)[c]	Saturated hydraulic conductivity (cm/s)[d]	Type of test
542	0.5-1.5	SP-SM	Sand	--	--	5.8×10^{-4}	C[e]
572	3.5-4.5	SP-SC	Sand	1.6	--	--	--
	6.5-7.5	SP-SC	Sand	4.0	--	--	--
	9.5-10.5	SP-SM	Sand	5.6	--	--	--
	12.8-13.5	SP-SM	Sand	15.5	--	--	--
574	2.5-3.5	SP-SM	Sand	1.2	103.6	--	--
	7.0-7.5	SP-SM	Sand	4.7	86.7	--	--
575	2.5-3.0	SP-SM	Sand	1.3	97.6	--	--
	7.0-8.0	SM	Sand	4.7	--	--	--
	13.0-14.0	SP-SM	Sand	5.0	--	--	--
578	2.5-3.0	SP-SM	Sand	2.2	90.1	--	--
	5.5-6.5	SP-SM	Sand	3.4	--	--	--
	7.0-8.0	SM	Sand	6.1	--	--	--
	10.0-11.0	SC	Sand	5.3	--	--	--

[a] Borehole locations are shown on Figure B.4.1. Blanks indicate the properties were not determined.

[b] Unified Soil Classification System; SP is poorly graded sands, gravelly sands; SM is silty sands, sand-silt mixtures; SC is clayey sands, sand-clay mixtures.

[c] pcf = pounds per cubic foot.

[d] cm/s = centimeters per second.

[e] C = constant-head test; the sample was remolded to average in-situ density and moisture content of sample tubes.

this shallow groundwater is limited by the lateral extent of the alluvium. The top unit is a maximum of 600 feet wide near the tailings pile. Monitor wells 702, 704, 705, 706, 707, 708, 808, and well points 563, 564, and 821 are completed in this unit.

A water table contour map of the top hydrostratigraphic unit (Figure B.4.7) was developed from water level data and the surveyed elevations of the wells in October, 1987 (see Table B.4.4). The depth to groundwater ranges from nine to 17 feet below the surface in the top unit. The hydraulic gradient within the top unit ranges from 0.0029 ft/ft near monitor well 707 to 0.0125 ft/ft near monitor wells 702 and 808.

Table B.4.6 presents a summary of aquifer hydraulic characteristics for the top hydrostratigraphic unit. The calculated geometric mean linear velocity of groundwater in the top unit is 1.14 ft/day. Groundwater in the top unit is recharged by flow from the upper-middle shale unit from the south, and by infiltration of surface runoff and precipitation in the channel of Brown's Wash. Groundwater discharges from Brown's Wash alluvium into the channel of Brown's Wash at a point west of the tailings pile where the site access bridge crosses Brown's Wash (see Figure B.4.1). From this point west to the Green River, the Dakota Sandstone and Cedar Mountain Formation inhibit the downward movement of water in the channel; however, a portion of this water likely infiltrates into the bedrock, especially where fractures are present. Water that flows west in the channel eventually mixes with backwater from the Green River (at surface-water sampling site 526, shown on Figure B.4.1).

Groundwater also discharges from the Brown's Wash alluvium into the underlying upper-middle shale unit of the Cedar Mountain Formation, to the atmosphere as evaporation, and to the tamarisk vegetation that lines the channel of Brown's Wash. The DOE (1988b) measured the base flow in Brown's Wash channel in November, 1985, at 2.3 gallons per minute (gpm). The measurement was made immediately west of the access bridge to the site near well point 564 (see Figure B.4.1). The remainder of the shallow alluvial groundwater from beneath the present tailings pile is lost to evapotranspiration and vertical downward leakage into the Cedar Mountain Formation. Since well points 564 and 821 and monitor well 706 are dry (see Figure B.4.1), very little flow is assumed to move downgradient to the alluvium west of monitor wells 706.

The groundwater flux through the top hydrostratigraphic unit beneath the present tailings pile can be estimated by using Darcy's Law (Todd, 1980) as follows:

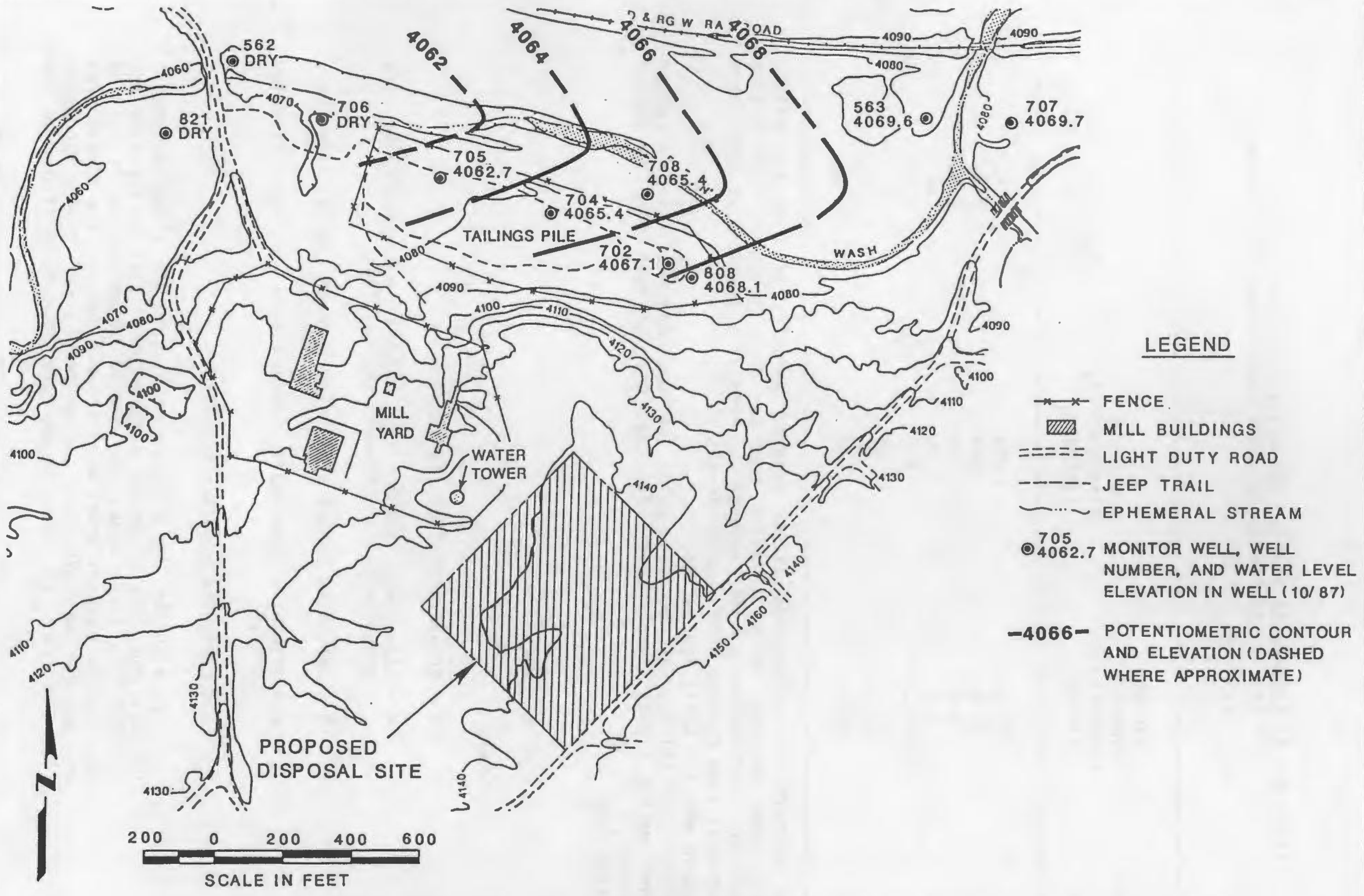


FIGURE B.4.7

WATER TABLE CONTOUR MAP AND MONITOR WELLS, TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER , UTAH, TAILINGS SITE, OCTOBER, 1987

Table B.4.6 Summary of aquifer hydraulic characteristics for the top hydrostratigraphic unit, Green River, Utah, tailings site[a]

Monitor well number	Average hydraulic conductivity (ft/day)	Average transmissivity (ft^2/day)	Average linear velocity (ft/day)
702	32.8	289	0.92[b]
704	54.6	339	1.51
705	16.4	75	0.55
706[c]	3.3	15	NA
707	226.3	815	2.19
808	11.1	80	b
mean[d]	25.0	139	1.14

[a] Linear velocity is a function of an assumed porosity of 0.30 for silty, gravelly sand (Walton, 1970); ft/day = feet per day; ft^2/day = feet squared per day; NA = not available (see Footnote c); hydraulic gradient is calculated at each well from October, 1987, water levels.

[b] Average of monitor wells 702 and 808.

[c] Hydraulic conductivity at monitor well 706 was measured shortly after drilling by DOE (1983), but the well has been dry for each sampling period thereafter.

[d] Geometric mean.

$$Q = WDki$$

where

Q = groundwater flux (ft^3/day).

W = saturated width of aquifer perpendicular to groundwater flow beneath the tailings.

D = saturated height of aquifer beneath the tailings (ft).

k = saturated hydraulic conductivity of the alluvium (ft/yr).

i = hydraulic gradient (ft/ft).

To calculate the groundwater flux in the alluvium beneath the tailings, the projected area perpendicular to the flow was divided into three areas represented by monitor wells 702 and 808 for the eastern area; monitor well 704 for the middle area and monitor well 705 for the western area. The groundwater flux for each of these areas and the total flux in the alluvium beneath the tailings is summarized in Table B.4.7. The total flux is estimated to be 9.9 gpm beneath the tailings.

B.4.7.2 Upper-middle hydrostratigraphic unit

Confined and semiconfined groundwater is present in the upper-middle unit beneath the Green River tailings site. This unit consists mostly of limestone and shale of the Cedar Mountain Formation. Beneath the tailings and the proposed disposal site, the upper-middle unit is separated into two units by a sandstone and conglomerate channel deposit. To the west and east of the tailings and proposed disposal site this sandstone and conglomerate is not present or intertongues as thin layers with the upper-middle shale unit (see Figures B.5.2 through B.5.4).

Beneath the proposed disposal site, fracturing occurs in the upper- and lower-middle units. A total of six core holes were drilled beneath and peripheral to the proposed disposal site. Core from all of these holes shows moderate to intense vertical and horizontal fracturing and fractures extending from the upper-middle unit down into the lower-middle unit (DOE, 1988b). Monitor wells completed in the upper-middle unit include 583, 584, 585, 701, 806, 807 (completed below the sandstone and conglomerate channel deposit), 809, 810, 812, 814, 816, 822, and 823. Monitor wells 812, 814, 816, 822, and 823 were installed at the disposal site; only well 816 encountered groundwater (at a depth of 60 feet). Depth to groundwater in the upper-middle unit beneath the tailings surface is about 26 feet at monitor well 701.

A potentiometric contour map of the upper-middle hydrostratigraphic unit (Figure B.4.8) was developed from water level data and the surveyed water elevations in the wells in October, 1987 (see Table B.4.4). The hydraulic gradient within the upper-middle hydrostratigraphic unit ranges from 0.0063 to 0.0083 ft/ft. Groundwater flux in the upper-middle unit is controlled by fractures, joints, or minor faulting, which is most evident in the vicinity of the tailings pile. A "trough" is present in the potentiometric surface; it trends east-west and is just south of the channel of Brown's Wash (see Figure B.4.8). Groundwater flux in the upper-middle unit is also controlled by vertical recharge from the overlying alluvial aquifer and the underlying lower-middle unit.

Table B.4.8 presents a summary of aquifer hydraulic characteristics for the upper-middle unit. The calculated average linear velocity of groundwater in the upper-middle unit ranges between 0.01 and 0.71 ft/day; the geometric mean velocity is 0.08 ft/day. Groundwater flux through the upper-middle unit beneath the present tailings pile was calculated based on the calculated hydraulic conductivities and water

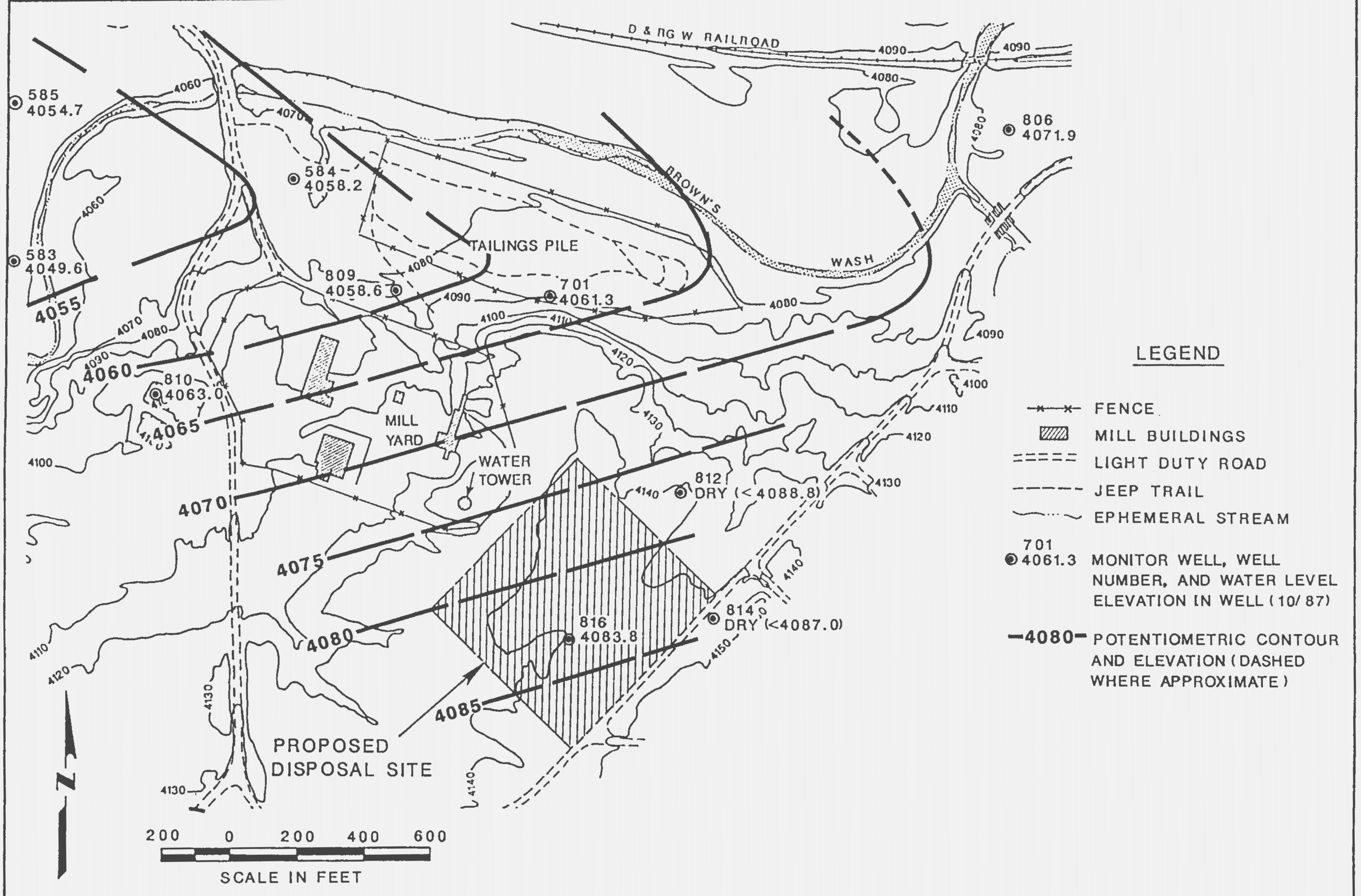


FIGURE B.4.8

POTENTIOMETRIC CONTOUR MAP AND MONITOR WELLS, UPPER - MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE, OCTOBER, 1987

Table B.4.7 Groundwater flux within the top hydrostratigraphic unit beneath the present tailings, Green River, Utah, tailings site

Flux component	Monitor wells 702 and 808	Monitor well 704	Monitor well 705
v (ft/day)[a]	0.28	0.45	0.17
W (ft)[b]	300	275	425
D (ft)[c]	9.7	6.3	4.4
Q (ft^3/s)[d]	0.0094	0.0090	0.0036
Q (gpm)[d]	4.2	4.1	1.6
Total flux = 4.2 + 4.1 + 1.6 = 9.9 gpm			

---

[a] Groundwater velocity; ft/day = feet per day.

[b] Width perpendicular to groundwater flow beneath the tailings pile represented by the respective well(s).

[c] Depth of flow represented by the depth of water in the respective well(s).

[d] Groundwater flux for incremental area represented by the respective well(s); ft^3/s = cubic feet per second; gpm = gallons per minute.

levels from monitor wells 584 and 701. The method for calculating groundwater flux was the same as that used to calculate flux through the top hydrostratigraphic unit. The total flux is estimated to be 4.9 gpm beneath the tailings in the upper-middle unit (Table B.4.9).

B.4.7.3 Lower-middle hydrostratigraphic unit

The lower-middle unit is the sandstone and conglomerate channel deposit within the upper-middle unit of the Cedar Mountain Formation. This unit is a maximum of 30 feet thick and is confined in the area of the present tailings pile by overlying shales and limestones of the upper-middle unit. The lower-middle unit does not appear to be present, or it intertongues as thin lenses with the limestone and shale, east and west of the tailings (see Figures B.4.2 through B.4.4). Monitor well 581 is drilled and completed in this unit beneath the tailings, and it flows at the surface. Monitor wells 561 and 562 are screened in both the upper-middle and lower-middle units and data collected from these wells may not represent actual conditions in either unit. However, monitor well 562 is completed beneath the proposed disposal site and well 561 is west of the disposal site; because of the fracturing present in the upper-middle and lower-middle units at the disposal site these two units are probably somewhat hydraulically connected, and the screened intervals in monitor wells 561 and 562 probably include the zone of hydraulic

Table B.4.8 Summary of aquifer hydraulic characteristics for the upper-middle hydrostratigraphic unit, Green River, Utah, tailings site[a]

Monitor well number	Average hydraulic conductivity (ft/day)	Average transmissivity (ft^2/day)	Average linear velocity (ft/day)
583	2.4	48	0.13
584	2.4	48	0.12
585	0.5	10	0.03
701	17.0	85	0.71
806	0.2	5	0.01
mean[b]	1.6	25	0.08

[a] Linear velocity is a function of an assumed porosity of 0.15 for shale and limestone (Walton, 1970); ft/day = feet per day; ft^2/day = square feet per day; hydraulic gradient is calculated at each well from October, 1987, water levels.

[b] Geometric mean.

connection. Other monitor wells drilled and completed in the lower-middle unit include 811, 813, and 815. Background monitor well 811, east of the tailings pile near Brown's Wash (see Figure B.4.1), encountered only thin, separated lenses of sandstone that are probably of the lower-middle unit.

A potentiometric contour map of the lower-middle unit (Figure B.4.9) was developed from water level data for October, 1987 (see Table B.4.4), and the surveyed elevations of the monitor wells. The potentiometric surface in the lower middle unit is two to three feet above the surface of the tailings at monitor well 581. The depth to water in this unit is approximately 60 feet at the proposed disposal site. The hydraulic gradient within the lower-middle unit ranges from 0.0083 to 0.025 ft/ft.

The flow of groundwater in the lower-middle unit is strongly influenced by the dip of the unit, its limited lateral extent to the east and west, and its recharge by underlying aquifers. Rock cores from monitor wells 562, 807, and 813 indicate this unit is fractured and is probably hydraulically connected with the overlying upper-middle shale unit beneath the proposed disposal site; however, the lower-middle unit is confined by the shale beneath the present tailings. Additionally, monitor well 581, which is drilled and completed in the lower-middle unit, flows at the surface. The strong, vertically upward hydraulic gradient between the

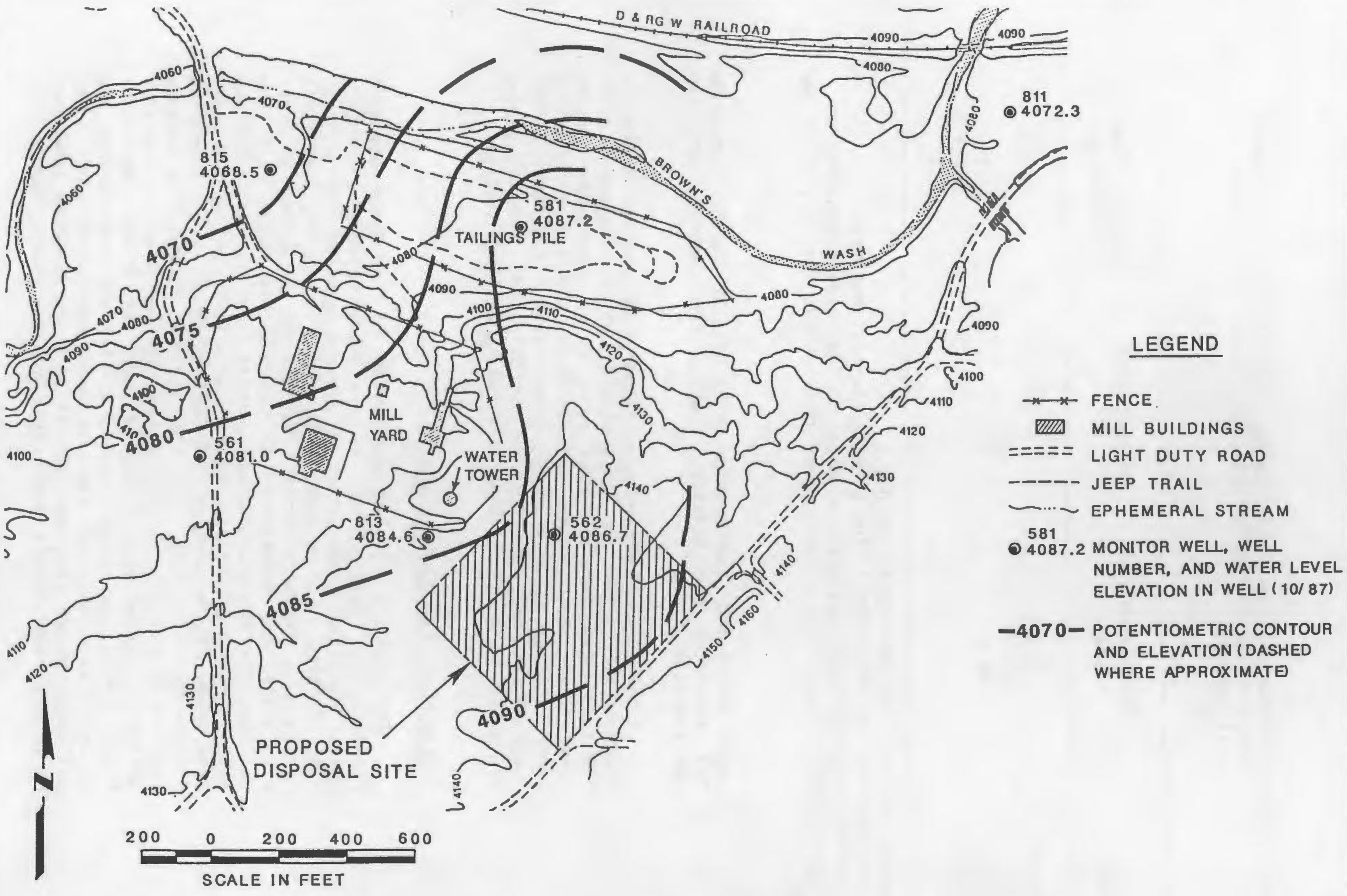


FIGURE B.4.9

POTENTIOMETRIC CONTOUR MAP AND MONITOR WELLS, LOWER - MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER , UTAH, TAILINGS SITE, OCTOBER, 1987

Table B.4.9 Groundwater flux within the upper-middle hydrostratigraphic unit beneath the present tailings, Green River, Utah, tailings site

Flux component	Monitor well 584	Monitor well 701	Average of monitor wells 584 and 701
v (ft/day)[a]	0.018	0.107	0.063
W (ft)[b]	450	450	450
D (ft)[c]	34.6	31.1	32.9
Q (ft^3/s)[d]			0.011
Q (gpm)[d]			4.9

[a] Groundwater velocity; ft/day = feet per day.

[b] Width perpendicular to groundwater flow beneath the tailings pile.

[c] Depth of flow represented by the depth of water in the respective well(s).

[d] Total groundwater flux; ft^3/s = cubic feet per second; gpm = gallons per minute.

upper-middle and lower-middle units beneath the tailings pile has prevented any tailings seepage from moving into the lower-middle unit.

Table B.4.10 presents a summary of aquifer hydraulic characteristics for the lower-middle hydrostratigraphic unit. The calculated average linear velocity of groundwater in the lower-middle unit ranges between 0.02 and 2.7 ft/day; the geometric mean is 0.14 ft/day. Groundwater flux through the lower-middle unit beneath the tailings was not calculated since this unit has not been affected by tailings seepage.

B.4.7.4 Bottom hydrostratigraphic unit

The Buckhorn Conglomerate Member of the Cedar Mountain Formation has been defined as the bottom hydrostratigraphic unit. Confined groundwater is present beneath the tailings site vicinity in this unit. The unit is 15 to 25 feet thick in the site vicinity and is confined by the maroon to gray-blue shales and mudstones that separate the bottom unit from the overlying hydrostratigraphic units. Monitor wells 582 and 819, drilled and completed near Brown's Wash west of the tailings, flow at the surface. The other monitor wells completed in this formation (586, 587, 588, and 818) do not flow because they are at a higher elevation than the flowing wells. Monitor well 817, located east of the tailings near Brown's Wash (see Figure B.4.1), was thought to be drilled and completed in the bottom unit. Detailed analyses and comparisons with other well data showed that well 817 is probably screened somewhere below the lower-middle unit (see Figure B.4.3). Because of

Table B.4.10 Summary of aquifer hydraulic characteristics for the lower-middle hydrostratigraphic unit, Green River, Utah, tailings site[a]

Monitor well number	Average hydraulic conductivity (ft/day)	Average transmissivity (ft^2/day)	Average linear velocity (ft/day)
581	21.6	432	2.70
811	0.2	3	0.02
813	4.5	91	0.19
815	0.4	4	0.04
mean[b]	1.7	26	0.14

[a] Linear velocity is a function of an assumed porosity of 0.20 for sandstone and conglomerate (Walton, 1970); ft/day = feet per day; ft^2/day = feet squared per day; hydraulic gradient is calculated at each well from October, 1987, water levels.

[b] Geometric mean.

the uncertainty associated with the completion of monitor well 817, data from the well have not been included in hydrogeologic analyses of any of the units.

A potentiometric contour map of the bottom unit (Figure B.4.10) was developed from water level data for October, 1987 (see Table B.4.4), and the surveyed elevations of the monitor wells. The potentiometric surface in the bottom unit is five to 14 feet above land surface in the vicinity of the present tailings, and 56 to 71 feet below land surface in the vicinity of the proposed disposal site. The hydraulic gradient within the bottom unit ranges from 0.040 to 0.044 ft/ft.

Table B.4.11 presents a summary of aquifer hydraulic characteristics for the bottom unit. The calculated average linear velocity of groundwater in the bottom unit ranges from 0.072 to 0.17 ft/day; the geometric mean is 0.12 ft/day. Groundwater flux through the bottom unit beneath the tailings was not calculated since tailings seepage has not affected this unit. Because of overlying confining layers and strong, vertically upward hydraulic gradients between the bottom unit and the two presently contaminated units, the bottom unit will not become contaminated from tailings seepage.

B.4.7.5 Vertical hydraulic gradients

Strong, vertically upward hydraulic gradients exist between the bedrock units in the vicinity of the Green River

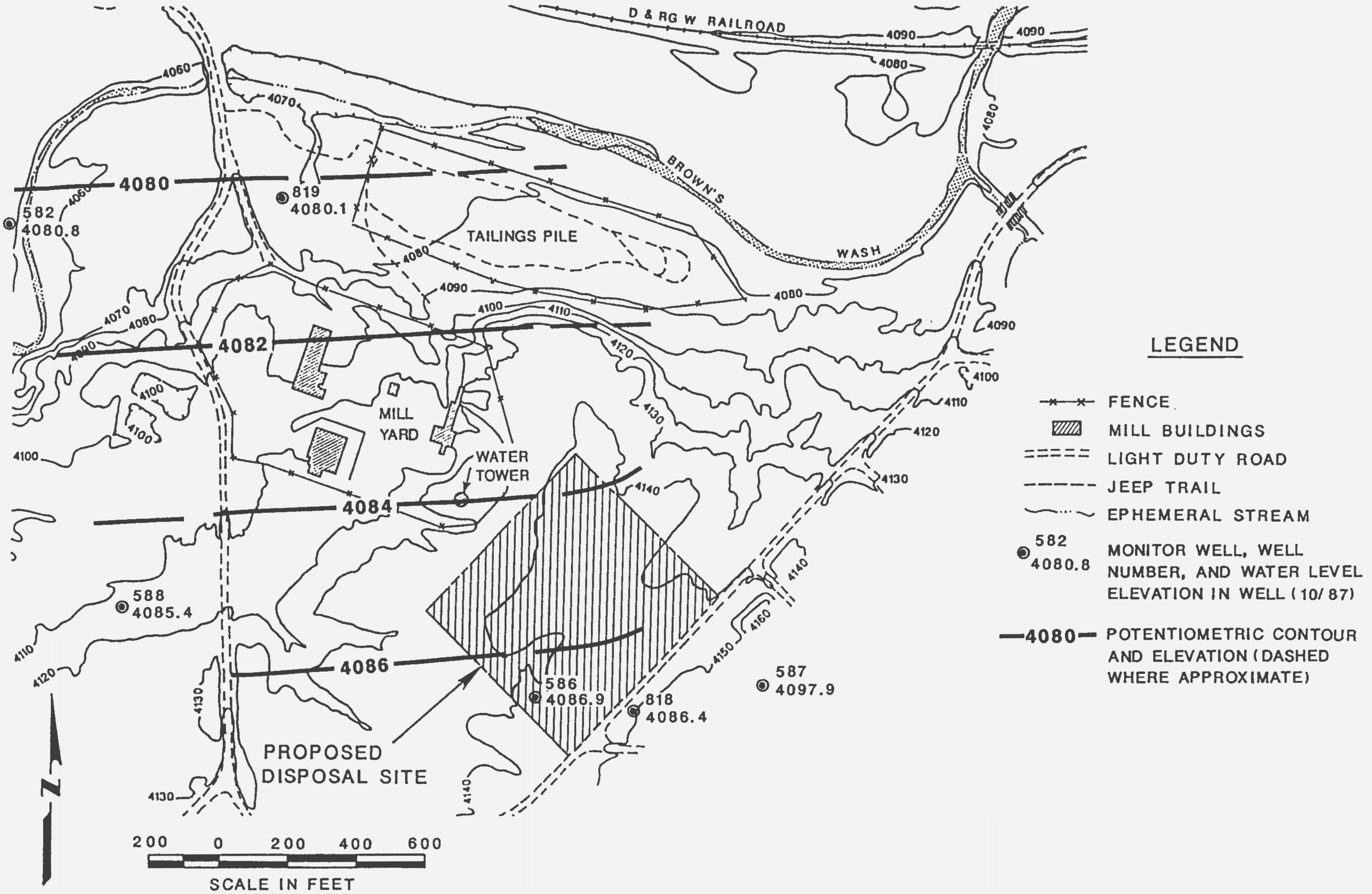


FIGURE B.4.10

POTENTIOMETRIC CONTOUR MAP AND MONITOR WELLS, BOTTOM HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE, OCTOBER, 1987

Table B.4.11 Summary of aquifer hydraulic characteristics for the bottom hydrostratigraphic unit, Green River, Utah, tailings site[a]

Monitor well number	Average hydraulic conductivity (ft/day)	Average transmissivity (ft^2/day)	Average linear velocity (ft/day)
582	3.6	72	0.07
588	5.8	116	0.13
818	7.6	151	0.17
mean[b]	5.3	103	0.12

[a] Linear velocity is a function of an assumed porosity of 0.20 for sandstone and conglomerate (Walton, 1970); ft/day = feet per day; ft^2/day = feet squared per day; hydraulic gradient is calculated at each well from October, 1987, water levels.

[b] Geometric mean.

tailings site. These gradients have prevented the downward movement of tailings seepage into the lower-middle and bottom hydrostratigraphic units beneath the present tailings pile. Beneath the proposed disposal site these gradients may limit the amount of mixing of any tailings seepage (as a result of the proposed remedial action) between the upper-middle and lower-middle units. Additionally, the strong gradients will restrict the movement of any tailings seepage into the bottom unit. Tables B.4.12 and B.4.13 summarize the vertical hydraulic gradients at the present tailings site and the proposed disposal site, respectively.

B.4.8 TAILINGS SOURCE CHARACTERIZATION

The tailings pile at the Green River site covers eight acres in area. The tailings are not presently saturated and there is no evidence of a groundwater mound beneath the tailings. Based on the available monitor well and water level information, the depth to groundwater beneath the base of the tailings ranges from four to ten feet.

The tailings are a fairly well-sorted sand with some silt. A remolded, constant-head hydraulic conductivity test on a tailings sample showed the saturated hydraulic conductivity was 5.8×10^{-4} cm/s (see Table B.4.5). This value is probably representative of the tailings (under 92 percent compaction) since there are no slimes within the pile and the tailings are uniform in texture. Under natural, uncompacted conditions, the vertical hydraulic conductivity is probably greater than 5.8×10^{-4} cm/s. The horizontal hydraulic conductivity

Table B.4.12 Summary of vertical hydraulic gradients beneath the present tailings pile, Green River, Utah, tailings site[a]

	Top unit	Upper-middle unit	Lower-middle unit	Bottom unit
Top unit	--	0.12 downward	0.38 upward	0.11 upward
Upper-middle unit	--	--	0.87 upward	0.16 upward
Lower-middle unit	--	--	--	0.07 downward

[a] Gradient values are in foot per foot. Gradients were calculated using October, 1987, water levels at the areal center of the tailings pile; the vertical distance between units was measured from cross section B-B' on Figure B.4.3.

Table B.4.13 Summary of vertical hydraulic gradients beneath the proposed disposal site, Green River, Utah, tailings site[a]

	Top unit	Upper-middle unit	Lower-middle unit	Bottom unit
Top unit	(The top unit is not present at the disposal site)[b]			
Upper-middle unit	--	--	0.55 upward	0.03 upward
Lower-middle unit	--	--	--	0.02 downward

[a] Gradient values are in foot per foot. Gradients were calculated using October, 1987, water levels at the areal center of the disposal site; the vertical distance between units was measured from cross section C-C' in Figure B.4.4.

[b] Groundwater is first encountered at a depth of about 60 feet beneath the proposed disposal site (near the contact of the upper-middle unit with the lower-middle unit).

of the underlying Brown's Wash alluvium (top hydrostratigraphic unit) is near 1 x 10^{-2} cm/s, based on average hydraulic conductivities at monitor wells 702, 704, 705, and 708 (see Table B.4.6). Considering that the alluvium is anisotropic (Bouwer, 1978), the vertical hydraulic conductivity is probably in the range of 5 x 10^{-3} to 1 x 10^{-3} cm/s.

C. W. Thornthwaite Associates (1964) and the DOE (1983) have calculated the net infiltration of annual precipitation to groundwater (deep percolation) for Green River, Utah. Both studies independently calculated the ratio of yearly precipitation to yearly actual evapotranspiration to be unity; that is, no water percolates to the groundwater from precipitation. In reality, there is some very small, discrete quantity of water that reaches the groundwater system when climate conditions allow deep percolation (i.e., sustained rainfalls or melting snow cover; Walton, 1970). Several investigators have estimated recharge to groundwater from direct precipitation. For Goshen County, Wyoming, Rapp et al. (1957) estimated that five percent of the mean annual precipitation of 14 inches, or 0.70 inch per year, recharges the groundwater system. Also in Wyoming, Morgan (1946) estimated that six percent of the average annual precipitation, or 0.84 inch per year, recharges the groundwater system in the Cheyenne area. In Alberta, Canada, the annual recharge rate has been calculated to be on the order of two to three percent of the average annual precipitation (Farvolden et al., 1963).

These recharge rates are high compared to the estimate for the Green River, Utah, area. Rush et al. (1982) estimate that approximately one percent of the average annual precipitation of the Green River area recharges the upper groundwater system. This rate was estimated by an empirical method of estimating average annual groundwater recharge from precipitation in desert regions developed by Eakin et al. (1951). Rush et al. (1982) note that the method is not precise; however, it has proven useful for reconnaissance estimates, and experience in using the method throughout Nevada and western Utah indicates that, in many areas in these desert regions, estimates probably are relatively close to actual long-term average annual recharge (Scott et al., 1971). Rush et al. (1982) also note that the recharge estimate for the Green River area is conservatively high because it assumes a maximum potential for soil wetting depth; that is, the soil at Green River is assumed to be relatively coarse-textured and of moderately-high permeability with a high potential for infiltration from direct precipitation. At the Green River tailings site, where the average annual precipitation is six inches (15.2 cm), annual deep percolation to shallow groundwater may be 0.06 inch (0.15 cm); this is equivalent to a percolation rate of 1.9 x 10^{-9} inch per second (in/s)(4.8 x 10^{-9} cm/s).

In an attempt to calculate deep percolation through the tailings, the following mixing relationship was used:

$$C_b(Q_r - Q_t) + C_tQ_t = C_rQ_r$$

where

C_b = concentration of water quality constituent upgradient (background) of the tailings (mg/l).

Q_r = volume flux rate of alluvial groundwater beneath the tailings (resultant volume flux rate from mixing the background groundwater with the fluid percolating through the tailings) (gpm).

C_t = concentration of water quality constituent in tailings pore fluid (lysimeter sample) (mg/l).

Q_t = volume flux rate (percolation) through the tailings (gpm).

C_r = concentration of water quality constituent in the alluvium beneath the tailings (resultant concentration from mixing background alluvial water with tailings pore water) (mg/l).

Using Q_r = 9.9 gpm (see Table B.4.7), average pore water concentrations from lysimeter 714 (Table B.4.14), average background groundwater concentrations from alluvial monitor wells 563 and 707, and resultant groundwater concentrations from alluvial on-site wells 702, 704, and 705, Q_t was calculated to be 0.010 gpm using both uranium and manganese concentrations. Other constituents were considered but were not useful either because their background concentrations were higher than resultant concentrations or pore water analyses were not available.

Based on the calculated Q_t, the continuous infiltration rate over the eight-acre area of the tailings is 6.4×10^{-11} ft/s (2.0×10^{-9} cm/s); the average annual rate is equal to 0.024 in/yr (0.06 cm/yr), or 0.4 percent of the average annual precipitation. While this method of calculating Q_t has inherent uncertainties (e.g., averages are used and geochemical attenuation is not considered), it indicates that the percolation rate of water through the tailings is small, and is probably within the range estimated by Rush et al. (1982). Detailed mixing calculations to estimate Q_t are on file in the UMTRA Project Office, Albuquerque, New Mexico.

Tailings pore water samples were collected and analyzed from lysimeter 714 located at the east end of the pile (see Figure B.4.1) in September, 1986, and March, 1987. Less than 500 milliliters could be obtained from the lysimeter each time, so only a select number of parameters could be analyzed. No pore water at all could be collected during October, 1987, and January, 1988, samplings. Since radionuclide analyses require one liter or more, radionuclide concentrations in the pore water could not be determined. In addition, since only a select number of constituents were analyzed, a cation/anion balance could not be accurately performed and the reliability of the results are uncertain. Finally, the pore water samples are highly sensitive to fluctuations in soil moisture content (responses to rainfall and evaporation); this seems to be reflected by the high variance in pore water parameters like chloride, potassium, nitrate, sulfate, total

Table B.4.14 Chemical analyses for lysimeter 714[a]

Parameter	Date of analyses	
	9/11/86	3/12/87
Aluminum	6300.	1840.
Ammonium	14.	11.
Antimony	-	0.003
Arsenic	-	0.03
Barium	-	0.1
Boron	0.5	0.1
Cadmium	-	0.032
Calcium	457.	385.
Chloride	113.	2900.
Chromium	2.61	1.14
Cobalt	-	30.9
Copper	-	45.8
Fluoride	0.1	0.2
Iron	2200.	267.
Lead	-	0.02
Magnesium	2640.	1090.
Manganese	360.	122.
Mercury	-	0.
Molybdenum	0.2	0.10
Nickel	-	25.3
Nitrate	4500.	2.
Nitrite	-	0.1
Phosphate	-	0.1
Potassium	0.19	16.0
Selenium	0.092	0.208
Silica	-	60.
Silver	-	0.01
Sodium	89.2	111.
Strontium	-	0.1
Sulfate	56200.	16000.
Tin	-	0.005
Total dissolved solids	80800.	26100.
Uranium	675.	221.
Vanadium	-	178.
Zinc	-	259.

---

[a] All values in mg/l. See Figure B.4.1 for the location of lysimeter 714.

dissolved solids (TDS), and uranium. The analyses, however, indicate the pore water has high concentrations of nitrate, sulfate, TDS, and uranium; concentrations of aluminum, manganese, and iron are also high.

B.4.9 BACKGROUND GROUNDWATER QUALITY

Background groundwater quality in the four hydrostratigraphic units at the Green River site was determined for the following constituents listed in the proposed EPA standards: chromium; molybdenum; nitrate; selenium; radium-226 and 228; uranium; and gross alpha. The other constituents listed in the proposed EPA standards (see Table B.2.1) were found to have levels below detection for the first two rounds of sampling in June, 1986, and September, 1986; consequently, these remaining constituents were excluded from subsequent sampling rounds and are not considered to be present as contamination at the Green River tailings site. Table B.4.15 describes all of the groundwater sampling locations and Table B.4.16 presents the results of the chemical analyses for all of the wells and well points.

B.4.9.1 Top hydrostratigraphic unit

The locations of background monitor well 707 and well point 563 are shown on Figure B.4.1. These monitoring locations are upstream and upgradient, respectively, of the existing tailings pile.

A background groundwater quality summary of the top unit is presented in Table B.4.17. The background concentration range exceeds proposed EPA MCLs for all the constituents in the table except for Ra-226 and 228 and gross alpha, the concentrations of which are below the proposed MCLs. Many other constituents exceed EPA Secondary and State of Utah Drinking Water Standards. These include (but are not limited to): chloride (>250 mg/l); sulfate (>5500 mg/l); and TDS (>9000 mg/l). (See Table B.4.16 for specific concentrations of these constituents.)

The general water type for the top unit is sodium sulfate; the water is Class II based on TDS (greater than 1000 mg/l TDS but less than 10,000 mg/l), but is Class III based on the high levels of chromium, molybdenum, nitrate, selenium, and uranium.

B.4.9.2 Upper-middle hydrostratigraphic unit

The locations of background monitor wells 816 and 806 are shown on Figure B.4.1. Monitor well 806 is upgradient of the tailings, and monitor well 816 is upgradient and updip of the tailings.

Table B.4.15 Description of groundwater samples, Green River, Utah, tailings site

Sample number	Hydrostratigraphic unit	Description of sample location
563	Top	Well point, north side of Brown's Wash, approximately 250 feet upgradient from tailings.
702	Top	Well, on-site.
704	Top	Well, on-site.
705	Top	Well, west edge of tailings, on-site.
707	Top	Well, south side of Brown's Wash approximately 900 feet upgradient from tailings.
708	Top	Well, between Brown's Wash and tailings, crossgradient.
808	Top	Well, 60 feet east of well 702, on-site.
583	Upper-middle	Well, north side of Brown's Wash, approximately 1000 feet downgradient from tailings.
584	Upper-middle	Well, south side of Brown's Wash, approximately 200 feet downgradient from tailings.
585	Upper-middle	Well, north side of Brown's Wash, approximately 1100 feet downgradient from tailings.
701	Upper-middle	Well, on-site.
806	Upper-middle	Well, upgradient, approximately 75 feet north of well 707.
807	Upper-middle	Well, upgradient, south of disposal site; well is completed in the upper-middle unit below the lower-middle unit.
809	Upper-middle	Well, downgradient, north of mill yard.
810	Upper-middle	Well, downgradient, in retention structure west of mill yard.
816	Upper-middle	Well, upgradient, center of disposal site.

Table B.4.15 Description of groundwater samples, Green River, Utah, tailings site (Concluded)

Sample number	Hydrostratigraphic unit	Description of sample location
561	Lower-middle	Well, approximately 100 feet southwest of mill site, west side of road and cross-gradient from tailings.
562	Lower-middle	Well, approximately 600 feet south (upgradient) from tailings, and 1000 feet east of well 561, located on proposed disposal site.
581	Lower-middle	Flowing well, on-site, between wells 701 and 704.
811	Lower-middle	Well, upgradient, approximately 60 feet east of well 808.
813	Lower-middle	Well, upgradient near disposal site, 100 feet south of water tower.
815	Lower-middle	Well, downgradient, west of tailings.
582	Bottom	Flowing well, north of Brown's Wash, adjacent to well 583 and downgradient from tailings.
586	Bottom	Well, approximately 1100 feet south of and upgradient from tailings, located on SOS disposal site.
587	Bottom	Well, approximately 120 feet southeast of tailings and 650 feet east of well 586, and upgradient from tailings.
588	Bottom	Well, approximately 1200 feet southwest of mill site and 1200 feet west of well site and upgradient from tailings.
818	Bottom	Well, between wells 587 and 586, upgradient from tailings.
819	Bottom	Well, downgradient, west of tailings.

Table B.4.16 Chemical analysis of groundwater, Green River, Utah, tailings site

Note: The "Formation of Completion" in Table B.4.16 refers to the hydrostratigraphic unit in which the respective wells are completed.

The hydrostratigraphic units are as follows:

"Alluvium" = Top hydrostratigraphic unit

"Shale" = Upper-middle hydrostratigraphic unit

"Conglomerate" = Lower-middle hydrostratigraphic unit

"Sandstone" = Bottom hydrostratigraphic unit

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site

FORMATION OF COMPLETION: URANIUM MILL TAILINGS
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		714-01 03/12/87	716-01 09/11/86			
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALUMINUM	MG/L	6300.	1840.			
AMMONIUM	MG/L	14.	11.			
ANTIMONY	MG/L	-	< 0.003			
ARSENIC	MG/L	-	0.03			
BARIUM	MG/L	-	< 0.1			
BORON	MG/L	0.5	< 0.1			
CADMIUM	MG/L	-	0.032			
CALCIUM	MG/L	457.	385.			
CHLORIDE	MG/L	113.	2900.			
CHROMIUM	MG/L	2.61	1.14			
COBALT	MG/L	-	30.9			
COPPER	MG/L	-	45.8			
FLUORIDE	MG/L	< 0.1	0.2			
IRON	MG/L	2200.	267.			
LEAD	MG/L	-	0.02			
MAGNESIUM	MG/L	2640.	1090.			
MANGANESE	MG/L	360.	122.			
MERCURY	MG/L	-	0.			
MOLYBDENUM	MG/L	0.2	0.10			
NICKEL	MG/L	-	25.3			
NITRATE	MG/L	4500.	2.			
NITRITE	MG/L	-	< 0.1			
PHOSPHATE	MG/L	-	< 0.1			
POTASSIUM	MG/L	0.19	16.0			
SELENIUM	MG/L	0.092	0.208			
SILICA	MG/L	-	60.			
SILVER	MG/L	-	< 0.01			
SODIUM	MG/L	89.2	111.			
STRONTIUM	MG/L	-	0.1			
SULFATE	MG/L	56200.	16000.			
TIN	MG/L	-	< 0.005			
TOTAL SOLIDS	MG/L	80800.	26100.			
URANIUM	MG/L	675.	221.			
VANADIUM	MG/L	-	178.			
ZINC	MG/L	-	259.			

MAPPER DATA FILE NAME: GRN01*UDPGW0101673

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		586-01 09/11/86		586-01 03/13/87		586-01 10/05/87		586-01 01/07/88		587-01 09/11/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	720.		424.		569.		586.		842.	
ALUMINUM	MG/L	0.5		0.1		< 0.1		< 0.1		0.8	
AMMONIUM	MG/L	1.0		2.4		0.2		0.1		1.0	
ANTIMONY	MG/L	< 0.003		-		-		-		< 0.003	
ARSENIC	MG/L	< 0.01		-		0.01		0.03		< 0.01	
BALANCE	%	-2.79		-		-		-		-2.08	
BARIUM	MG/L	< 0.1		-		-		-		< 0.1	
BORON	MG/L	0.6		0.7		0.6		0.65		0.4	
CADMIUM	MG/L	< 0.001		-		-		-		< 0.001	
CALCIUM	MG/L	8.20		6.42		12.3		12.5		3.18	
CHLORIDE	MG/L	110.		142.		183.		180.		190.	
CHROMIUM	MG/L	0.03		0.06		< 0.01		0.07		0.04	
COBALT	MG/L	< 0.05		-		-		-		< 0.05	
CONDUCTANCE	UMHO/CM	2500.		2300.		2400.		2290.		3500.	
COPPER	MG/L	< 0.02		-		-		-		0.03	
FLUORIDE	MG/L	2.7		3.0		2.6		0.81		3.0	
GROSS ALPHA	PCI/L	-		1.	11.	0.0	20.	2.5	8.7	-	
GROSS BETA	PCI/L	-		4.5	5.7	0.0	14.	9.	10.	-	
IRON	MG/L	0.07		< 0.03		< 0.03		0.34		0.04	
LEAD	MG/L	0.01		-		-		-		0.01	
MAGNESIUM	MG/L	3.48		2.20		4.5		3.45		0.011	
MANGANESE	MG/L	0.03		0.02		< 0.01		< 0.01		0.03	
MERCURY	MG/L	< 0.0002		-		-		-		< 0.0002	
MOLYBDENUM	MG/L	0.14		< 0.1		< 0.01		0.02		0.09	
NICKEL	MG/L	< 0.04		-		-		-		< 0.04	
NITRATE	MG/L	2.		0.4		< 1.0		< 0.1		< 1.	
NITRITE	MG/L	< 0.1		-		-		-		< 0.1	
ORG. CARBON	MG/L	-		-		6.		117.		-	
PH	SU	9.92		10.51		8.1		8.05		11.49	
PHOSPHATE	MG/L	< 0.1		-		-		-		< 0.1	
POTASSIUM	MG/L	8.20		2.46		1.34		1.34		17.1	
RA-226	PCI/L	-		0.1	0.2	0.1	0.1	0.	0.1	-	
RA-228	PCI/L	-		-		1.2	0.8	0.3	0.8	-	
SELENIUM	MG/L	0.036		< 0.002		< 0.005		0.021		0.106	
SILICA	MG/L	10.		-		-		-		13.	
SILVER	MG/L	< 0.01		-		-		-		< 0.01	
SODIUM	MG/L	680.		643.		640.		682.		730.	
STRONTIUM	MG/L	0.2		-		-		-		0.1	
SULFATE	MG/L	699.		720.		690.		702.		546.	
TEMPERATURE	C - DEGREE	16.		16.5		17.0		16.0		17.	
TH-230	PCI/L	-		0.0	0.4	-		-		-	
TIN	MG/L	< 0.005		-		-		-		< 0.005	
TOTAL SOLIDS	MG/L	1920.		1920.		1830.		1870.		1990.	
URANIUM	MG/L	0.0049		0.0036		< 0.003		0.0012		< 0.0003	
VANADIUM	MG/L	0.19		-		< 0.01		< 0.01		0.22	
ZINC	MG/L	0.015		-		0.007		0.012		< 0.005	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		587-01 03/13/87		587-01 10/05/87		587-01 01/10/88		588-01 09/11/86		588-01 03/13/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	546.		419.		593.		565.		614.	
ALUMINUM	MG/L	1.1		< 0.1		0.1		0.3		0.3	
AMMONIUM	MG/L	1.0		0.2		0.1		0.9		0.6	
ANTIMONY	MG/L	-		-		-		< 0.003		-	
ARSENIC	MG/L	-		0.01		0.006		< 0.01		-	
BALANCE	%	-		-		-		-2.87		-	
BARIUM	MG/L	-		-		-		< 0.1		-	
BORON	MG/L	0.9		0.8		0.78		0.6		0.6	
CADMIUM	MG/L	-		-		-		< 0.001		-	
CALCIUM	MG/L	7.28		3.1		6.78		9.96		5.49	
CHLORIDE	MG/L	79.1		93.		76.		240.		319.	
CHROMIUM	MG/L	0.03		< 0.01		0.03		0.06		0.02	
COBALT	MG/L	-		-		-		< 0.05		-	
CONDUCTANCE	UMHO/CM	3000.		2700.		2820.		2350.		2500.	
COPPER	MG/L	-		-		-		0.03		-	
FLUORIDE	MG/L	5.5		5.1		5.3		3.2		3.4	
GROSS ALPHA	PCI/L	1.	13.	0.9	5.9	21.	12.	-		1.	13.
GROSS BETA	PCI/L	13.	8.	0.0	16.	0.	10.	-		0.0	9.4
IRON	MG/L	< 0.03		< 0.03		0.19		0.14		0.04	
LEAD	MG/L	-		-		-		< 0.01		-	
MAGNESIUM	MG/L	0.03		0.78		1.73		1.78		1.30	
MANGANESE	MG/L	< 0.01		< 0.01		< 0.01		0.02		0.03	
MERCURY	MG/L	-		-		-		< 0.0002		-	
MOLYBDENUM	MG/L	< 0.1		0.03		0.07		0.09		< 0.1	
NICKEL	MG/L	-		-		-		< 0.04		-	
NITRATE	MG/L	0.8		< 1.0		< 0.1		3.		< 0.1	
NITRITE	MG/L	-		-		-		< 0.1		-	
ORG. CARBON	MG/L	-		7.		138.		-		-	
PH	SU	11.61		9.35		9.0		8.65		8.30	
PHOSPHATE	MG/L	-		-		-		< 0.1		-	
POTASSIUM	MG/L	4.09		1.27		1.29		1.51		1.21	
RA-226	PCI/L	0.0	0.2	0.1	0.1	0.1	0.1	-		0.2	0.2
RA-228	PCI/L	-		2.9	1.0	0.	0.8	-		-	
SELENIUM	MG/L	< 0.002		< 0.005		0.043		0.096		< 0.002	
SILICA	MG/L	-		-		-		8.		-	
SILVER	MG/L	-		-		-		< 0.01		-	
SODIUM	MG/L	803.		740.		864.		677.		731.	
STRONTIUM	MG/L	-		-		-		0.4		-	
SULFATE	MG/L	1170.		950.		1193.		645.		635.	
TEMPERATURE	C - DEGREE	15.0		16.0		16.1		19.		11.0	
TH-230	PCI/L	0.0	0.4	-		-		-		0.3	0.5
TIN	MG/L	-		-		-		< 0.005		-	
TOTAL SOLIDS	MG/L	2480.		2200.		2430.		2000.		2170.	
URANIUM	MG/L	0.0016		0.003		0.0027		< 0.0003		0.0010	
VANADIUM	MG/L	-		< 0.01		< 0.01		0.22		-	
ZINC	MG/L	-		0.005		< 0.005		0.010		-	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		588-01 10/02/87		588-01 01/10/88		817-01 10/22/87		817-02 10/22/87		817-03 10/22/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUE	+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	555.		545.		655.		655.		655.	
ALUMINUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		0.1	
AMMONIUM	MG/L	0.2		< 0.1		0.2		0.2		0.2	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	0.01		0.01		< 0.01		< 0.01		< 0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BORON	MG/L	0.7		0.69		0.6		0.6		0.6	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	4.2		4.43		2.7		2.7		2.7	
CHLORIDE	MG/L	220.		240.		320.		310.		320.	
CHROMIUM	MG/L	< 0.01		0.02		< 0.01		< 0.01		< 0.01	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2390.		2460.		1950.		1950.		1950.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	2.6		2.67		5.6		5.4		4.3	
GROSS ALPHA	PCI/L	0.0	22.	0.	12.	30.	22.	0.0	20.	0.0	20.
GROSS BETA	PCI/L	0.0	20.	0.	9.	25.	17.	0.0	15.	0.0	15.
IRON	MG/L	< 0.03		0.1		< 0.03		< 0.03		< 0.03	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	0.90		0.89		0.71		0.73		0.73	
MANGANESE	MG/L	< 0.01		< 0.01		0.02		0.02		0.02	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.01		0.02		0.03		0.04		0.04	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	< 1.0		< 0.1		< 1.0		< 1.0		< 1.0	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	4.		34.8		< 1.		< 1.		< 1.	
PH	SU	8.15		8.25		8.2		8.2		8.2	
PHOSPHATE	MG/L	-		-		-		-		-	
POTASSIUM	MG/L	0.92		0.97		1.11		1.11		1.09	
RA-226	PCI/L	0.4	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1
RA-228	PCI/L	1.1	1.1	0.1	0.8	0.5	0.9	3.8	1.3	0.1	1.4
SELENIUM	MG/L	0.007		0.027		< 0.005		< 0.005		< 0.005	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	690.		683.		550.		550.		590.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	660.		674.		134.		133.		140.	
TEMPERATURE	C - DEGREE	16.0		16.2		17.0		17.0		17.0	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	1880.		1930.		1500.		1490.		1490.	
URANIUM	MG/L	< 0.003		< 0.0003		< 0.003		< 0.003		0.003	
VANADIUM	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
ZINC	MG/L	< 0.005		0.007		< 0.005		< 0.005		< 0.005	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE 817-04 10/22/87			817-05 10/22/87			817-01 01/10/88			817-02 01/10/88			817-03 01/10/88		
		PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY		
ALKALINITY	MG/L CACO3		655.			655.			688.			688.			688.	
ALUMINUM	MG/L	<	0.1		<	0.1		<	0.1			0.2		<	0.1	
AMMONIUM	MG/L		0.2			0.2		<	0.1		<	0.1		<	0.1	
ANTIMONY	MG/L		-			-			-			-			-	
ARSENIC	MG/L	<	0.01		<	0.01		<	0.01		<	0.01		<	0.01	
BALANCE	%		-			-			-			-			-	
BARIUM	MG/L		-			-			-			-			-	
BORON	MG/L		0.7			0.7			0.73			0.77			0.77	
CADMIUM	MG/L		-			-			-			-			-	
CALCIUM	MG/L		2.6			2.7			2.57			2.58			2.54	
CHLORIDE	MG/L		320.			320.			310.			320.			330.	
CHROMIUM	MG/L	<	0.01		<	0.01			0.03			0.03			0.03	
COBALT	MG/L		-			-			-			-			-	
CONDUCTANCE	UMHO/CM		1950.			1950.			1960.			1960.			1960.	
COPPER	MG/L		-			-			-			-			-	
FLUORIDE	MG/L		3.3			3.0			4.94			5.1			5.08	
GROSS ALPHA	PCI/L		0.0	15.		0.0	17.		0.	6.6		5.	12.		6.	11.
GROSS BETA	PCI/L		0.0	10.		22.	15.		0.	4.9		2.2	8.		6.	8.6
IRON	MG/L	<	0.03		<	0.03			0.15			0.15			0.15	
LEAD	MG/L		-			-			-			-			-	
MAGNESIUM	MG/L		0.73			0.73			0.61			0.61			0.60	
MANGANESE	MG/L		0.01			0.01		<	0.01		<	0.01		<	0.01	
MERCURY	MG/L		-			-			-			-			-	
MOLYBDENUM	MG/L		0.04			0.04			0.06			0.07			0.06	
NICKEL	MG/L		-			-			-			-			-	
NITRATE	MG/L	<	1.0		<	1.0		<	0.1		<	0.1		<	0.1	
NITRITE	MG/L		-			-			-			-			-	
ORG. CARBON	MG/L	<	1.			2.			154.			151.			155.	
PH	SU		8.2			8.2			8.4			8.4			8.4	
PHOSPHATE	MG/L		-			-			-			-			-	
POTASSIUM	MG/L		1.07			1.08			0.87			0.83			0.85	
RA-226	PCI/L		0.0	0.1		0.0	0.1		0.1	0.2		0.1	0.2		0.	0.1
RA-228	PCI/L		0.5	1.1		0.4	1.8		0.	0.8		0.	0.8		0.1	0.9
SELENIUM	MG/L	<	0.005		<	0.005			0.007			0.009			0.008	
SILICA	MG/L		-			-			-			-			-	
SILVER	MG/L		-			-			-			-			-	
SODIUM	MG/L		570.			580.			557.			556.			564.	
STRONTIUM	MG/L		-			-			-			-			-	
SULFATE	MG/L		138.			139.			137.			137.			139.	
TEMPERATURE	C - DEGREE		17.0			17.0			15.5			15.5			15.5	
TH-230	PCI/L		-			-			-			-			-	
TIN	MG/L		-			-			-			-			-	
TOTAL SOLIDS	MG/L		1470.			1480.			1500.			1500.			1490.	
URANIUM	MG/L	<	0.003		<	0.003		<	0.0003		<	0.0003		<	0.0003	
VANADIUM	MG/L	<	0.01		<	0.01		<	0.01		<	0.01		<	0.01	
ZINC	MG/L	<	0.005		<	0.005			0.009			0.011		<	0.005	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

LOCATION ID - SAMPLE ID AND LOG DATE

PARAMETER	UNIT OF MEASURE	817-04 01/10/88 PARAMETER VALUE+/-UNCERTAINTY		817-05 01/10/88 PARAMETER VALUE+/-UNCERTAINTY		818-01 10/20/87 PARAMETER VALUE+/-UNCERTAINTY		818-02 10/20/87 PARAMETER VALUE+/-UNCERTAINTY		818-03 10/20/87 PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	688.		688.		541.		541.		541.	
ALUMINUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
AMMONIUM	MG/L	< 0.1		< 0.1		0.2		0.2		0.2	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		0.01		0.01		0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BORON	MG/L	0.79		0.8		0.7		0.7		0.7	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	2.54		2.51		6.4		6.5		6.4	
CHLORIDE	MG/L	320.		330.		450.		450.		400.	
CHROMIUM	MG/L	0.03		0.03		< 0.01		< 0.01		< 0.01	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	1960.		1960.		2900.		2900.		2900.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	5.16		5.22		2.6		2.1		2.4	
GROSS ALPHA	PCI/L	4.6	9.3	3.	10.	0.0	2.1	0.0	28.	0.0	27.
GROSS BETA	PCI/L	11.	9.	5.3	9.1	0.2	2.4	5.6	22.	8.1	23.
IRON	MG/L	0.15		0.15		< 0.03		< 0.03		< 0.03	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	0.62		0.61		1.39		1.40		1.40	
MANGANESE	MG/L	< 0.01		< 0.01		0.03		0.04		0.04	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.07		0.07		< 0.01		< 0.01		< 0.01	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	< 0.1		< 0.1		< 1.0		< 1.0		< 1.0	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	163.		160.		6.		10.		< 1.	
PH	SU	8.4		8.4		8.3		8.3		8.3	
PHOSPHATE	MG/L	-		-		-		-		-	
POTASSIUM	MG/L	0.85		0.86		1.41		1.40		1.40	
RA-226	PCI/L	0.	0.1	0.1	0.1	0.3	0.1	0.3	0.1	0.3	0.1
RA-228	PCI/L	0.	0.8	0.	0.7	0.6	1.4	0.1	1.4	1.0	1.3
SELENIUM	MG/L	0.008		0.007		0.007		< 0.005		< 0.005	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	560.		558.		810.		780.		790.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	137.		139.		620.		590.		620.	
TEMPERATURE	C - DEGREE	15.5		15.5		18.0		18.0		18.0	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	1490.		1490.		2170.		2160.		2140.	
URANIUM	MG/L	< 0.0003		< 0.0003		0.005		0.003		0.003	
VANADIUM	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
ZINC	MG/L	< 0.005		0.006		0.005		< 0.005		< 0.005	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		848-04 10/20/87		848-05 10/20/87		848-01 01/05/88		848-02 01/05/88		848-03 01/05/88	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	541.		541.		546.		546.		546.	
ALUMINUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
AMMONIUM	MG/L	0.2		0.2		0.3		0.1		0.1	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	0.01		0.01		0.01		0.01		0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BORON	MG/L	0.7		0.6		0.61		0.61		0.59	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	6.4		6.4		8.59		8.56		8.47	
CHLORIDE	MG/L	400.		440.		600.		600.		610.	
CHROMIUM	MG/L	< 0.01		< 0.01		0.03		0.03		0.03	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2900.		2900.		3160.		3160.		3160.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	2.7		2.7		2.9		2.98		2.92	
GROSS ALPHA	PCI/L	32.	29.	0.0	23.	2.	14.	9.	17.	2.	13.
GROSS BETA	PCI/L	2.0	18.	0.0	21.	23.	16.	7.	18.	0.	18.
IRON	MG/L	< 0.03		< 0.03		0.15		0.15		0.15	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	1.43		1.41		1.65		1.63		1.61	
MANGANESE	MG/L	0.04		0.04		0.02		0.02		0.02	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.01		< 0.01		0.04		0.08		0.09	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	< 1.0		< 1.0		< 0.1		< 0.1		< 0.1	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	< 1.		1.		146.		146.		144.	
PH	SU	8.3		8.3		8.35		8.35		8.35	
PHOSPHATE	MG/L	-		-		-		-		-	
POTASSIUM	MG/L	1.40		1.42		2.1		1.42		1.35	
RA-226	PCI/L	0.2	0.1	0.4	0.1	0.1	0.1	0.2	0.2	0.2	0.2
RA-228	PCI/L	1.5	2.1	1.5	1.7	0.8	0.8	0.6	1.0	0.	0.9
SELENIUM	MG/L	< 0.005		< 0.005		0.018		0.018		0.016	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	800.		730.		906.		904.		900.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	580.		590.		599.		589.		594.	
TEMPERATURE	C - DEGREE	18.0		18.0		16.2		16.2		16.2	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	2170.		2170.		2470.		2420.		2420.	
URANIUM	MG/L	0.004		0.005		0.0011		0.0012		0.0013	
VANADIUM	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
ZINC	MG/L	< 0.005		< 0.005		< 0.005		0.009		0.007	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

LOCATION ID - SAMPLE ID AND LOG DATE

PARAMETER	UNIT OF MEASURE	818-04 01/05/88 PARAMETER VALUE+/-UNCERTAINTY		818-05 01/05/88 PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	546.		546.				
ALUMINUM	MG/L	< 0.1		< 0.1				
AMMONIUM	MG/L	0.1		0.2				
ANTIMONY	MG/L	-		-				
ARSENIC	MG/L	0.01		0.007				
BALANCE	%	-		-				
BARIUM	MG/L	-		-				
BORON	MG/L	0.61		0.61				
CADMIUM	MG/L	-		-				
CALCIUM	MG/L	8.72		8.54				
CHLORIDE	MG/L	610.		610.				
CHROMIUM	MG/L	0.03		0.03				
COBALT	MG/L	-		-				
CONDUCTANCE	UMHO/CM	3160.		3160.				
COPPER	MG/L	-		-				
FLUORIDE	MG/L	2.93		2.94				
GROSS ALPHA	PCI/L	8.	16.	19.	16.			
GROSS BETA	PCI/L	15.	18.	8.	16.			
IRON	MG/L	0.15		0.15				
LEAD	MG/L	-		-				
MAGNESIUM	MG/L	1.65		1.62				
MANGANESE	MG/L	0.02		0.02				
MERCURY	MG/L	-		-				
MOLYBDENUM	MG/L	0.08		0.09				
NICKEL	MG/L	-		-				
NITRATE	MG/L	< 0.1		< 0.1				
NITRITE	MG/L	-		-				
ORG. CARBON	MG/L	135.		147.				
PH	SU	8.35		8.35				
PHOSPHATE	MG/L	-		-				
POTASSIUM	MG/L	1.56		2.01				
RA-226	PCI/L	0.4	0.2	0.5	0.3			
RA-228	PCI/L	0.5	0.9	0.4	0.8			
SELENIUM	MG/L	0.017		0.016				
SILICA	MG/L	-		-				
SILVER	MG/L	-		-				
SODIUM	MG/L	904.		902.				
STRONTIUM	MG/L	-		-				
SULFATE	MG/L	604.		600.				
TEMPERATURE	C - DEGREE	16.2		16.2				
TH-230	PCI/L	-		-				
TIN	MG/L	-		-				
TOTAL SOLIDS	MG/L	2410.		2410.				
URANIUM	MG/L	0.0012		0.0013				
VANADIUM	MG/L	< 0.01		< 0.01				
ZINC	MG/L	< 0.005		0.005				

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		701-01 07/14/82		701-01 06/06/86		701-02 06/06/86		701-03 06/06/86		701-04 06/06/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	330.00		442.		442.		442.		442.	
ALUMINUM	MG/L	< 0.10		-		-		-		-	
AMMONIUM	MG/L	-		34.		30.		30.		30.	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
BALANCE	%	-		-1.10		-0.02		-0.02		-0.02	
BARIUM	MG/L	-		-		-		-		-	
BICARBONATE	MG/L	403.00		-		-		-		-	
BORON	MG/L	-		-		-		-		-	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	390.00		511.		510.		510.		510.	
CHLORIDE	MG/L	100.00		107.		110.		110.		110.	
CHROMIUM	MG/L	-		-		-		-		-	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	7410.00		5000.		5000.		5000.		5000.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	2.00		0.9		0.9		0.9		0.9	
GROSS ALPHA	PCI/L	-		-		-		-		-	
GROSS BETA	PCI/L	-		-		-		-		-	
IRON	MG/L	< 0.05		0.08		0.08		0.08		0.08	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	140.00		190.		190.		190.		190.	
MANGANESE	MG/L	-		2.2		2.3		2.3		2.3	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.05		0.2		0.18		0.2		0.2	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	28.00		1370.		1190.		1190.		1190.	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		-		-	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.00		7.67		7.67		7.67		7.67	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	11.00		13.5		13.3		13.3		13.3	
RA-226	PCI/L	< 2.00		0.3	0.2	-		-		-	
RA-228	PCI/L	-		0.6	0.9	-		-		-	
SELENIUM	MG/L	0.36		0.01		0.01		0.01		0.01	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	1530.00		1190.		1170.		1170.		1170.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	3610.00		3040.		3020.		3020.		3020.	
TEMPERATURE	C - DEGREE	18.00		17.		17.		17.		17.	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	6010.00		7110.		7160.		7100.		7120.	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		701-01 07/14/82	701-01 06/06/86	701-02 06/06/86	701-03 06/06/86	701-04 06/06/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
URANIUM	MG/L	1.40	3.11	2.94	2.99	2.98
VANADIUM	MG/L	< 0.05	-	-	-	-
ZINC	MG/L	-	-	-	-	-

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		701-05 06/06/86		701-01 09/07/86		701-01 03/13/87		701-01 10/06/87		701-01 01/12/88	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	442.		395.		407.		398.		253.	
ALUMINUM	MG/L	-		0.3		0.2		< 0.1		0.4	
AMMONIUM	MG/L	30.		30.		32.		47.		47.7	
ANTIMONY	MG/L	-		< 0.003		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		-		< 0.01		< 0.01	
BALANCE	%	-0.02		0.09		-		-		-	
BARIUM	MG/L	-		0.1		-		-		-	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	-		0.6		0.6		0.6		0.69	
CADMIUM	MG/L	-		< 0.001		-		-		-	
CALCIUM	MG/L	510.		337.		366.		380.		407.	
CHLORIDE	MG/L	110.		100.		86.		96.		96.	
CHROMIUM	MG/L	-		0.05		0.03		< 0.01		0.02	
COBALT	MG/L	-		0.09		-		-		-	
CONDUCTANCE	UMHO/CM	5000.		500.		4100.		6200.		5450.	
COPPER	MG/L	-		0.03		-		-		-	
FLUORIDE	MG/L	0.9		1.0		1.0		1.0		0.92	
GROSS ALPHA	PCI/L	-		-		-		970.	120.	1100.	100.
GROSS BETA	PCI/L	-		-		-		270.	56.	620.	40.
IRON	MG/L	0.08		0.05		0.12		< 0.03		0.25	
LEAD	MG/L	-		< 0.01		-		-		-	
MAGNESIUM	MG/L	190.		139.		160.		180.		176.	
MANGANESE	MG/L	2.3		1.23		1.60		1.65		1.81	
MERCURY	MG/L	-		< 0.0002		-		-		-	
MOLYBDENUM	MG/L	0.2		0.13		< 0.1		0.01		0.14	
NICKEL	MG/L	-		0.06		-		-		-	
NITRATE	MG/L	1190.		570.		2480.		1120.		1020.	
NITRITE	MG/L	-		< 0.1		-		-		-	
ORG. CARBON	MG/L	-		96.		-		41.		110.	
PB-210	PCI/L	-		13.	2.	-		-		-	
PH	SU	7.67		7.60		7.18		6.85		6.88	
PHOSPHATE	MG/L	-		< 0.1		-		-		-	
PO-210	PCI/L	-		1.4	0.8	-		-		-	
POTASSIUM	MG/L	13.3		12.2		10.8		9.6		10.4	
RA-226	PCI/L	-		0.8	0.3	-		0.8	0.3	0.1	0.1
RA-228	PCI/L	-		0.9	1.0	-		1.0	0.8	0.8	0.7
SELENIUM	MG/L	0.01		0.121		0.150		0.37		0.546	
SILICA	MG/L	-		8.		-		-		-	
SILVER	MG/L	-		< 0.01		-		-		-	
SODIUM	MG/L	1170.		1400.		1900.		1300.		1190.	
STRONTIUM	MG/L	-		7.0		-		-		-	
SULFATE	MG/L	3020.		3420.		3170.		3100.		3000.	
TEMPERATURE	C - DEGREE	17.		17.0		16.		16.0		14.6	
TH-230	PCI/L	-		1.7	0.8	-		-		-	
TIN	MG/L	-		< 0.005		-		-		-	
TOTAL SOLIDS	MG/L	7120.		6550.		7070.		6460.		6130.	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		701-05 06/06/86	701-01 09/07/86	701-01 03/13/87	701-01 10/06/87	701-01 01/12/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
URANIUM	MG/L	3.05	1.86	1.59	1.71	2.23
VANADIUM	MG/L	-	0.18	-	< 0.01	0.07
ZINC	MG/L	-	0.017	-	0.038	0.011

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		703-01 06/07/86	703-01 09/07/86	703-01 02/24/87		
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	243.	247.	272.		
ALUMINUM	MG/L	-	0.3	< 0.1		
AMMONIUM	MG/L	18.	50.	5.0		
ANTIMONY	MG/L	-	< 0.003	-		
ARSENIC	MG/L	< 0.01	< 0.01	-		
BALANCE	%	-0.19	0.65	-		
BARIUM	MG/L	-	0.1	-		
BICARBONATE	MG/L	-	-	-		
BORON	MG/L	-	0.4	0.30		
CADMIUM	MG/L	-	< 0.001	-		
CALCIUM	MG/L	461.	455.	435.		
CHLORIDE	MG/L	88.	70.	95.6		
CHROMIUM	MG/L	-	0.03	0.02		
COBALT	MG/L	-	< 0.05	-		
CONDUCTANCE	UMHO/CM	3350.	3900.	2750.		
COPPER	MG/L	-	< 0.02	-		
FLUORIDE	MG/L	0.8	0.8	0.74		
GROSS ALPHA	PCI/L	-	-	-		
GROSS BETA	PCI/L	-	-	-		
IRON	MG/L	0.06	0.07	0.13		
LEAD	MG/L	-	< 0.01	-		
MAGNESIUM	MG/L	117.	159.	137.		
MANGANESE	MG/L	0.18	0.23	0.05		
MERCURY	MG/L	-	< 0.0002	-		
MOLYBDENUM	MG/L	0.14	0.20	< 0.1		
NICKEL	MG/L	-	0.05	-		
NITRATE	MG/L	2.	150.	182.		
NITRITE	MG/L	-	< 0.1	-		
ORG. CARBON	MG/L	-	-	-		
PB-210	PCI/L	-	-	-		
PH	SU	7.07	7.13	7.05		
PHOSPHATE	MG/L	-	< 0.1	-		
PO-210	PCI/L	-	-	-		
POTASSIUM	MG/L	12.1	13.6	9.70		
RA-226	PCI/L	-	-	-		
RA-228	PCI/L	-	-	-		
SELENIUM	MG/L	< 0.005	< 0.005	0.24		
SILICA	MG/L	-	7.	-		
SILVER	MG/L	-	< 0.01	-		
SODIUM	MG/L	890.	910.	909.		
STRONTIUM	MG/L	-	6.5	-		
SULFATE	MG/L	3150.	3280.	3100.		
TEMPERATURE	C - DEGREE	14.	19.	14.		
TH-230	PCI/L	-	-	-		
TIN	MG/L	-	< 0.005	-		
TOTAL SOLIDS	MG/L	5190.	5040.	5090.		

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE		
		703-01 06/07/86	703-01 09/07/86	703-01 02/24/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
URANIUM	MG/L	0.437	0.639	1.062
VANADIUM	MG/L	-	0.30	-
ZINC	MG/L	-	0.015	-

MAPPER DATA FILE NAME: GRN01*UDPGWQ101670

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE									
		582-01 09/12/86		582-01 03/13/87		582-01 10/02/87		582-01 01/10/88		819-01 10/26/87	
		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	530.		560.		521.		521.		500.	
ALUMINUM	MG/L	0.3		0.2		< 0.1		< 0.1		< 0.1	
AMMONIUM	MG/L	0.7		0.3		0.3		< 0.1		0.4	
ANTIMONY	MG/L	< 0.003		-		-		-		-	
ARSENIC	MG/L	< 0.01		-		< 0.01		< 0.01		< 0.01	
BALANCE	%	-0.88		-		-		-		-	
BARIUM	MG/L	0.2		-		-		-		-	
BORON	MG/L	0.8		0.5		0.7		0.7		0.5	
CADMIUM	MG/L	< 0.001		-		-		-		-	
CALCIUM	MG/L	7.32		4.83		4.4		4.54		24.	
CHLORIDE	MG/L	640.		307.		300.		300.		146.	
CHROMIUM	MG/L	0.01		< 0.01		< 0.01		0.02		< 0.01	
COBALT	MG/L	< 0.05		-		-		-		-	
CONDUCTANCE	UMHO/CM	2500.		2550.		2500.		2400.		3300.	
COPPER	MG/L	< 0.02		-		-		-		-	
FLUORIDE	MG/L	4.4		4.3		4.2		3.65		2.9	
GROSS ALPHA	PCI/L	-		-		0.0	18.	2.	13.	0.0	18.
GROSS BETA	PCI/L	-		-		1.9	15.	0.	11.	0.0	19.
IRON	MG/L	< 0.03		0.05		< 0.03		0.12		< 0.03	
LEAD	MG/L	< 0.01		-		-		-		-	
MAGNESIUM	MG/L	1.20		0.99		0.94		0.88		11.6	
MANGANESE	MG/L	0.02		0.01		< 0.01		< 0.01		< 0.01	
MERCURY	MG/L	< 0.0002		-		-		-		-	
MOLYBDENUM	MG/L	0.10		< 0.1		< 0.01		0.02		0.01	
NICKEL	MG/L	< 0.04		-		-		-		-	
NITRATE	MG/L	5.6		0.4		< 1.0		< 0.1		6.5	
NITRITE	MG/L	< 0.1		-		-		-		-	
ORG. CARBON	MG/L	62.		-		< 1.		125.		12.	
PB-210	PCI/L	0.0	1.7	-		-		-		-	
PH	SU	8.84		8.34		8.0		8.4		8.0	
PHOSPHATE	MG/L	< 0.1		-		-		-		-	
PO-210	PCI/L	0.0	0.5	-		-		-		-	
POTASSIUM	MG/L	2.01		0.90		0.92		1.02		2.6	
RA-226	PCI/L	0.1	0.1	-		0.4	0.2	0.3	0.1	0.3	0.2
RA-228	PCI/L	0.0	1.1	-		1.2	1.0	0.	0.9	0.0	1.1
SELENIUM	MG/L	0.076		< 0.002		< 0.005		0.027		< 0.005	
SILICA	MG/L	5.		-		-		-		-	
SILVER	MG/L	< 0.01		-		-		-		-	
SODIUM	MG/L	936.		712.		700.		698.		1160.	
STRONTIUM	MG/L	0.6		-		-		-		-	
SULFATE	MG/L	619.		615.		630.		624.		2120.	
TEMPERATURE	C - DEGREE	18.		16.5		16.0		14.3		16.0	
TH-230	PCI/L	0.3	0.5	-		-		-		-	
TIN	MG/L	< 0.005		-		-		-		-	
TOTAL SOLIDS	MG/L	2000.		2130.		1930.		1930.		3820.	
URANIUM	MG/L	< 0.0003		0.0026		< 0.003		< 0.0003		0.009	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		582-01 09/12/86	582-01 03/13/87	582-01 10/02/87	582-01 01/10/88	819-01 10/26/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	0.19	-	< 0.01	< 0.01	< 0.01
ZINC	MG/L	0.008	-	< 0.005	0.01	< 0.005

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

LOCATION ID - SAMPLE ID AND LOG DATE
819-01 01/05/88

PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	547.					
ALUMINUM	MG/L	< 0.1					
AMMONIUM	MG/L	0.3					
ANTIMONY	MG/L	-					
ARSENIC	MG/L	0.002					
BALANCE	%	-					
BARIUM	MG/L	-					
BORON	MG/L	0.62					
CADMIUM	MG/L	-					
CALCIUM	MG/L	6.63					
CHLORIDE	MG/L	630.					
CHROMIUM	MG/L	0.02					
COBALT	MG/L	-					
CONDUCTANCE	UMHO/CM	3150.					
COPPER	MG/L	-					
FLUORIDE	MG/L	5.58					
GROSS ALPHA	PCI/L	0.	9.				
GROSS BETA	PCI/L	0.	14.				
IRON	MG/L	0.11					
LEAD	MG/L	-					
MAGNESIUM	MG/L	1.31					
MANGANESE	MG/L	0.01					
MERCURY	MG/L	-					
MOLYBDENUM	MG/L	0.04					
NICKEL	MG/L	-					
NITRATE	MG/L	< 0.1					
NITRITE	MG/L	-					
ORG. CARBON	MG/L	108.					
PB-210	PCI/L	-					
PH	SU	8.2					
PHOSPHATE	MG/L	-					
PO-210	PCI/L	-					
POTASSIUM	MG/L	1.3					
RA-226	PCI/L	0.2	0.2				
RA-228	PCI/L	0.6	0.9				
SELENIUM	MG/L	0.019					
SILICA	MG/L	-					
SILVER	MG/L	-					
SODIUM	MG/L	908.					
STRONTIUM	MG/L	-					
SULFATE	MG/L	578.					
TEMPERATURE	C - DEGREE	14.3					
TH-230	PCI/L	-					
TIN	MG/L	-					
TOTAL SOLIDS	MG/L	2480.					
URANIUM	MG/L	< 0.0003					

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SANDSTONE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		819-01 01/05/88				
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY				
VANADIUM	MG/L	< 0.01				
ZINC	MG/L	0.02				

MAPPER DATA FILE NAME: GRN01*UDPGWQ101671

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		806-01 10/23/87		806-01 01/10/88		807-01 10/06/87		807-01 01/07/88		816-01 10/23/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	988.		967.		627.		643.		-	
ALUMINUM	MG/L	< 0.1		< 0.1		< 0.1		0.1		0.9	
AMMONIUM	MG/L	0.2		0.1		0.4		0.1		1.4	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		0.021		< 0.01	
BORON	MG/L	0.8		0.89		0.8		0.84		0.6	
CALCIUM	MG/L	4.9		5.20		83.		137.		410.	
CHLORIDE	MG/L	188.		160.		100.		100.		165.	
CHROMIUM	MG/L	< 0.01		0.02		< 0.01		0.02		< 0.01	
CONDUCTANCE	UMHO/CM	2750.		2870.		8000.		8880.		3700.	
FLUORIDE	MG/L	1.8		1.95		1.9		1.24		0.8	
GROSS ALPHA	PCI/L	0.0	23.	5.	13.	0.0	36.	31.	32.	-	
GROSS BETA	PCI/L	4.5	18.	2.3	9.6	0.0	38.	49.	35.	-	
IRON	MG/L	< 0.03		0.12		< 0.03		0.14		0.43	
MAGNESIUM	MG/L	1.54		1.54		45.		54.7		300.	
MANGANESE	MG/L	< 0.01		0.01		0.04		0.05		0.21	
MOLYBDENUM	MG/L	< 0.01		0.02		0.07		0.11		0.02	
NITRATE	MG/L	< 1.0		< 0.1		670.		975.		85.	
ORG. CARBON	MG/L	4.		233.		19.		176.		-	
PH	SU	7.9		8.0		7.65		7.4		7.6	
POTASSIUM	MG/L	1.42		1.57		4.4		5.5		22.4	
RA-226	PCI/L	0.1	0.1	0.3	0.2	1.5	0.4	0.	0.1	-	
RA-228	PCI/L	0.3	0.9	0.	0.9	1.1	0.8	0.4	0.9	-	
SELENIUM	MG/L	< 0.005		0.049		0.17		0.25		0.72	
SODIUM	MG/L	850.		871.		2260.		2450.		790.	
SULFATE	MG/L	570.		770.		4000.		4160.		3600.	
TEMPERATURE	C - DEGREE	16.0		14.8		17.5		14.3		15.0	
TOTAL SOLIDS	MG/L	2200.		2400.		7550.		9540.		6220.	
URANIUM	MG/L	< 0.003		< 0.0003		0.005		0.0053		0.038	
VANADIUM	MG/L	< 0.01		< 0.01		< 0.01		0.02		< 0.01	
ZINC	MG/L	< 0.005		0.019		< 0.005		0.013		0.046	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

LOCATION ID - SAMPLE ID AND LOG DATE

816-01 01/07/88

PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	485.					
ALUMINUM	MG/L	0.4					
AMMONIUM	MG/L	< 0.1					
ARSENIC	MG/L	0.014					
BORON	MG/L	0.52					
CALCIUM	MG/L	436.					
CHLORIDE	MG/L	340.					
CHROMIUM	MG/L	0.05					
CONDUCTANCE	UMHO/CM	5210.					
FLUORIDE	MG/L	0.52					
GROSS ALPHA	PCI/L	21.	25.				
GROSS BETA	PCI/L	40.	27.				
IRON	MG/L	0.4					
MAGNESIUM	MG/L	542.					
MANGANESE	MG/L	0.1					
MOLYBDENUM	MG/L	0.05					
NITRATE	MG/L	93.					
ORG. CARBON	MG/L	81.7					
PH	SU	7.2					
POTASSIUM	MG/L	29.5					
RA-226	PCI/L	0.1	0.1				
RA-228	PCI/L	0.7	0.8				
SELENIUM	MG/L	2.5					
SODIUM	MG/L	707.					
SULFATE	MG/L	3940.					
TEMPERATURE	C - DEGREE	13.3					
TOTAL SOLIDS	MG/L	7300.					
URANIUM	MG/L	0.0074					
VANADIUM	MG/L	0.08					
ZINC	MG/L	0.068					

MAPPER DATA FILE NAME: GRN01*UDPGWQ101669

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		583-01 09/12/86		583-01 03/13/87		583-01 10/02/87		583-01 01/11/88		584-01 09/11/86	
PARAMETER	UNIT OF MEASURF	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	193.		670.		1030.		1220.		286.	
ALUMINUM	MG/L	0.3		< 0.1		< 0.1		0.2		0.2	
AMMONIUM	MG/L	1.1		0.4		0.5		0.3		1.0	
ANTIMONY	MG/L	< 0.003		-		-		-		< 0.003	
ARSENIC	MG/L	< 0.01		-		< 0.01		< 0.01		< 0.01	
BALANCE	%	0.11		-		-		-		-0.38	
BARIUM	MG/L	0.2		-		-		-		0.2	
BORON	MG/L	0.4		1.0		1.2		1.23		0.3	
CADMIUM	MG/L	< 0.001		-		-		-		< 0.001	
CALCIUM	MG/L	303.		327.		230.		218.		57.5	
CHLORIDE	MG/L	710.		925.		830.		900.		530.	
CHROMIUM	MG/L	0.02		0.02		< 0.01		0.03		0.02	
COBALT	MG/L	< 0.05		-		-		-		< 0.05	
CONDUCTANCE	UMHO/CM	4500.		7000.		7000.		6270.		4800.	
COPPER	MG/L	0.03		-		-		-		< 0.02	
FLUORIDE	MG/L	1.2		0.4		0.2		0.36		1.9	
GROSS ALPHA	PCI/L	-		-		0.8	61.	4.	27.	-	
GROSS BETA	PCI/L	-		-		0.0	38.	0.	19.	-	
IRON	MG/L	< 0.03		0.03		0.16		0.56		< 0.03	
LEAD	MG/L	< 0.01		-		-		-		0.03	
MAGNESIUM	MG/L	127.		136.		112.		87.7		15.2	
MANGANESE	MG/L	0.07		0.09		0.02		0.07		0.02	
MERCURY	MG/L	< 0.0002		-		-		-		< 0.0002	
MOLYBDENUM	MG/L	0.10		< 0.1		< 0.01		0.09		0.10	
NICKEL	MG/L	0.05		-		-		-		0.04	
NITRATE	MG/L	14.		71.		40.		48.3		5.	
NITRITE	MG/L	< 0.1		-		-		-		< 0.1	
ORG. CARBON	MG/L	120.		-		2.		279.		62.	
PB-210	PCI/L	0.0	1.4	-		-		-		1.5	1.3
PH	SU	8.10		6.79		6.60		6.7		9.08	
PHOSPHATE	MG/L	< 0.1		-		-		-		< 0.1	
PO-210	PCI/L	0.0	0.6	-		-		-		0.0	0.5
POTASSIUM	MG/L	10.3		10.7		6.6		6.68		4.78	
RA-226	PCI/L	0.7	0.3	-		1.1	0.3	0.7	0.2	0.2	0.2
RA-228	PCI/L	0.1	1.2	-		2.6	1.2	2.	1.	0.0	1.0
SELENIUM	MG/L	0.111		0.009		0.019		0.104		0.093	
SILICA	MG/L	3.		-		-		-		5.	
SILVER	MG/L	< 0.01		-		-		-		< 0.01	
SODIUM	MG/L	1220.		1520.		1690.		1870.		1880.	
STRONTIUM	MG/L	6.5		-		-		-		3.1	
SULFATE	MG/L	2630.		2580.		2340.		2290.		3160.	
TEMPERATURE	C - DEGREE	17.5		14.		16.0		13.0		17.0	
TH-230	PCI/L	0.7	0.6	-		-		-		0.6	0.6
TIN	MG/L	< 0.005		-		-		-		< 0.005	
TOTAL SOLIDS	MG/L	5360.		6100.		5840.		6200.		4890.	
URANIUM	MG/L	0.0042		0.0139		0.014		0.0105		< 0.0003	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		583-01 09/12/86	583-01 03/13/87	583-01 10/02/87	583-01 01/11/88	584-01 09/11/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	0.23	-	< 0.01	0.03	0.27
ZINC	MG/L	0.054	-	0.005	0.013	0.013

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		584-01 03/13/87		584-01 10/06/87		584-01 01/12/88		585-01 09/12/86		585-01 03/13/87	
PARAMETER	UNIT OF MEASURF	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	267.		252.		263.		1007.		938.	
ALUMINUM	MG/L	0.2		< 0.1		0.17		0.3		0.3	
AMMONIUM	MG/L	0.9		0.7		0.5		1.0		2.0	
ANTIMONY	MG/L	-		-		-		< 0.003		-	
ARSENIC	MG/L	-		< 0.01		0.01		< 0.01		-	
BALANCE	%	-		-		-		-0.33		-	
BARIUM	MG/L	-		-		-		0.1		-	
BORON	MG/L	0.3		0.6		0.67		1.5		0.8	
CADMIUM	MG/L	-		-		-		< 0.001		-	
CALCIUM	MG/L	39.7		47.		39.4		78.6		25.8	
CHLORIDE	MG/L	95.4		120.		110.		1200.		837.	
CHROMIUM	MG/L	0.02		< 0.01		0.02		0.02		0.03	
COBALT	MG/L	-		-		-		< 0.05		-	
CONDUCTANCE	UMHO/CM	4250.		4620.		5100.		4900.		6500.	
COPPER	MG/L	-		-		-		0.03		-	
FLUORIDE	MG/L	1.9		1.9		1.76		0.6		0.5	
GROSS ALPHA	PCI/L	-		0.0	40.	15.	19.	-		-	
GROSS BETA	PCI/L	-		0.0	29.	6.	13.	-		-	
IRON	MG/L	0.11		0.08		0.22		0.05		< 0.03	
LEAD	MG/L	-		-		-		< 0.01		-	
MAGNESIUM	MG/L	12.8		14.7		12.9		14.1		7.52	
MANGANESE	MG/L	0.05		0.02		0.03		0.04		< 0.01	
MERCURY	MG/L	-		-		-		< 0.0002		-	
MOLYBDENUM	MG/L	< 0.1		< 0.01		< 0.01		0.09		< 0.1	
NICKEL	MG/L	-		-		-		0.04		-	
NITRATE	MG/L	0.4		5.8		< 0.1		< 1.		0.4	
NITRITE	MG/L	-		-		-		< 0.1		-	
ORG. CARBON	MG/L	-		4.		30.		140.		-	
PB-210	PCI/L	-		-		-		0.6	1.3	-	
PH	SU	8.41		7.95		8.0		7.30		8.52	
PHOSPHATE	MG/L	-		-		-		< 0.1		-	
PO-210	PCI/L	-		-		-		0.0	0.5	-	
POTASSIUM	MG/L	2.60		2.7		2.91		5.71		8.61	
RA-226	PCI/L	-		0.8	0.3	0.1	0.1	0.6	0.3	-	
RA-228	PCI/L	-		2.8	1.2	0.2	0.7	0.6	1.0	-	
SELENIUM	MG/L	< 0.002		< 0.005		0.249		0.039		< 0.002	
SILICA	MG/L	-		-		-		11.		-	
SILVER	MG/L	-		-		-		< 0.01		-	
SODIUM	MG/L	1610.		1490.		1580.		2240.		1940.	
STRONTIUM	MG/L	-		-		-		3.4		-	
SULFATE	MG/L	3150.		3100.		2560.		2370.		2170.	
TEMPERATURE	C - DEGREE	15.0		14.8		14.0		17.5		15.0	
TH-230	PCI/L	-		-		-		0.4	0.5	-	
TIN	MG/L	-		-		-		< 0.005		-	
TOTAL SOLIDS	MG/L	5130.		5040.		4930.		5660.		5650.	
URANIUM	MG/L	< 0.0003		0.003		0.0009		< 0.0003		< 0.0003	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		584-01 03/13/87	584-01 10/06/87	584-01 01/12/88	585-01 09/12/86	585-01 03/13/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	-	< 0.01	0.02	0.25	-
ZINC	MG/L	-	0.024	0.007	0.019	-

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		585-01 10/07/87		585-01 01/10/88		809-01 10/23/87		809-01 01/07/88		810-01 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	848.		766.		530.		485.		369.	
ALUMINUM	MG/L	0.1		< 0.1		< 0.1		< 0.1		< 0.1	
AMMONIUM	MG/L	1.3		0.7		0.6		0.7		0.3	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		0.014		< 0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BORON	MG/L	1.1		1.1		0.5		0.64		0.6	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	40.		36.8		33.		27.7		7.7	
CHLORIDE	MG/L	750.		740.		92.		100.		550.	
CHROMIUM	MG/L	< 0.01		0.07		< 0.01		0.02		< 0.01	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	7000.		5960.		5500.		5240.		4200.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.2		0.32		1.9		1.93		5.4	
GROSS ALPHA	PCI/L	0.0	56.	7.	38.	0.0	33.	0.8	1.4	0.0	28.
GROSS BETA	PCI/L	9.0	46.	16.	28.	0.0	31.	0.	1.7	0.0	23.
IRON	MG/L	< 0.03		0.35		< 0.03		0.13		< 0.03	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	8.8		8.65		16.		11.9		1.70	
MANGANESE	MG/L	0.01		0.03		0.01		0.09		< 0.01	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.01		0.02		< 0.01		0.04		< 0.01	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	< 1.0		< 0.1		< 1.0		< 0.1		1.0	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	5.		36.2		3.		118.		3.	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.10		6.9		8.2		8.3		8.3	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	3.6		3.59		4.1		3.46		1.25	
RA-226	PCI/L	0.3	0.2	0.3	0.1	0.6	0.2	0.2	0.2	0.1	0.2
RA-228	PCI/L	1.8	1.5	0.9	0.9	0.5	1.3	0.9	0.9	1.0	1.4
SELENIUM	MG/L	< 0.005		0.155		< 0.005		0.124		< 0.005	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	1900.		1920.		1670.		1800.		810.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	2490.		2400.		3140.		3270.		620.	
TEMPERATURE	C - DEGREE	16.0		14.3		15.0		14.1		16.0	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	
TOTAL SOLIDS	MG/L	5420.		5550.		5340.		5100.		2740.	
URANIUM	MG/L	< 0.003		< 0.0003		< 0.003		0.0014		0.005	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		585-01 10/02/87	585-01 01/10/88	809-01 10/23/87	809-01 01/07/88	810-01 10/26/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	< 0.01	< 0.01	< 0.01	0.01	< 0.01
ZINC	MG/L	< 0.005	0.025	< 0.005	0.009	< 0.005

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE					
		810-01 01/07/88					
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	423.					
ALUMINUM	MG/L	< 0.1					
AMMONIUM	MG/L	0.1					
ANTIMONY	MG/L	-					
ARSENIC	MG/L	0.01					
BALANCE	%	-					
BARIUM	MG/L	-					
BORON	MG/L	0.59					
CADMIUM	MG/L	-					
CALCIUM	MG/L	17.1					
CHLORIDE	MG/L	150.					
CHROMIUM	MG/L	0.07					
COBALT	MG/L	-					
CONDUCTANCE	UMHO/CM	4110.					
COPPER	MG/L	-					
FLUORIDE	MG/L	3.27					
GROSS ALPHA	PCI/L	10.	18.				
GROSS BETA	PCI/L	19.	18.				
IRON	MG/L	0.32					
LEAD	MG/L	-					
MAGNESIUM	MG/L	6.94					
MANGANESE	MG/L	0.21					
MERCURY	MG/L	-					
MOLYBDENUM	MG/L	0.04					
NICKEL	MG/L	-					
NITRATE	MG/L	< 0.1					
NITRITE	MG/L	-					
ORG. CARBON	MG/L	99.6					
PB-210	PCI/L	-					
PH	SU	8.05					
PHOSPHATE	MG/L	-					
PO-210	PCI/L	-					
POTASSIUM	MG/L	2.5					
RA-226	PCI/L	0.2	0.2				
RA-228	PCI/L	1.3	0.9				
SELENIUM	MG/L	0.083					
SILICA	MG/L	-					
SILVER	MG/L	-					
SODIUM	MG/L	1280.					
STRONTIUM	MG/L	-					
SULFATE	MG/L	2140.					
TEMPERATURE	C - DEGREE	14.3					
TH-230	PCI/L	-					
TIN	MG/L	-					
TOTAL SOLIDS	MG/L	3970.					
URANIUM	MG/L	0.004					

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: SHALE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE
		810-01 01/07/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	< 0.01
ZINC	MG/L	0.127

MAPPER DATA FILE NAME: GRN01*UDPGWQ101668

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE						
		815-01 10/26/87		815-01 01/05/88				
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	427.		546.				
ALUMINUM	MG/L	< 0.1		< 0.1				
AMMONIUM	MG/L	0.3		0.3				
ARSENIC	MG/L	< 0.01		0.002				
BORON	MG/L	0.6		0.57				
CALCIUM	MG/L	7.6		8.18				
CHLORIDE	MG/L	930.		950.				
CHROMIUM	MG/L	< 0.01		0.03				
CONDUCTANCE	UMHO/CM	3850.		3760.				
FLUORIDE	MG/L	3.2		3.21				
GROSS ALPHA	PCI/L	0.0	37.	4.	16.			
GROSS BETA	PCI/L	0.0	28.	16.	19.			
IRON	MG/L	< 0.03		0.14				
MAGNESIUM	MG/L	2.71		2.64				
MANGANESE	MG/L	< 0.01		< 0.01				
MOLYBDENUM	MG/L	0.01		0.05				
NITRATE	MG/L	1.0		< 0.1				
ORG. CARBON	MG/L	10.		113.				
PH	SU	8.15		8.20				
POTASSIUM	MG/L	1.43		1.55				
RA-226	PCI/L	0.3	0.2	0.1	0.2			
RA-228	PCI/L	0.0	1.2	0.	0.8			
SELENIUM	MG/L	< 0.005		0.027				
SODIUM	MG/L	960.		1070.				
SULFATE	MG/L	480.		572.				
TEMPERATURE	C - DEGREE	15.5		14.4				
TOTAL SOLIDS	MG/L	2860.		2930.				
URANIUM	MG/L	< 0.003		< 0.003				
VANADIUM	MG/L	< 0.01		< 0.01				
ZINC	MG/L	0.012		0.009				

MAPPER DATA FILE NAME: GRN01*UDPGWQ101667

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE								
		581-01 09/11/86		581-01 03/13/87		581-01 10/05/87		581-01 01/12/88		
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	1021.		1012.		973.		961.		
ALUMINUM	MG/L	0.3		0.2		< 0.1		0.09		
AMMONIUM	MG/L	2.4		0.8		0.6		0.5		
ANTIMONY	MG/L	< 0.003		-		-		-		
ARSENIC	MG/L	< 0.01		-		< 0.01		0.03		
BALANCE	%	-0.21		-		-		-		
BARIUM	MG/L	0.1		-		-		-		
BORON	MG/L	0.9		0.7		0.8		0.83		
CADMIUM	MG/L	< 0.001		-		-		-		
CALCIUM	MG/L	29.5		20.5		18.1		20.0		
CHLORIDE	MG/L	100.		95.1		229.		130.		
CHROMIUM	MG/L	0.01		0.01		< 0.01		0.02		
COBALT	MG/L	< 0.05		-		-		-		
CONDUCTANCE	UMHO/CM	5000.		4100.		5500.		4900.		
COPPER	MG/L	< 0.02		-		-		-		
FLUORIDE	MG/L	1.3		1.2		1.2		1.13		
GROSS ALPHA	PCI/L	-		-		0.0	32.	7.	21.	
GROSS BETA	PCI/L	-		-		9.9	31.	12.	16.	
IRON	MG/L	0.05		0.04		< 0.03		0.12		
LEAD	MG/L	< 0.01		-		-		-		
MAGNESIUM	MG/L	10.3		9.51		9.3		9.71		
MANGANESE	MG/L	0.02		0.03		< 0.01		0.01		
MERCURY	MG/L	< 0.0002		-		-		-		
MOLYBDENUM	MG/L	0.09		< 0.1		< 0.01		< 0.01		
NICKEL	MG/L	< 0.04		-		-		-		
NITRATE	MG/L	4.2		0.4		< 1.0		< 0.1		
NITRITE	MG/L	< 0.1		-		-		-		
ORG. CARBON	MG/L	120.		-		5.		218.		
PB-210	PCI/L	0.5	1.3	-		-		-		
PH	SU	7.91		7.77		7.7		7.8		
PHOSPHATE	MG/L	< 0.1		-		-		-		
PO-210	PCI/L	0.0	0.5	-		-		-		
POTASSIUM	MG/L	3.86		1.88		2.26		2.25		
RA-226	PCI/L	1.2	0.5	-		0.7	0.2	0.3	0.1	
RA-228	PCI/L	0.2	1.4	-		2.7	0.9	0.3	0.8	
SELENIUM	MG/L	0.124		< 0.002		< 0.005		0.157		
SILICA	MG/L	8.		-		-		-		
SILVER	MG/L	< 0.01		-		-		-		
SODIUM	MG/L	1680.		1540.		1570.		1610.		
STRONTIUM	MG/L	2.5		-		-		-		
SULFATE	MG/L	2520.		2380.		2390.		2570.		
TEMPERATURE	C - DEGREE	17.		16.5		16.0		15.0		
TH-230	PCI/L	8.4	1.7	-		-		-		
TIN	MG/L	< 0.005		-		-		-		
TOTAL SOLIDS	MG/L	4770.		47900.		4520.		4630.		
URANIUM	MG/L	< 0.0003		< 0.0003		< 0.003		0.0010		

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE			
		581-01 09/11/86	581-01 03/13/87	581-01 10/05/87	581-01 01/12/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	0.22	-	< 0.01	< 0.01
ZINC	MG/L	0.010	-	0.007	0.006

MAPPER DATA FILE NAME: GRN01*UDPGWQ101666

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		562-01 06/05/86	562-02 06/05/86	562-03 06/05/86	562-04 06/05/86	562-05 06/05/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	600.	600.	600.	600.	600.
ALUMINUM	MG/L	0.7	0.2	0.2	0.2	0.2
AMMONIUM	MG/L	0.1	< 0.1	< 0.1	< 0.1	< 0.1
ANTIMONY	MG/L	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
BALANCE	%	0.22	0.25	0.25	0.26	0.23
BARIUM	MG/L	0.1	0.2	0.2	0.2	0.2
BORON	MG/L	0.9	0.4	0.4	0.5	0.4
CADMIUM	MG/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
CALCIUM	MG/L	369.	368.	368.	368.	368.
CHLORIDE	MG/L	126.	127.	127.	127.	127.
CHROMIUM	MG/L	0.04	0.04	0.04	0.04	0.04
COBALT	MG/L	0.13	0.1	0.1	0.1	0.1
CONDUCTANCE	UMHO/CM	6000.	6000.	6000.	6000.	6000.
COPPER	MG/L	0.05	0.04	0.04	0.04	0.04
FLUORIDE	MG/L	1.	0.9	0.9	0.9	0.9
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	0.06	0.08	0.08	0.08	0.08
LEAD	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
MAGNESIUM	MG/L	150.	141.	141.	141.	141.
MANGANESE	MG/L	0.38	0.39	0.39	0.39	0.39
MERCURY	MG/L	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
MOLYBDENUM	MG/L	0.18	0.11	0.11	0.11	0.11
NICKEL	MG/L	0.09	0.09	0.09	0.09	0.09
NITRATE	MG/L	45.	66.	66.	65.	68.
NITRITE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
ORG. CARBON	MG/L	-	-	-	-	-
PH	SU	7.3	7.3	7.3	7.3	7.3
PHOSPHATE	MG/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
POTASSIUM	MG/L	8.41	8.83	8.83	8.83	8.83
RA-226	PCI/L	-	-	-	-	-
RA-228	PCI/L	-	-	-	-	-
SELENIUM	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
SILICA	MG/L	4.	4.	4.	4.	4.
SILVER	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
SODIUM	MG/L	1740.	1830.	1830.	1830.	1830.
STRONTIUM	MG/L	10.8	11.2	11.2	11.2	11.2
SULFATE	MG/L	4330.	4460.	4460.	4460.	4460.
TEMPERATURE	C - DEGREE	18.	18.	18.	18.	18.
TIN	MG/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
TOTAL SOLIDS	MG/L	7620.	7690.	7980.	7920.	7930.
URANIUM	MG/L	0.0201	0.0231	0.0254	0.0331	0.035
VANADIUM	MG/L	0.1	0.12	0.11	0.1	0.12
ZINC	MG/L	0.015	0.016	0.017	0.016	0.016

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		562-01 09/07/86		562-01 02/27/87		562-01 10/02/87		562-01 04/05/88		811-01 10/22/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	701.		745.		588.		635.		1019.	
ALUMINUM	MG/L	0.2		< 0.1		< 0.1		0.2		< 0.1	
AMMONIUM	MG/L	0.3		< 0.1		< 0.1		< 0.1		0.3	
ANTIMONY	MG/L	< 0.003		-		-		-		-	
ARSENIC	MG/L	< 0.01		-		< 0.01		< 0.001		< 0.01	
BALANCE	%	-0.16		-		-		-		-	
BARIUM	MG/L	0.2		-		-		-		-	
BORON	MG/L	0.9		0.59		0.7		0.74		0.7	
CADMIUM	MG/L	< 0.001		-		-		-		-	
CALCIUM	MG/L	321.		298.		300.		270.		4.1	
CHLORIDE	MG/L	60.		118.		129.		120.		159.	
CHROMIUM	MG/L	< 0.01		0.02		< 0.01		0.01		< 0.01	
COBALT	MG/L	0.06		-		-		-		-	
CONDUCTANCE	UMHO/CM	5200.		4575.		7900.		5700.		2700.	
COPPER	MG/L	0.03		-		-		-		-	
FLUORIDE	MG/L	1.0		0.73		0.9		0.81		2.3	
GROSS ALPHA	PCI/L	-		-		82.	74.	100.	40.	27.	32.
GROSS BETA	PCI/L	-		-		0.0	40.	39.	29.	39.	25.
IRON	MG/L	0.37		0.08		< 0.03		0.19		< 0.03	
LEAD	MG/L	< 0.01		-		-		-		-	
MAGNESIUM	MG/L	144.		150.		167.		123.		1.33	
MANGANESE	MG/L	0.43		0.09		0.49		0.49		0.01	
MERCURY	MG/L	< 0.0002		-		-		-		-	
MOLYBDENUM	MG/L	0.18		< 0.1		0.02		0.12		< 0.01	
NICKEL	MG/L	0.05		-		-		-		-	
NITRATE	MG/L	130.		133.		173.		62.		< 1.0	
NITRITE	MG/L	< 0.1		-		-		-		-	
ORG. CARBON	MG/L	-		-		25.		237.		< 1.	
PH	SU	7.03		6.93		6.9		6.9		8.0	
PHOSPHATE	MG/L	< 0.1		-		-		-		-	
POTASSIUM	MG/L	8.48		5.10		7.2		6.25		1.35	
RA-226	PCI/L	-		-		1.3	0.3	0.2	0.2	0.1	0.1
RA-228	PCI/L	-		-		1.8	1.0	0.9	0.8	2.1	1.1
SELENIUM	MG/L	< 0.005		0.32		0.020		0.164		< 0.005	
SILICA	MG/L	4.		-		-		-		-	
SILVER	MG/L	< 0.01		-		-		-		-	
SODIUM	MG/L	1900.		1910.		1750.		1570.		740.	
STRONTIUM	MG/L	0.8		-		-		-		-	
SULFATE	MG/L	4480.		4510.		4600.		3550.		450.	
TEMPERATURE	C - DEGREE	18.5		16.5		16.5		15.9		15.5	
TIN	MG/L	< 0.005		-		-		-		-	
TOTAL SOLIDS	MG/L	7160.		7610.		7440.		7070.		2050.	
URANIUM	MG/L	0.0354		0.0462		0.146		0.0792		< 0.003	
VANADIUM	MG/L	0.38		-		< 0.01		0.04		< 0.01	
ZINC	MG/L	0.020		-		0.022		0.007		0.006	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		811-01 01/11/88		813-01 10/06/87		813-01 01/07/88					
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	937.		670.		651.					
ALUMINUM	MG/L	< 0.1		< 0.1		0.2					
AMMONIUM	MG/L	< 0.1		0.2		< 0.1					
ANTIMONY	MG/L	-		-		-					
ARSENIC	MG/L	< 0.01		0.01		0.023					
BALANCE	%	-		-		-					
BARIUM	MG/L	-		-		-					
BORON	MG/L	0.81		0.8		0.7					
CADMIUM	MG/L	-		-		-					
CALCIUM	MG/L	4.17		210.		212.					
CHLORIDE	MG/L	150.		116.		110.					
CHROMIUM	MG/L	0.07		< 0.01		0.01					
COBALT	MG/L	-		-		-					
CONDUCTANCE	UMHO/CM	2460.		7000.		6540.					
COPPER	MG/L	-		-		-					
FLUORIDE	MG/L	2.19		1.0		0.96					
GROSS ALPHA	PCI/L	4.3	9.7	44.	67.	150.	50.				
GROSS BETA	PCI/L	3.5	6.7	31.	48.	52.	32.				
IRON	MG/L	0.3		< 0.03		0.19					
LEAD	MG/L	-		-		-					
MAGNESIUM	MG/L	1.24		122.		111.					
MANGANESE	MG/L	0.02		0.17		0.15					
MERCURY	MG/L	-		-		-					
MOLYBDENUM	MG/L	0.02		0.07		0.22					
NICKEL	MG/L	-		-		-					
NITRATE	MG/L	< 0.1		67.		12.					
NITRITE	MG/L	-		-		-					
ORG. CARBON	MG/L	229.		15.		227.					
PH	SU	8.1		6.90		6.9					
PHOSPHATE	MG/L	-		-		-					
POTASSIUM	MG/L	1.45		6.3		6.68					
RA-226	PCI/L	0.1	0.1	2.6	0.5	0.1	0.2				
RA-228	PCI/L	0.	0.8	1.3	0.8	1.4	0.9				
SELENIUM	MG/L	0.033		0.007		0.178					
SILICA	MG/L	-		-		-					
SILVER	MG/L	-		-		-					
SODIUM	MG/L	756.		1660.		1870.					
STRONTIUM	MG/L	-		-		-					
SULFATE	MG/L	532.		3900.		4140.					
TEMPERATURE	C - DEGREE	14.3		17.0		15.7					
TIN	MG/L	-		-		-					
TOTAL SOLIDS	MG/L	2120.		6820.		6770.					
URANIUM	MG/L	< 0.0003		0.070		0.0707					
VANADIUM	MG/L	< 0.01		< 0.01		0.03					
ZINC	MG/L	0.009		0.019		0.021					

MAPPER DATA FILE NAME: GRN01*UDPGW0101665

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: CONGLOMERATE
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE						
		561-01 06/04/86	561-01 09/07/86	561-01 02/27/87	561-01 10/01/87		561-01 01/10/88	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	745.	707.	790.	606.		606.	
ALUMINUM	MG/L	13.1	5.3	0.8	< 0.1		0.7	
AMMONIUM	MG/L	1.2	0.8	0.6	0.2		0.7	
ANTIMONY	MG/L	< 0.003	< 0.003	-	-		-	
ARSENIC	MG/L	< 0.01	< 0.01	-	0.02		0.01	
BALANCE	%	-3.92	1.05	-	-		-	
BARIUM	MG/L	0.4	0.3	-	-		-	
BORON	MG/L	0.4	0.9	0.76	0.7		0.71	
CADMIUM	MG/L	< 0.001	< 0.001	-	-		-	
CALCIUM	MG/L	101.	19.6	4.94	4.1		4.40	
CHLORIDE	MG/L	190.	430.	198.	226.		240.	
CHROMIUM	MG/L	0.04	0.04	< 0.01	< 0.01		0.02	
COBALT	MG/L	0.09	< 0.05	-	-		-	
CONDUCTANCE	UMHO/CM	2200.	2200.	1925.	2310.		2330.	
COPPER	MG/L	0.04	< 0.02	-	-		-	
FLUORIDE	MG/L	2.9	3.2	2.92	2.7		2.87	
GROSS ALPHA	PCI/L	-	-	-	0.0	13.	0.	11.
GROSS BETA	PCI/L	-	-	-	2.9	12.	0.	11.
IRON	MG/L	9.53	2.13	0.16	< 0.03		0.32	
LEAD	MG/L	< 0.01	< 0.01	-	-		-	
MAGNESIUM	MG/L	12.2	3.01	1.32	0.90		1.03	
MANGANESE	MG/L	0.87	0.12	0.02	< 0.01		< 0.01	
MERCURY	MG/L	< 0.0002	< 0.0002	-	-		-	
MOLYBDENUM	MG/L	0.13	0.15	< 0.1	< 0.01		< 0.01	
NICKEL	MG/L	0.08	< 0.04	-	-		-	
NITRATE	MG/L	0.3	< 1.	< 0.1	< 1.0		< 0.1	
NITRITE	MG/L	< 0.1	< 0.1	-	-		-	
ORG. CARBON	MG/L	-	-	-	5.		136.	
PH	SU	8.16	8.23	8.44	8.15		8.5	
PHOSPHATE	MG/L	0.1	< 0.1	-	-		-	
POTASSIUM	MG/L	5.93	2.40	1.60	0.92		1.41	
RA-226	PCI/L	-	-	-	0.1	0.1	0.1	0.1
RA-228	PCI/L	-	-	-	2.2	0.9	0.3	0.8
SELENIUM	MG/L	< 0.005	< 0.005	0.11	< 0.005		0.051	
SILICA	MG/L	4.	4.	-	-		-	
SILVER	MG/L	< 0.01	< 0.01	-	-		-	
SODIUM	MG/L	556.	840.	723.	680.		666.	
STRONTIUM	MG/L	0.5	0.2	-	-		-	
SULFATE	MG/L	700.	481.	670.	650.		648.	
TEMPERATURE	C - DEGREE	19.	19.5	17.0	17.0		15.5	
TIN	MG/L	< 0.005	< 0.005	-	-		-	
TOTAL SOLIDS	MG/L	1940.	1890.	2120.	1870.		1900.	
URANIUM	MG/L	0.0008	< 0.0003	0.0028	< 0.003		< 0.0003	
VANADIUM	MG/L	0.1	0.18	-	< 0.01		< 0.01	
ZINC	MG/L	0.062	0.020	-	0.005		0.013	

MAPPER DATA FILE NAME: GRN01*UDPGU0101664

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE					
		708-01 09/15/82	708-01 11/23/82	708-01 09/07/86	708-01 02/25/87	708-01 01/11/88	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	272.00	261.00	283.	263.	206.	
ALUMINUM	MG/L	0.01	0.037	0.2	< 0.1	0.35	
AMMONIUM	MG/L	-	-	< 0.1	8.2	< 0.1	
ANTIMONY	MG/L	-	-	< 0.003	-	-	
ARSENIC	MG/L	< 0.01	0.007	< 0.01	-	0.01	
BALANCE	%	-	-	0.01	-	-	
BARIUM	MG/L	0.021	-	< 0.1	-	-	
BICARBONATE	MG/L	332.00	318.00	-	-	-	
BORON	MG/L	-	-	0.5	0.23	0.36	
CADMIUM	MG/L	< 0.01	-	< 0.001	-	-	
CALCIUM	MG/L	440.00	319.00	512.	383.	405.	
CHLORIDE	MG/L	343.00	592.00	150.	358.	320.	
CHROMIUM	MG/L	< 0.01	-	0.03	0.04	0.01	
COBALT	MG/L	-	-	0.09	-	-	
CONDUCTANCE	UMHO/CM	10400.00	9670.00	6750.	4650.	6700.	
COPPER	MG/L	0.033	-	0.03	-	-	
FLUORIDE	MG/L	< 1.00	< 1.00	0.7	0.50	0.5	
GROSS ALPHA	PCI/L	-	-	-	-	31.	37.
GROSS BETA	PCI/L	-	-	-	-	17.	27.
IRON	MG/L	< 0.05	-	0.06	0.05	0.2	
LEAD	MG/L	< 0.01	-	< 0.01	-	-	
MAGNESIUM	MG/L	325.00	319.00	320.	313.	190.	
MANGANESE	MG/L	-	-	0.03	0.03	0.02	
MERCURY	MG/L	< 0.002	-	< 0.0002	-	-	
MOLYBDENUM	MG/L	< 0.05	< 0.05	0.11	< 0.1	0.13	
NICKEL	MG/L	-	-	0.06	-	-	
NITRATE	MG/L	2.00	< 5.00	9.	1.6	1.3	
NITRITE	MG/L	-	-	< 0.1	-	-	
ORG. CARBON	MG/L	-	-	-	-	55.9	
PH	SU	6.97	6.97	7.28	7.61	7.1	
PHOSPHATE	MG/L	-	-	< 0.1	-	-	
POTASSIUM	MG/L	21.00	18.00	22.1	16.6	12.9	
RA-226	PCI/L	< 2.00	< 2.00	-	-	0.1	0.1
RA-228	PCI/L	< 2.00	-	-	-	0.0	0.8
SELENIUM	MG/L	0.013	0.014	< 0.005	0.40	0.284	
SILCON	MG/L	6.70	-	-	-	-	
SILICA	MG/L	-	-	7.	-	-	
SILVER	MG/L	< 0.01	-	< 0.01	-	-	
SODIUM	MG/L	2225.00	2100.00	1980.	2320.	1760.	
STRONTIUM	MG/L	-	-	0.8	-	-	
SULFATE	MG/L	5409.00	5684.00	6180.	6280.	4800.	
TEMPERATURE	C - DEGREE	21.00	13.00	20.	10.0	8.2	
TH-230	PCI/L	< 0.10	-	-	-	-	
TIN	MG/L	-	-	< 0.005	-	-	
TOTAL SOLIDS	MG/L	8940.00	9190.00	9310.	10400.	7800.	
URANIUM	MG/L	0.027	0.034	0.0080	0.0077	0.0175	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: CROSS GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		708-01 09/15/82	708-01 11/23/82	708-01 09/07/86	708-01 02/25/87	708-01 01/11/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
VANADIUM	MG/L	< 0.05	< 0.05	0.22	-	0.06
ZINC	MG/L	-	-	0.024	-	0.016

MAPPER DATA FILE NAME: GRN01*UDPGWQ101663

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		702-01 07/14/82		702-01 09/16/82		702-01 06/07/86		702-01 09/07/86		702-02 09/07/86	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	215.00		270.00		237.		245.		245.	
ALUMINUM	MG/L	< 0.10		0.01		-		0.3		0.3	
AMMONIUM	MG/L	-		-		21.		24.		24.	
ANTIMONY	MG/L	-		-		-		< 0.003		< 0.003	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		< 0.01		< 0.01	
BALANCE	%	-		-		-0.12		0.08		0.08	
BARIUM	MG/L	< 0.10		0.02		-		< 0.1		< 0.1	
BICARBONATE	MG/L	262.00		329.00		-		-		-	
BORON	MG/L	-		-		-		0.4		0.4	
CADMIUM	MG/L	< 0.01		< 0.01		-		< 0.001		< 0.001	
CALCIUM	MG/L	470.00		-		499.		520.		520.	
CHLORIDE	MG/L	120.00		101.00		93.		100.		100.	
CHROMIUM	MG/L	< 0.01		< 0.01		-		0.02		0.02	
COBALT	MG/L	-		-		-		< 0.05		< 0.05	
CONDUCTANCE	UMHO/CM	4900.00		5560.00		3500.		3900.		3900.	
COPPER	MG/L	0.027		0.011		-		0.03		0.03	
FLUORIDE	MG/L	2.00		2.00		0.8		0.9		0.9	
GROSS ALPHA	PCI/L	700.00		-		-		-		-	
GROSS BETA	PCI/L	-		-		-		-		-	
IRON	MG/L	< 0.05		< 0.05		0.07		< 0.03		< 0.03	
LEAD	MG/L	< 0.01		< 0.01		-		< 0.01		< 0.01	
MAGNESIUM	MG/L	160.00		150.00		122.		175.		175.	
MANGANFSE	MG/L	-		-		0.37		0.47		0.47	
MERCURY	MG/L	< 0.002		< 0.002		-		< 0.0002		< 0.0002	
MOLYBDENUM	MG/L	< 0.05		< 0.05		0.27		0.09		0.10	
NICKEL	MG/L	-		-		-		0.05		0.05	
NITRATE	MG/L	2.00		14.00		3.		440.		440.	
NITRITE	MG/L	-		-		-		< 0.1		< 0.1	
ORG. CARBON	MG/L	-		-		-		70.		70.	
PB-210	PCI/L	-		-		-		4.4	1.6	3.5	1.6
PH	SU	7.20		6.95		7.34		6.81		6.81	
PHOSPHATE	MG/L	-		-		-		< 0.1		< 0.1	
PO-210	PCI/L	-		-		-		0.4	0.7	0.2	0.7
POTASSIUM	MG/L	14.00		14.00		11.7		14.8		14.8	
RA-226	PCI/L	< 2.00		< 2.00		0.	0.1	0.1	0.2	0.1	0.2
RA-228	PCI/L	< 5.00		< 2.00		0.	0.9	0.0	1.0	0.8	1.0
SFLENIUM	MG/L	0.25		0.083		< 0.005		0.100		0.099	
SILCON	MG/L	10.60		-		-		-		-	
SILICA	MG/L	-		-		-		9.		9.	
SILVER	MG/L	0.01		< 0.01		-		< 0.01		< 0.01	
SODIUM	MG/L	830.00		901.00		798.		800.		800.	
STRONTIUM	MG/L	-		-		-		5.5		5.5	
SULFATE	MG/L	3260.00		3005.00		3070.		2980.		2980.	
TEMPERATURE	C - DEGREE	26.00		16.00		15.		20.		20.	
TH-230	PCI/L	< 0.10		< 0.10		-		3.1	1.1	1.8	0.8
TIN	MG/L	-		-		-		< 0.005		< 0.005	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		702-01 07/14/82	702-01 09/16/82	702-01 06/07/86	702-01 09/07/86	702-02 09/07/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	4990.00	4870.00	5050.	5090.	5100.
URANIUM	MG/L	0.90	0.70	0.739	1.19	1.19
VANADIUM	MG/L	< 0.05	< 0.05	-	0.24	-
ZINC	MG/L	-	-	-	0.023	0.023

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE												
		702-03 09/07/86			702-04 09/07/86			702-05 09/07/86			702-01 03/13/87		702-02 03/13/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY			PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3		245.			245.			245.			271.		271.
ALUMINUM	MG/L		0.3			0.3			0.3			0.1		0.2
AMMONIUM	MG/L		24.			24.			24.			18.		19.
ANTIMONY	MG/L	<	0.003		<	0.003		<	0.003			-		-
ARSENIC	MG/L	<	0.01		<	0.01		<	0.01			-		-
BALANCE	%		0.08			0.08			0.08			-		-
BARIUM	MG/L	<	0.1		<	0.1		<	0.1			-		-
BICARBONATE	MG/L		-			-			-			-		-
BORON	MG/L		0.4			0.4			0.4			0.7		0.7
CADMIUM	MG/L	<	0.001		<	0.001		<	0.001			-		-
CALCIUM	MG/L		520.			520.			520.			475.		475.
CHLORIDE	MG/L		100.			100.			100.			76.		76.
CHROMIUM	MG/L		0.02			0.02			0.02			0.02		0.02
COBALT	MG/L	<	0.05		<	0.05		<	0.05			-		-
CONDUCTANCE	UMHO/CM		3900.			3900.			3900.			2650.		2650.
COPPER	MG/L		0.03			0.03			0.03			-		-
FLUORIDE	MG/L		0.9			0.9			0.9			0.7		0.7
GROSS ALPHA	PCI/L		-			-			-			-		-
GROSS BETA	PCI/L		-			-			-			-		-
IRON	MG/L	<	0.03		<	0.03		<	0.03			0.05		0.04
LEAD	MG/L	<	0.01		<	0.01		<	0.01			-		-
MAGNESIUM	MG/L		175.			175.			175.			150.		150.
MANGANESE	MG/L		0.47			0.47			0.47			0.43		0.42
MERCURY	MG/L	<	0.0002		<	0.0002		<	0.0002			-		-
MOLYBDENUM	MG/L		0.09			0.10			0.10		<	0.1	<	0.1
NICKEL	MG/L		0.05			0.05			0.05			-		-
NITRATE	MG/L		440.			440.			440.			142.		142.
NITRITE	MG/L	<	0.1		<	0.1		<	0.1			-		-
ORG. CARBON	MG/L		70.			70.			70.			-		-
PB-210	PCI/L		4.0	1.4		4.2	1.9		5.2	1.7		-		-
PH	SU		6.81			6.81			6.81			6.86		6.86
PHOSPHATE	MG/L	<	0.1		<	0.1		<	0.1			-		-
PO-210	PCI/L		0.2	1.2		0.0	0.6		0.3	0.7		-		-
POTASSIUM	MG/L		14.8			14.8			14.8			12.4		12.5
RA-226	PCI/L		0.1	0.2		0.1	0.2		0.2	0.2		-		-
RA-228	PCI/L		0.0	1.0		0.0	0.8		0.0	0.8		-		-
SELENIUM	MG/L		0.099			0.100			0.100			0.049		0.050
SILCON	MG/L		-			-			-			-		-
SILICA	MG/L		9.			9.			9.			-		-
SILVER	MG/L	<	0.01		<	0.01		<	0.01			-		-
SODIUM	MG/L		800.			800.			800.			767.		767.
STRONTIUM	MG/L		5.5			5.5			5.5			-		-
SULFATE	MG/L		2980.			2980.			2980.			2950.		2950.
TEMPERATURE	C - DEGREE		20.0			20.			20.			14.0		14.0
TH-230	PCI/L		1.6	0.8		1.9	0.9		2.8	1.0		-		-
TIN	MG/L	<	0.005		<	0.005		<	0.005			-		-

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		702-03 09/07/86	702-04 09/07/86	702-05 09/07/86	702-01 03/13/87	702-02 03/13/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	5090.	5100.	5090.	4860.	4860.
URANIUM	MG/L	1.22	1.10	1.16	1.96	1.90
VANADIUM	MG/L	0.24	0.24	0.24	-	-
ZINC	MG/L	0.023	0.023	0.023	-	-

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

LOCATION ID - SAMPLE ID AND LOG DATE

PARAMETER	UNIT OF MEASURF	702-03 03/13/87		702-04 03/13/87		702-05 03/13/87		702-01 10/06/87		702-01 01/12/88	
		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	271.		271.		271.		265.		217.	
ALUMINUM	MG/L	0.2		0.2		0.2		< 0.1		0.39	
AMMONIUM	MG/L	19.		18.		19.		42.		24.8	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	-		-		-		< 0.01		< 0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	0.7		0.7		0.7		0.4		0.44	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	474.		474.		475.		460.		449.	
CHLORIDE	MG/L	76.		76.		76.		110.		86.	
CHROMIUM	MG/L	0.02		0.03		0.03		< 0.01		0.02	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	2650.		2650.		2650.		4800.		4090.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.7		0.7		0.7		0.8		0.76	
GROSS ALPHA	PCI/L	-		-		-		450.	90.	690.	60.
GROSS BETA	PCI/L	-		-		-		147.	44.	340.	20.
IRON	MG/L	0.04		0.03		0.04		< 0.03		0.24	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	150.		151.		150.		140.		126.	
MANGANESE	MG/L	0.44		0.42		0.42		0.27		0.28	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.1		< 0.1		< 0.1		< 0.01		0.10	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	142.		142.		142.		50.		97.5	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	-		-		-		8.		79.4	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	6.86		6.86		6.86		6.90		6.85	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	12.5		12.5		12.5		2.7		10.4	
RA-226	PCI/L	-		-		-		0.3	0.2	0.	0.1
RA-228	PCI/L	-		-		-		2.8	1.0	0.3	0.7
SELENIUM	MG/L	0.049		0.049		0.049		0.040		0.319	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	768.		767.		768.		890.		806.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	2950.		2950.		2950.		3100.		2900.	
TEMPERATURE	C - DEGREE	14.0		14.0		14.0		16.0		14.7	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		702-03 03/13/87	702-04 03/13/87	702-05 03/13/87	702-01 10/06/87	702-01 01/12/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	4860.	4860.	4860.	5280.	4820.
URANIUM	MG/L	2.07	2.15	2.23	0.79	1.09
VANADIUM	MG/L	-	-	-	< 0.01	0.07
ZINC	MG/L	-	-	-	0.009	0.006

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		704-01 07/14/82		704-01 06/05/86		704-01 09/07/86		704-01 03/13/87		704-01 01/12/88	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	400.00		368.		390.		376.		350.	
ALUMINUM	MG/L	< 0.10		-		0.3		0.2		0.37	
AMMONIUM	MG/L	-		41.		38.		36.		32.3	
ANTIMONY	MG/L	-		-		< 0.003		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		< 0.01		-		< 0.01	
BALANCE	%	-		-0.21		-0.09		-		-	
BARIUM	MG/L	-		-		< 0.1		-		-	
BICARBONATE	MG/L	488.00		-		-		-		-	
BORON	MG/L	-		-		0.4		0.5		0.55	
CADMIUM	MG/L	-		-		< 0.001		-		-	
CALCIUM	MG/L	450.00		483.		531.		433.		419.	
CHLORIDE	MG/L	300.00		258.		480.		225.		220.	
CHROMIUM	MG/L	-		-		0.02		0.02		0.02	
COBALT	MG/L	-		-		0.06		-		-	
CONDUCTANCE	UMHO/CM	8160.00		2850.		6100.		4050.		6780.	
COPPER	MG/L	-		-		0.04		-		-	
FLUORIDE	MG/L	2.00		1.1		1.2		1.1		1.09	
GROSS ALPHA	PCI/L	-		200.	110.	-		-		190.	60.
GROSS BETA	PCI/L	-		180.	60.	-		-		150.	30.
IRON	MG/L	< 0.05		0.09		0.03		0.05		0.2	
LEAD	MG/L	-		-		< 0.01		-		-	
MAGNESIUM	MG/L	280.00		231.		247.		220.		205.	
MANGANESE	MG/L	-		0.98		0.48		0.52		0.34	
MERCURY	MG/L	-		-		< 0.0002		-		-	
MOLYBDENUM	MG/L	< 0.05		0.25		0.14		< 0.1		0.17	
NICKEL	MG/L	-		-		0.05		-		-	
NITRATE	MG/L	4.00		20.		350.		167.		57.	
NITRITE	MG/L	-		-		< 0.1		-		-	
ORG. CARBON	MG/L	-		104.		70.		-		112.	
PB-210	PCI/L	-		1.	0.9	1.5	1.7	-		-	
PH	SU	7.90		7.16		7.11		7.15		7.0	
PHOSPHATE	MG/L	-		-		< 0.1		-		-	
PO-210	PCI/L	-		0.4	0.6	0.0	0.6	-		-	
POTASSIUM	MG/L	16.00		18.7		20.0		32.0		13.8	
RA-226	PCI/L	< 2.00		-		0.0	0.2	-		0.	0.1
RA-228	PCI/L	-		-		0.0	1.1	-		0.1	0.7
SELENIUM	MG/L	0.012		< 0.005		0.092		< 0.002		0.223	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		10.		-		-	
SILVER	MG/L	-		-		< 0.01		-		-	
SODIUM	MG/L	1550.00		1290.		2010.		1840.		1690.	
STRONTIUM	MG/L	-		-		6.6		-		-	
SULFATE	MG/L	4580.00		4200.		5290.		5150.		4840.	
TEMPERATURE	C - DEGREE	24.00		15.		22.		14.5		13.7	
TH-230	PCI/L	-		0.	0.2	1.1	0.7	-		-	
TIN	MG/L	-		-		< 0.005		-		-	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		704-01 07/14/82	704-01 06/05/86	704-01 09/07/86	704-01 03/13/87	704-01 01/12/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	7420.00	8580.	8490.	8090.	7810.
URANIUM	MG/L	0.70	0.487	0.288	0.254	0.411
VANADIUM	MG/L	< 0.05	-	0.24	-	0.07
ZINC	MG/L	-	-	0.025	-	0.012

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		705-01 07/15/82	705-01 09/16/82	705-01 06/06/86	705-01 09/07/86	705-01 02/24/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	250.00	244.00	294.	298.	346.
ALUMINUM	MG/L	0.27	< 0.01	-	0.4	< 0.1
AMMONIUM	MG/L	-	-	27.	41.	8.0
ANTIMONY	MG/L	-	-	-	< 0.003	-
ARSENIC	MG/L	< 0.01	< 0.01	< 0.01	< 0.01	-
BALANCE	%	-	-	-0.09	-0.04	-
BARIUM	MG/L	-	0.014	-	< 0.1	-
BICARBONATE	MG/L	305.00	298.00	-	-	-
BORON	MG/L	-	-	-	0.6	0.35
CADMIUM	MG/L	-	< 0.01	-	< 0.001	-
CALCIUM	MG/L	450.00	490.00	456.	483.	413.
CHLORIDE	MG/L	400.00	324.00	321.	140.	369.
CHROMIUM	MG/L	-	< 0.01	-	0.02	0.04
COBALT	MG/L	-	-	-	0.08	-
CONDUCTANCE	UMHO/CM	15400.00	8960.00	4900.	6200.	4700.
COPPER ,	MG/L	-	0.024	-	0.04	-
FLUORIDE	MG/L	1.00	< 1.00	0.8	0.8	0.63
GROSS ALPHA	PCI/L	-	-	-	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	< 0.05	< 0.05	0.07	0.06	0.05
LEAD	MG/L	-	< 0.01	-	< 0.01	-
MAGNESIUM	MG/L	280.00	330.00	268.	316.	315.
MANGANESE	MG/L	-	-	0.02	0.03	0.03
MERCURY	MG/L	-	< 0.002	-	< 0.0002	-
MOLYBDENUM	MG/L	< 0.05	< 0.05	0.24	0.16	< 0.1
NICKEL	MG/L	-	-	-	0.10	-
NITRATE	MG/L	1.00	6.00	5.	22.	8.9
NITRITE	MG/L	-	-	-	< 0.1	-
ORG. CARBON	MG/L	-	-	-	-	-
PB-210	PCI/L	-	-	-	-	-
PH	SU	7.20	7.13	7.46	7.31	7.34
PHOSPHATE	MG/L	-	-	-	< 0.1	-
PO-210	PCI/L	-	-	-	-	-
POTASSIUM	MG/L	16.00	18.00	19.4	20.4	17.0
RA-226	PCI/L	< 2.00	< 2.00	-	-	-
RA-228	PCI/L	-	< 2.00	-	-	-
SELENIUM	MG/L	0.023	0.014	< 0.005	< 0.005	0.41
SILCON	MG/L	-	6.70	-	-	-
SILICA	MG/L	-	-	-	7.	-
SILVER	MG/L	-	< 0.01	-	< 0.01	-
SODIUM	MG/L	1680.00	1840.00	2100.	2090.	2450.
STRONTIUM	MG/L	-	-	-	6.6	-
SULFATE	MG/L	5410.00	5071.00	5930.	6420.	6590.
TEMPERATURE	C - DEGREE	18.00	19.00	15.	18.	14.
TH-230	PCI/L	-	< 0.10	-	-	-
TIN	MG/L	-	-	-	< 0.005	-

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		705-01 07/15/82	705-01 09/16/82	705-01 06/06/86	705-01 09/07/86	705-01 02/24/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	8390.00	8180.00	9870.	9730.	10400.
URANIUM	MG/L	0.09	0.118	0.0419	0.0485	0.0578
VANADIUM	MG/L	< 0.05	< 0.05	-	0.21	-
ZINC	MG/L	-	-	-	0.027	-

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE									
		705-01 10/06/87		705-01 01/12/88		808-01 10/23/87		808-02 10/23/87		808-03 10/23/87	
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	302.		335.		270.		270.		270.	
ALUMINUM	MG/L	< 0.1		0.37		< 0.1		< 0.1		< 0.1	
AMMONIUM	MG/L	42.		36.1		19.1		18.7		18.7	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		0.02		< 0.01		< 0.01		< 0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	0.4		0.55		0.4		0.4		0.4	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	420.		425.		530.		520.		510.	
CHLORIDE	MG/L	360.		370.		101.		100.		99.	
CHROMIUM	MG/L	< 0.01		0.02		< 0.01		< 0.01		< 0.01	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	9800.		9070.		4500.		4500.		4500.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.8		0.66		0.6		0.7		0.7	
GROSS ALPHA	PCI/L	115.	68.	59.	44.	980.	120.	950.	130.	700.	115.
GROSS BETA	PCI/L	76.	57.	93.	33.	310.	56.	450.	88.	450.	75.
IRON	MG/L	< 0.03		0.22		< 0.03		< 0.03		< 0.03	
LFAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	310.		315.		165.		161.		157.	
MANGANESE	MG/L	< 0.01		0.03		0.51		0.45		0.46	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	0.03		0.21		< 0.01		< 0.01		< 0.01	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	11.5		3.5		137.		143.		129.	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	5.		97.3		12.		13.		12.	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.2		7.15		6.8		6.8		6.8	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	16.3		17.7		10.5		10.5		10.5	
RA-226	PCI/L	0.5	0.3	0.1	0.1	0.0	0.1	0.2	0.1	0.1	0.1
RA-228	PCI/L	1.2	0.9	0.1	0.8	0.1	0.9	0.2	1.0	0.0	0.9
SELENIUM	MG/L	< 0.005		0.367		0.32		0.31		0.35	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	2300.		2540.		720.		700.		690.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	5800.		6890.		3000.		3000.		3000.	
TEMPERATURE	C - DEGREE	16.5		15.0		17.0		17.0		17.0	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		705-01 10/06/87	705-01 01/12/88	808-01 10/23/87	808-02 10/23/87	808-03 10/23/87
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	10400.	10800.	4980.	4960.	4970.
URANIUM	MG/L	0.081	0.0617	1.31	1.64	1.23
VANADIUM	MG/L	< 0.01	0.07	< 0.01	< 0.01	< 0.01
ZINC	MG/L	< 0.005	0.007	0.036	0.042	0.029

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

PARAMETER	UNIT OF MEASURE	LOCATION ID - SAMPLE ID AND LOG DATE									
		808-04 10/23/87		808-05 10/23/87		808-01 01/11/88		808-02 01/11/88		808-03 01/11/88	
		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	270.		270.		226.		226.		226.	
ALUMINUM	MG/L	< 0.1		< 0.1		0.38		0.39		0.4	
AMMONIUM	MG/L	18.9		18.9		19.1		18.6		18.6	
ANTIMONY	MG/L	-		-		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		0.01		< 0.01		0.01	
BALANCE	%	-		-		-		-		-	
BARIUM	MG/L	-		-		-		-		-	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	0.3		0.4		0.47		0.45		0.43	
CADMIUM	MG/L	-		-		-		-		-	
CALCIUM	MG/L	460.		490.		460.		452.		458.	
CHLORIDE	MG/L	98.		102.		83.		78.		78.	
CHROMIUM	MG/L	< 0.01		< 0.01		0.01		0.01		0.01	
COBALT	MG/L	-		-		-		-		-	
CONDUCTANCE	UMHO/CM	4500.		4500.		4020.		4020.		4020.	
COPPER	MG/L	-		-		-		-		-	
FLUORIDE	MG/L	0.7		0.8		0.72		0.73		0.72	
GROSS ALPHA	PCI/L	1020.	160.	810.	110.	950.	60.	900.	60.	920.	60.
GROSS BETA	PCI/L	410.	180.	370.	59.	480.	20.	500.	20.	490.	20.
IRON	MG/L	< 0.03		< 0.03		0.2		0.2		0.2	
LEAD	MG/L	-		-		-		-		-	
MAGNESIUM	MG/L	156.		150.		133.		130.		132.	
MANGANESE	MG/L	0.45		0.49		0.56		0.55		0.54	
MERCURY	MG/L	-		-		-		-		-	
MOLYBDENUM	MG/L	< 0.01		< 0.01		0.10		0.11		0.15	
NICKEL	MG/L	-		-		-		-		-	
NITRATE	MG/L	142.		131.		70.		69.		68.	
NITRITE	MG/L	-		-		-		-		-	
ORG. CARBON	MG/L	12.		8.		76.		77.2		76.6	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	6.8		6.8		7.0		7.0		7.0	
PHOSPHATE	MG/L	-		-		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	10.5		10.5		10.5		10.5		10.6	
RA-226	PCI/L	0.0	0.2	0.0	0.1	0.	0.1	0.	0.1	0.	0.1
RA-228	PCI/L	7.5	1.6	0.0	0.9	0.1	0.8	0.4	0.8	0.	0.7
SELENIUM	MG/L	0.30		0.35		0.502		0.428		0.441	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	-		-		-		-		-	
SILVER	MG/L	-		-		-		-		-	
SODIUM	MG/L	670.		660.		702.		593.		702.	
STRONTIUM	MG/L	-		-		-		-		-	
SULFATE	MG/L	3000.		3000.		2560.		2560.		2570.	
TEMPERATURE	C - DEGREE	17.0		17.0		14.1		14.1		14.1	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	-		-		-		-		-	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE				
		808-04 10/23/87	808-05 10/23/87	808-01 01/11/88	808-02 01/11/88	808-03 01/11/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	4990.	4960.	4610.	4640.	4640.
URANIUM	MG/L	1.67	1.67	1.67	1.80	1.72
VANADIUM	MG/L	< 0.01	< 0.01	0.06	0.06	0.07
ZINC	MG/L	0.028	0.035	0.016	0.014	0.014

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE						
		808-04 01/11/88		808-05 01/11/88				
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE	+/-UNCERTAINTY	PARAMETER VALUF	+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	226.		226.				
ALUMINUM	MG/L	0.4		0.4				
AMMONIUM	MG/L	18.6		18.6				
ANTIMONY	MG/L	-		-				
ARSENIC	MG/L	< 0.01		< 0.01				
BALANCE	%	-		-				
BARIUM	MG/L	-		-				
BICARBONATE	MG/L	-		-				
BORON	MG/L	0.42		0.45				
CADMIUM	MG/L	-		-				
CALCIUM	MG/L	455.		456.				
CHLORIDE	MG/L	78.		78.				
CHROMIUM	MG/L	0.01		0.01				
COBALT	MG/L	-		-				
CONDUCTANCE	UMHO/CM	4020.		4020.				
COPPER	MG/L	-		-				
FLUORIDE	MG/L	0.7		0.7				
GROSS ALPHA	PCI/L	940.	60.	1200.	100.			
GROSS BETA	PCI/L	490.	20.	530.	20.			
IRON	MG/L	0.19		0.2				
LEAD	MG/L	-		-				
MAGNESIUM	MG/L	131.		132.				
MANGANESE	MG/L	0.53		0.54				
MERCURY	MG/L	-		-				
MOLYBDENUM	MG/L	0.11		0.10				
NICKEL	MG/L	-		-				
NITRATE	MG/L	63.		67.				
NITRITE	MG/L	-		-				
ORG. CARBON	MG/L	76.5		75.5				
PB-210	PCI/L	-		-				
PH	SU	7.0		7.0				
PHOSPHATE	MG/L	-		-				
PO-210	PCI/L	-		-				
POTASSIUM	MG/L	10.2		10.3				
RA-226	PCI/L	0.2	0.1	0.	0.1			
RA-228	PCI/L	0.	0.7	0.	0.8			
SELENIUM	MG/L	0.760		0.725				
SILCON	MG/L	-		-				
SILICA	MG/L	-		-				
SILVER	MG/L	-		-				
SODIUM	MG/L	699.		691.				
STRONTIUM	MG/L	-		-				
SULFATE	MG/L	2560.		2570.				
TEMPERATURE	C - DEGREE	14.1		14.1				
TH-230	PCI/L	-		-				
TIN	MG/L	-		-				

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: ON-SITE

		LOCATION ID - SAMPLE ID AND LOG DATE	
		808-04 01/11/88	808-05 01/11/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	4620.	4640.
URANIUM	MG/L	1.80	1.69
VANADIUM	MG/L	0.06	0.06
ZINC	MG/L	0.012	0.014

MAPPER DATA FILE NAME: GRN01*UDPGWQ101662

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: DOWN GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		706-01 07/14/82	706-01 11/23/82			
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	160.00	407.00			
ALUMINUM	MG/L	< 0.01	0.02			
ARSENIC	MG/L	< 0.01	0.007			
BARIUM	MG/L	< 0.10	-			
BICARBONATE	MG/L	120.00	497.00			
CADMIUM	MG/L	< 0.01	-			
CALCIUM	MG/L	530.00	458.00			
CHLORIDE	MG/L	360.00	400.00			
CHROMIUM	MG/L	0.029	-			
CONDUCTANCE	UMHO/CM	8500.00	8680.00			
COPPER	MG/L	0.065	-			
FLUORIDE	MG/L	1.00	< 1.00			
GROSS ALPHA	PCI/L	73.00	-			
IRON	MG/L	< 0.05	-			
LEAD	MG/L	< 0.01	-			
MAGNESIUM	MG/L	45.00	326.00			
MERCURY	MG/L	< 0.002	-			
MOLYBDENUM	MG/L	0.104	< 0.05			
NITRATE	MG/L	4.00	40.00			
PH	SU	7.01	7.01			
POTASSIUM	MG/L	23.00	20.00			
RA-226	PCI/L	< 2.00	< 2.00			
RA-228	PCI/L	< 5.00	-			
SELENIUM	MG/L	0.054	0.018			
SILCON	MG/L	4.70	-			
SILVER	MG/L	0.016	-			
SODIUM	MG/L	1480.00	1540.00			
SULFATE	MG/L	3750.00	5000.00			
TEMPERATURE	C - DEGREE	25.00	13.00			
TH-230	PCI/L	< 0.10	-			
TOTAL SOLIDS	MG/L	6290.00	8030.00			
URANIUM	MG/L	0.003	0.554			
VANADIUM	MG/L	< 0.05	< 0.05			

MAPPER DATA FILE NAME: GRN01*UDPGWQ101661

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		707-01 07/15/82	707-01 09/16/82	707-01 11/23/82	707-01 06/04/86	707-01 09/07/86
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	180.00	190.00	251.00	360.	176.
ALUMINUM	MG/L	0.13	< 0.01	0.023	0.4	0.2
AMMONIUM	MG/L	-	-	-	< 0.1	2.4
ANTIMONY	MG/L	-	-	-	< 0.003	< 0.003
ARSENIC	MG/L	< 0.01	< 0.01	0.006	< 0.01	< 0.01
BALANCE	%	-	-	-	-1.20	0.18
BARIUM	MG/L	< 0.10	0.015	< 0.05	0.3	< 0.1
BICARBONATE	MG/L	220.00	232.00	306.00	-	-
BORON	MG/L	-	-	-	0.6	0.4
CADMIUM	MG/L	< 0.01	< 0.01	< 0.005	< 0.001	< 0.001
CALCIUM	MG/L	450.00	470.00	460.00	488.	520.
CHLORIDE	MG/L	430.00	345.00	561.00	312.	590.
CHROMIUM	MG/L	< 0.01	< 0.01	< 0.005	0.05	0.02
COBALT	MG/L	-	-	-	0.09	0.07
CONDUCTANCE	UMHO/CM	8640.00	9650.00	9440.00	4900.	6200.
COPPER	MG/L	0.057	0.021	< 0.005	0.05	0.04
FLUORIDE	MG/L	1.00	< 1.00	< 1.00	0.6	0.7
GROSS ALPHA	PCI/L	200.00	-	230.00	-	-
GROSS BETA	PCI/L	-	-	-	-	-
IRON	MG/L	< 0.05	< 0.05	< 0.05	0.18	0.04
LEAD	MG/L	< 0.01	< 0.01	< 0.005	< 0.01	< 0.01
MAGNESIUM	MG/L	360.00	225.00	361.00	368.	388.
MANGANESE	MG/L	-	-	-	0.04	0.03
MERCURY	MG/L	< 0.002	< 0.002	< 0.002	< 0.0002	< 0.0002
MOLYBDENUM	MG/L	< 0.05	< 0.05	< 0.05	0.18	0.06
NICKEL	MG/L	-	-	-	0.09	0.08
NITRATE	MG/L	1.00	14.00	< 5.00	11.	120.
NITRITE	MG/L	-	-	-	< 0.1	< 0.1
ORG. CARBON	MG/L	-	-	-	-	41.
PB-210	PCI/L	-	-	-	-	0.0 1.3
PH	SU	7.10	7.12	6.93	7.88	7.56
PHOSPHATE	MG/L	-	-	-	< 0.1	< 0.1
PO-210	PCI/L	-	-	-	-	0.0 0.6
POTASSIUM	MG/L	18.00	21.00	18.00	19.3	26.1
RA-226	PCI/L	4.00	< 2.00	< 2.00	0.2 0.2	0.2 0.2
RA-228	PCI/L	8.00	< 2.00	-	1.1 0.9	0.0 0.8
SELENIUM	MG/L	0.13	0.104	0.124	< 0.005	0.069
SILCON	MG/L	8.80	6.70	6.20	-	-
SILICA	MG/L	-	-	-	4.	8.
SILVER	MG/L	0.014	< 0.01	< 0.005	< 0.01	< 0.01
SODIUM	MG/L	1880.00	1945.00	1790.00	1680.	2080.
STRONTIUM	MG/L	-	-	-	7.2	6.3
SULFATE	MG/L	5830.00	5532.00	6210.00	5530.	6070.
TEMPERATURE	C - DEGREE	21.00	22.00	16.00	15.	19.
TH-230	PCI/L	< 0.10	< 0.10	< 0.10	-	0.0 1.6
TIN	MG/L	-	-	-	< 0.005	< 0.005

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		707-01 07/15/82	707-01 09/16/82	707-01 11/23/82	707-01 06/04/86	707-01 09/07/86
PARAMFTER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	9080.00	8680.00	9560.00	9420.	9480.
URANIUM	MG/L	0.016	0.025	0.03	0.0125	0.0090
VANADIUM	MG/L	< 0.05	< 0.05	< 0.05	0.29	0.16
ZINC	MG/L	-	-	-	0.023	0.023

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE							
		707-01 03/13/87		707-01 10/02/87		707-01 01/10/88			
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
ALKALINITY	MG/L CACO3	261.		159.		160.			
ALUMINUM	MG/L	0.2		< 0.1		0.4			
AMMONIUM	MG/L	< 0.1		0.1		< 0.1			
ANTIMONY	MG/L	-		-		-			
ARSENIC	MG/L	-		< 0.01		0.01			
BALANCE	%	-		-		-			
BARIUM	MG/L	-		-		-			
BICARBONATE	MG/L	-		-		-			
BORON	MG/L	0.6		0.4		0.51			
CADMIUM	MG/L	-		-		-			
CALCIUM	MG/L	425.		440.		509.			
CHLORIDE	MG/L	295.		300.		310.			
CHROMIUM	MG/L	0.03		< 0.01		< 0.01			
COBALT	MG/L	-		-		-			
CONDUCTANCE	UMHO/CM	4400.		8500.		7480.			
COPPER	MG/L	-		-		-			
FLUORIDE	MG/L	0.5		0.6		0.47			
GROSS ALPHA	PCI/L	-		0.0	51.	7.	38.		
GROSS BETA	PCI/L	-		0.0	44.	17.	28.		
IRON	MG/L	0.05		< 0.03		0.2			
LEAD	MG/L	-		-		-			
MAGNESIUM	MG/L	355.		380.		416.			
MANGANESE	MG/L	0.02		< 0.01		0.03			
MERCURY	MG/L	-		-		-			
MOLYBDENUM	MG/L	< 0.1		< 0.01		0.20			
NICKEL	MG/L	-		-		-			
NITRATE	MG/L	140.		36.		8.7			
NITRITE	MG/L	-		-		-			
ORG. CARBON	MG/L	-		4.		35.5			
PB-210	PCI/L	-		-		-			
PH	SU	7.77		7.4		7.5			
PHOSPHATE	MG/L	-		-		-			
PO-210	PCI/L	-		-		-			
POTASSIUM	MG/L	34.2		17.2		16.9			
RA-226	PCI/L	-		0.2	0.1	0.	0.1		
RA-228	PCI/L	-		1.5	1.0	0.	0.7		
SELENIUM	MG/L	0.034		0.12		0.324			
SILCON	MG/L	-		-		-			
SILICA	MG/L	-		-		-			
SILVER	MG/L	-		-		-			
SODIUM	MG/L	1920.		1790.		1680.			
STRONTIUM	MG/L	-		-		-			
SULFATE	MG/L	5830.		5700.		5820.			
TEMPERATURE	C - DEGREE	14.0		17.0		13.7			
TH-230	PCI/L	-		-		-			
TIN	MG/L	-		-		-			

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		707-01 03/13/87	707-01 10/02/87	707-01 01/10/88		
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY		
TOTAL SOLIDS	MG/L	9130.	9000.	9090.		
URANIUM	MG/L	0.0109	0.016	0.0167		
VANADIUM	MG/L	-	< 0.01	0.07		
ZINC	MG/L	-	< 0.005	0.007		

MAPPER DATA FILE NAME: GRN01*UDPGW0101660

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Continued)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE									
		563-01 06/04/86		563-01 09/07/86		563-01 02/27/87		563-01 10/02/87		563-01 01/10/88	
PARAMETER	UNIT OF MEASURF	PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY		PARAMETER VALUE+/-UNCERTAINTY	
ALKALINITY	MG/L CACO3	157.		182.		138.		165.		162.	
ALUMINUM	MG/L	0.4		0.3		< 0.1		< 0.1		0.3	
AMMONIUM	MG/L	< 0.1		< 0.1		< 0.1		0.1		< 0.1	
ANTIMONY	MG/L	< 0.003		< 0.003		-		-		-	
ARSENIC	MG/L	< 0.01		< 0.01		-		0.01		0.01	
BALANCE	%	0.16		0.06		-		-		-	
BARIUM	MG/L	0.2		0.2		-		-		-	
BICARBONATE	MG/L	-		-		-		-		-	
BORON	MG/L	0.3		0.5		0.27		0.4		0.48	
CADMIUM	MG/L	< 0.001		< 0.001		-		-		-	
CALCIUM	MG/L	488.		500.		377.		410.		417.	
CHLORIDE	MG/L	312.		240.		312.		290.		310.	
CHROMIUM	MG/L	0.05		0.02		0.03		< 0.01		0.03	
COBALT	MG/L	0.09		0.07		-		-		-	
CONDUCTANCE	UMHO/CM	5500.		6250.		6500.		8300.		6530.	
COPPER	MG/L	0.05		0.03		-		-		-	
FLUORIDE	MG/L	0.6		0.7		0.48		0.6		0.48	
GROSS ALPHA	PCI/L	-		-		-		0.0	43.	41.	38.
GROSS BETA	PCI/L	-		-		-		15.	48.	1.	27.
IRON	MG/L	0.18		0.20		0.59		0.79		1.23	
LFAD	MG/L	< 0.01		< 0.01		-		-		-	
MAGNESIUM	MG/L	364.		367.		347.		340.		337.	
MANGANESE	MG/L	0.04		0.03		0.03		< 0.01		0.06	
MERCURY	MG/L	< 0.0002		< 0.0002		-		-		-	
MOLYBDENUM	MG/L	0.15		0.14		< 0.1		< 0.01		0.20	
NICKEL	MG/L	0.09		< 0.04		-		-		-	
NITRATE	MG/L	11.		41.		44.3		34.		23.9	
NITRITE	MG/L	< 0.1		< 0.1		-		-		-	
ORG. CARRON	MG/L	-		-		-		< 1.		39.8	
PB-210	PCI/L	-		-		-		-		-	
PH	SU	7.69		7.55		7.58		7.25		7.5	
PHOSPHATE	MG/L	< 0.1		< 0.1		-		-		-	
PO-210	PCI/L	-		-		-		-		-	
POTASSIUM	MG/L	18.8		22.6		12.6		16.7		17.4	
RA-226	PCI/L	-		-		-		0.3	0.2	0.	0.1
RA-228	PCI/L	-		-		-		1.4	1.0	0.4	0.9
SFLENIUM	MG/L	< 0.005		< 0.005		0.38		0.12		0.320	
SILCON	MG/L	-		-		-		-		-	
SILICA	MG/L	4.		7.		-		-		-	
SILVER	MG/L	< 0.01		< 0.01		-		-		-	
SODIUM	MG/L	1680.		1830.		1810.		1600.		1900.	
STRONTIUM	MG/L	7.2		0.6		-		-		-	
SULFATE	MG/L	5540.		5960.		5490.		5500.		5740.	
TEMPERATURE	C - DEGREE	19.		17.		9.5		17.5		9.9	
TH-230	PCI/L	-		-		-		-		-	
TIN	MG/L	< 0.005		< 0.005		-		-		-	

Table B.4.16 Chemical analyses of groundwater, Green River, Utah, tailings site (Concluded)

FORMATION OF COMPLETION: ALLUVIUM
HYDRAULIC FLOW RELATIONSHIP: UP GRADIENT

		LOCATION ID - SAMPLE ID AND LOG DATE				
		563-01 06/04/86	563-01 09/07/86	563-01 02/27/87	563-01 10/02/87	563-01 01/10/88
PARAMETER	UNIT OF MEASURE	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY	PARAMETER VALUE+/-UNCERTAINTY
TOTAL SOLIDS	MG/L	9230.	8800.	9240.	8740.	9080.
URANIUM	MG/L	0.0121	0.0104	0.0105	0.013	0.0105
VANADIUM	MG/L	0.32	0.22	-	< 0.01	0.07
ZINC	MG/L	0.026	0.131	-	0.026	0.045

Table B.4.17 Background groundwater quality summary for the top hydrostratigraphic unit (wells 563 and 707), Green River, Utah, tailings site

Constituent[a]	Number of analyses[b]	Arithmetic mean[c]($\bar{X}$)	Standard deviation x2[c](2s)	Statistical concentration range[c]($\bar{X}\pm2s$)	Observed concentration range	Proposed EPA groundwater standards[d]
Chromium (mg/l)	8	0.03	0.03	<0.01-0.06	0.03-0.06	0.05
Molybdenum (mg/l)	8	0.09	0.13	<0.01-0.22	<0.01-0.18	0.10
Nitrate (NO_3) (mg/l)	8	55	97	<1-152	11-140	44
Selenium (mg/l)	8	0.090	0.250	<0.005-0.340	<0.005-0.38	0.010
Radium-226 and 228 (pci/l)	4	ND	ND	ND	0.2-1.7	5.0
Uranium-234 and 238 (mg/l)	8	0.0118	0.0043	0.0075-0.0161	0.0090-0.0160	0.0440
Gross alpha (pCi/l)	2	ND	ND	ND	0	15

---

[a] All constituents listed are included in the proposed EPA groundwater standards (52 FR 36000) and have EPA National and State of Utah Primary Drinking Water Standards, with the exception of molybdenum, which does not have a maximum concentration limit in Utah. Arsenic, barium, cadmium, lead, mercury, and silver are also included in the proposed EPA groundwater standards, and the EPA National and State of Utah Primary Drinking Water Standards. However, because these constituents were found to be below detection limits for the first two rounds of water sampling in June, 1986, and September, 1986, they were excluded from subsequent sampling rounds and are not considered to be present as contamination at the Green River site.

[b] The analyses may include the results from one or more of the following rounds of sampling: 6/86; 9/86; 3/87; and 10/87; depending on if the well(s) were in existence at the time of sampling. If less than six analyses were available, a statistical analysis was not performed.

[c] ND = not determined because number of analyses is less than six.

[d] Concentration limits are the same for EPA National and State of Utah Primary Drinking Water Standards.

A background groundwater quality summary of the upper-middle unit is presented in Table B.4.18. The wide range of background quality reflects the range in concentrations found at each well. High concentrations of the contaminants listed in Table B.4.18 are found at well 816, which is located south (upgradient) of the tailings at the proposed disposal site. Proposed EPA MCLs for nitrate and selenium concentrations are exceeded in monitor well 816. Radionuclides could not be tested because of the limited amount of sample water that could be collected from this well. The measured uranium concentration is very close to the proposed MCL. The nature of the contamination present in this well suggests the source may be from the surface, as well as from recharge by naturally contaminated water from underlying aquifers.

The general water type in both background wells is sodium sulfate; however, the concentrations of both sodium and sulfate are much higher in monitor well 816 than in monitor well 806. The water in the upper-middle unit is Class II based on TDS, but is Class III based on the high nitrate and selenium concentrations.

Monitor well 807 is completed in the upper-middle shale unit below the lower-middle sandstone (see Figure B.4.2). The screened interval in well 807 is from 78 to 98 feet (see Table B.4.1). The water quality analysis of a sample taken from this well in October, 1987, (see Table B.4.16) shows that nitrate and selenium concentration exceed proposed EPA MCLs and state of Utah standards for these constituents. The nitrate concentration was measured at 670 mg/l and selenium was measured at 0.17 mg/l; each of these concentrations are well over one order of magnitude greater than the proposed EPA MCLs and Utah standards for the constituents. In addition, the boron concentration was measured at 0.8 mg/l, which is slightly greater than the state of Utah standard for boron (see Table B.2.1); the molybdenum concentration was measured at 0.07 mg/l, which is slightly less than the proposed EPA MCL of 0.10 mg/l and the Utah standard. Finally, total dissolved solids were measured at 7550 mg/l, and the sulfate concentration was 4000 mg/l. Since this saturated zone within the Cedar Mountain Formation is isolated from surface contamination by strong, vertically upward hydraulic gradients, the source for the contaminants found within this unit is from somewhere off the site, and possibly from below the elevation of the well screen.

B.4.9.3 Lower-middle hydrostratigraphic unit

The locations of background monitor wells 562, 811, and 813 are shown on Figure B.4.1. Monitor well 811 is upgradient of the tailings, and monitor wells 562 and 813 are upgradient and updip of the tailings.

Table B.4.18 Background groundwater quality summary for the upper-middle hydrostratigraphic unit (wells 816 and 806), Green River, Utah, tailings site

Constituent[a]	Number of analyses[b]	Arithmetic mean[c] ($\bar{X}$)	Standard deviation x2[c] (2s)	Statistical concentration range[c] ($\bar{X} \pm 2s$)	Observed concentration range	Proposed EPA groundwater standards[d]
Chromium (mg/l)	0	ND	ND	ND	ND	0.05
Molybdenum (mg/l)	2	ND	ND	ND	<0.01-0.02	0.1
Nitrate (NO$_3$) (mg/l)	2	ND	ND	ND	1-98	44
Selenium (mg/l)	2	ND	ND	ND	<0.005-0.72	0.01
Radium-226 and 228 (pci/l)	1	ND	ND	ND	1.4	5.0
Uranium-234 and 238 (mg/l)	2	ND	ND	ND	<0.003-0.038	0.044
Gross alpha (pCi/l)	1	ND	ND	ND	0.0	15

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[a] All constituents listed are included in the proposed EPA groundwater standards (52 FR36000) and have EPA National and State of Utah Primary Drinking Water Standards, with the exception of molybdenum, which does not have a maximum concentration limit in Utah. Arsenic, barium, cadmium, lead, mercury, and silver are also included in the proposed EPA groundwater standards, and the EPA National and State of Utah Primary Drinking Water Standards. However, because these constituents were found to be below detection limits for the first two rounds of water sampling in June, 1986, and September, 1986, they were excluded from subsequent sampling rounds and are not considered to be present as contamination at the Green River site.

[b] The analyses may include the results from one or more of the following rounds of sampling: 6/86; 9/86; 3/87; and 10/87; depending on if the well(s) were in existence at the time of sampling. If less than six analyses were available, a statistical analysis was not performed.

[c] ND = not determined because number of analyses is less than six.

[d] Concentration limits are the same for EPA National and State of Utah Primary Drinking Water Standards.

A background groundwater quality summary of the lower-middle unit is presented in Table B.4.19. The range of background groundwater quality in this unit is similar to that of the upper-middle unit. Beneath the proposed disposal area, the upper- and lower-middle hydrostratigraphic units may be hydraulically connected by numerous vertical fractures. In the north, away from the disposal area and toward the present tailings pile, the vertical fractures are not as intense or abundant and the lower-middle unit is confined by the overlying shales and limestones of the upper-middle unit. Background concentrations of molybdenum, nitrate, selenium, uranium, and gross alpha activity exceed the proposed EPA MCLs south (upgradient) of the tailings at the proposed disposal site. The source of this contamination, like that found in the upper-middle unit, is probably from upgradient sources south of the disposal area or from underlying aquifers. There is no evidence at the ground surface that the proposed disposal site is a source of contamination.

The general water type in the lower-middle unit is sodium sulfate; the water is Class II based on TDS, but is Class III based on high levels of molybdenum, nitrate, selenium, and uranium.

B.4.9.4 Bottom hydrostratigraphic unit

The locations of background monitor wells 586, 587, and 818 are shown on Figure B.4.1. These monitor wells are upgradient and updip of the tailings.

For the September, 1986, and March, 1987, rounds of water sampling, monitor wells 586 and 587 were considered to be cement-grout contaminated since the time the wells were drilled and completed. The pH of the water samples from these wells ranged from 9.92 to 11.61 standard units. For the October, 1987, sampling, the pH was measured as 8.10 in monitor well 586 and 9.35 in monitor well 587, indicating the majority of the grout was removed from the producing intervals during the purging (sampling) process. The pH values for all of the sampling dates for monitor wells 586, 587, and 818 were plotted versus molybdenum, nitrate, selenium, uranium, and sulfate concentrations on a linear-linear graph (Figure B.4.11) to show the effect of pH on the concentrations of these constituents. A linear regression was done for each constituent, the coefficient of determination (r^2) was calculated, and Student's "t" statistic (McClave and Dietrich, 1979) was calculated to test the null hypothesis that the slopes of the best-fit regression lines for each parameter are not different from zero. The calculated "t" statistics indicate that at a 99 percent level of confidence there does not appear to be any linear relationship between pH and the concentrations of the constituents tested. Based on these results, values for these constituents and all other

Table B.4.19 Background groundwater quality summary for the lower-middle hydrostratigraphic unit (wells 562, 811, and 813), Green River, Utah, tailings site

Constituent[a]	Number of analyses[b]	Arithmetic mean[c] ($\bar{X}$)	Standard deviation x2[c] (2s)	Statistical concentration range[c] ($\bar{X}\pm2s$)	Observed concentration range	Proposed EPA groundwater standards[d]
Chromium (mg/l)	4	ND	ND	ND	<0.01-0.04	0.05
Molybdenum (mg/l)	6	0.09	0.14	<0.01-0.23	0.02-0.18	0.1
Nitrate (NO_3) (mg/l)	6	92	126	<1-218	1-169	44
Selenium (mg/l)	6	0.06	0.25	<0.005-0.31	<0.005-0.32	0.01
Radium-226 and 228 (pci/l)	3	ND	ND	ND	2.2-3.9	5.0
Uranium-234 and 238 (mg/l)	6	0.0535	0.1015	<0.003-0.1460	0.003-0.1550	0.044
Gross alpha (pCi/l)	3	ND	ND	ND	19-82	15

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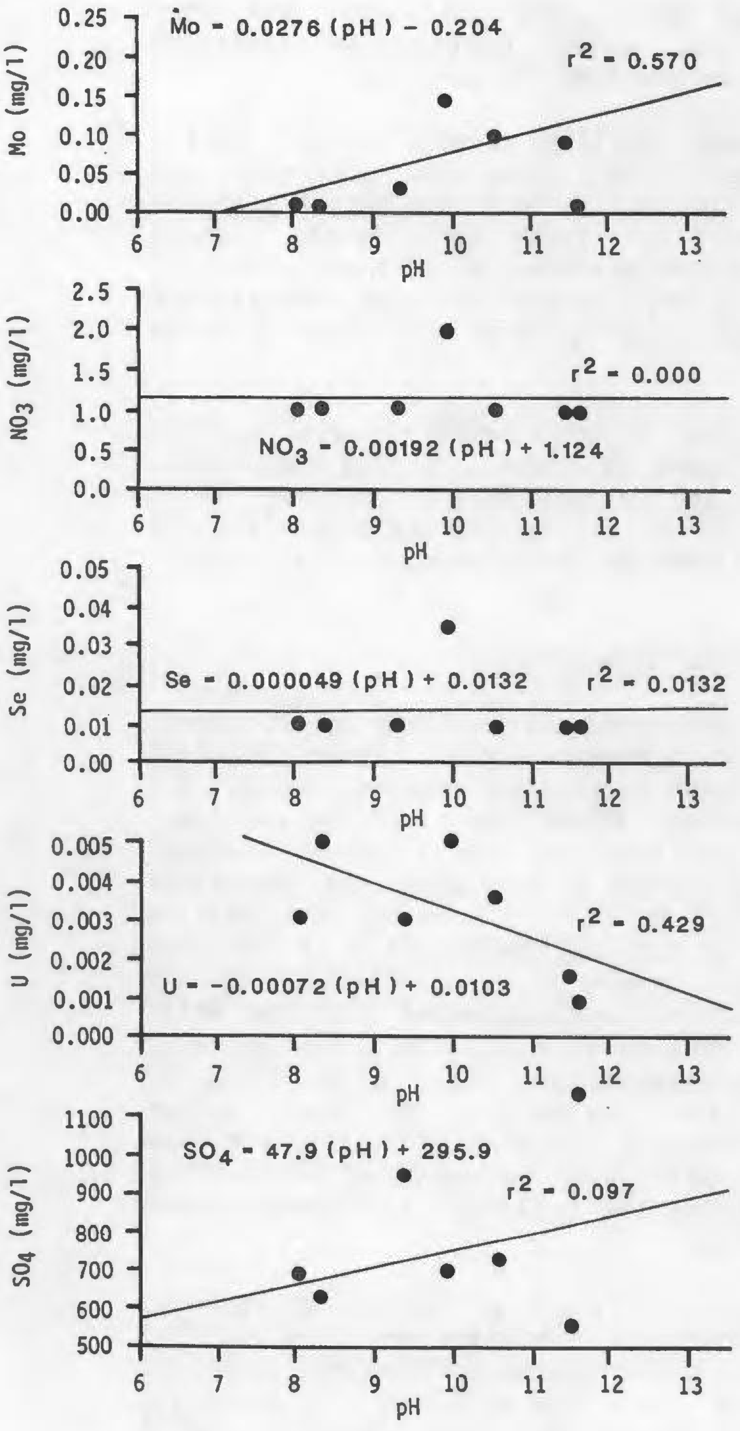
[a] All constituents listed are included in the proposed EPA groundwater standards (52 FR36000) and have EPA National and State of Utah Primary Drinking Water Standards, with the exception of molybdenum, which does not have a maximum concentration limit in Utah. Arsenic, barium, cadmium, lead, mercury, and silver are also included in the proposed EPA groundwater standards, and the EPA National and State of Utah Primary Drinking Water Standards. However, because these constituents were found to be below detection limits for the first two rounds of water sampling in June, 1986, and September, 1986, they were excluded from subsequent sampling rounds and are not considered to be present as contamination at the Green River site.

[b] The analyses may include the results from one or more of the following rounds of sampling: 6/86; 9/86; 3/87; and 10/87; depending on if the well(s) were in existence at the time of sampling. If less than six analyses were available, a statistical analysis was not performed.

[c] ND = not determined because number of analyses is less than six.

[d] Concentration limits are the same for EPA National and State of Utah Primary Drinking Water Standards.



pH	Molybdenum (mg/l)
8.10	<0.01
8.30	<0.01
9.35	0.03
9.92	0.14
10.51	0.10
11.49	0.09
11.61	<0.10

pH	Nitrate (mg/l)
8.10	<1
8.30	<1
9.35	<1
9.92	2
10.51	<1
11.49	<1
11.61	<1

pH	Selenium (mg/l)
8.10	<0.01
8.30	<0.01
9.35	<0.01
9.92	0.036
10.51	<0.01
11.49	<0.01
11.61	<0.01

pH	Uranium (mg/l)
8.10	<0.003
8.30	0.005
9.35	<0.003
9.92	0.005
10.51	0.0036
11.49	0.0015
11.61	<0.001

pH	Sulfate (mg/l)
8.10	690
8.30	620
9.35	950
9.92	700
10.51	720
11.49	540
11.61	1170

FIGURE B.4.11

PLOTS OF pH vs. MOLYBDENUM, NITRATE, SELENIUM, URANIUM, AND SULFATE FOR BOTTOM UNIT BACKGROUND MONITOR WELLS 586, 587, AND 818

constituents analyzed from wells 586, 587, and 818 were included in the background water quality calculations, regardless of the water pH at the time of sampling.

A background groundwater quality summary of the bottom unit is presented in Table B.4.20. Chromium, molybdenum, and selenium concentrations in the bottom unit are slightly higher than the proposed EPA MCLs for these constituents. These levels probably reflect high natural levels of these constituents, and indicate that the high levels of these constituents found in the overlying hydrostratigraphic units may also be from natural sources.

Groundwater in this unit is much better in quality than the three shallower units; the TDS level is near 2000 mg/l. The general water type is sodium sulfate and the water is at the lower end of Class II based on TDS, but is also Class III because of high levels of chromium, molybdenum, and selenium.

B.4.9.5 Summary of background groundwater quality

The range of background groundwater quality in the upper- and lower-middle hydrostratigraphic units (Cedar Mountain Formation) is wide because background monitor wells are located both east (upstream) and south (updip) of the tailings. The wells south of the tailings (at the proposed disposal site) indicate there is a source of contamination upgradient of the disposal site that is not related to the milling processes since it would be outside the boundary of the mill site. If the high nitrate levels are an indication of the source, it may be from activities associated with the White Sands Missile Range test complex (see Section 3.8, Land Use, of this environmental assessment, or EA). High levels of chromium, molybdenum, and selenium in the bottom hydrostratigraphic unit indicate these constituents are from natural sources; because this unit is confined by a thick shale unit in the vicinity of the tailings site contamination from the surface is unlikely.

Because the high background levels of nitrate, molybdenum, chromium, and selenium indicate contamination from natural sources, groundwater in all four hydrostratigraphic units at the Green River site may be classified as Class III, according to the proposed standards in 40 CFR Part 192.21(g), which states that Class III groundwater includes water that is not a current or potential source of drinking water because widespread, ambient contamination not due to activities involving residual radioactive materials from a designated processing site exists that cannot be cleaned up by using treatment methods reasonably employed in public water-supply systems.

Table B.4.20 Background groundwater quality summary for the bottom hydrostratigraphic unit (wells 586, 587, and 818), Green River, Utah, tailings site

Constituent[a]	Number of analyses[b]	Arithmetic mean[c] ($\bar{X}$)	Standard deviation x2[c] (2s)	Statistical concentration range[c] ($\bar{X}\pm2s$)	Observed concentration range	Proposed EPA groundwater standards[d]
Chromium (mg/l)	6	0.04	0.02	0.02-0.06	0.03-0.06	0.05
Molybdenum (mg/l)	7	0.07	0.10	<0.01-0.17	<0.01-0.14	0.1
Nitrate (NO_3) (mg/l)	7	2	4	<1-6	0.4-2	44
Selenium (mg/l)	7	0.02	0.08	<0.005-0.100	<0.005-0.106	0.01
Radium-226 and 228 (pci/l)	3	ND	ND	ND	0.9-3.0	5.0
Uranium-234 and 238 (mg/l)	7	0.0034	0.0024	<0.003-0.0058	<0.003-0.0049	0.044
Gross alpha (pCi/l)	5	ND	ND	ND	0.0-1.0	15

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[a] All constituents listed are included in the proposed EPA groundwater standards (52 FR36000) and have EPA National and State of Utah Primary Drinking Water Standards, with the exception of molybdenum, which does not have a maximum concentration limit in Utah. Arsenic, barium, cadmium, lead, mercury, and silver are also included in the proposed EPA groundwater standards, and the EPA National and State of Utah Primary Drinking Water Standards. However, because these constituents were found to be below detection limits for the first two rounds of water sampling in June, 1986, and September, 1986, they were excluded from subsequent sampling rounds and are not considered to be present as contamination at the Green River site.

[b] The analyses may include the results from one or more of the following rounds of sampling: 6/86; 9/86; 3/87; and 10/87; depending on if the well(s) were in existence at the time of sampling. If less than six analyses were available, a statistical analysis was not performed.

[c] ND = not determined because number of analyses is less than six.

[d] Concentration limits are the same for EPA National and State of Utah Primary Drinking Water Standards.

The town of Green River currently takes water from the Green River upstream of its confluence with Brown's Wash for domestic use and irrigation. Because an ample supply of good-quality surface water is available for domestic use, the development of groundwater in the potentially affected environment of the Green River tailings site is highly unlikely. See Section B.8.1 for a more complete discussion of groundwater use, value, and alternate supplies at the Green River tailings site.

B.4.10 EXTENT OF CONTAMINATION

Percolation of tailings seepage into the groundwater system beneath the tailings pile has adversely impacted the water quality in both the top and upper-middle hydrostratigraphic units. The vertical extent of contamination is confined to these two shallow units by strong, vertically upward hydraulic gradients between the upper-middle unit and the underlying units. The maximum depth of contamination beneath the surface of the present tailings pile is about 65 feet.

B.4.10.1 Top hydrostratigraphic unit

Gross alpha activity, molybdenum, nitrate, selenium, and uranium concentrations exceed background levels and proposed EPA and state of Utah groundwater standards beneath and downgradient of the tailings. Table B.4.21 shows the maximum and minimum observed concentrations of contaminants in the top unit and the proposed EPA MCLs. The range in concentrations of contaminants varies widely from sampling to sampling, probably in response to evaporation and percolation of rainfall and snowmelt through the tailings; this type of variation is also seen in the pore water sample analyses for the same reasons (see Section B.4.8). Figures B.4.12 through B.4.16 show the lateral extent of contamination as gross alpha, molybdenum, nitrate, selenium, and uranium, respectively, in the top unit (Brown's Wash alluvium) and in the channel of Brown's Wash, based on the maximum observed concentrations.

The contamination resulting from tailings seepage travels downgradient through the alluvium toward the northwest and the channel of Brown's Wash. Once in Brown's Wash, the contaminants move west with groundwater flow in the shallow alluvium or on the surface. Surface water sample analyses from Brown's Wash (see Section B.1.4) indicate contaminated groundwater discharges to Brown's Wash; however, flow in the channel is intermittent and the concentrations of contaminants (as well as major anions and cations) are a function of the evaporation of water in the channel (i.e., evaporation causes a relative increase in concentration of the contaminants). The contaminated water travels downstream (west) in Brown's Wash and mixes with backwater from the Green River in

Table B.4.21 Summary of maximum and minimum observed concentrations in the top hydrostratigraphic unit from tailings seepage, Green River, Utah, tailings site

Constituent	Number of analyses[a]	Observed maximum	Observed minimum	Proposed EPA MCL[b]
Chromium (mg/l)	12	0.040	0.005	0.050
Molybdenum (mg/l)	17	0.270	0.005	0.100
Nitrate (NO_3) (mg/l)	17	440	1	44
Selenium (mg/l)	17	0.410	0.001	0.010
Radium-226 and 228 (pCi/l)	11	3.8	0.0	5.0
Uranium-234 and 238 (mg/l)	17	2.062	0.0419	0.0440
Gross alpha (pCi/l)	5	910	20	15

[a] Analyses are from on-site monitor wells 702, 704, 705, and 808.
[b] MCL = maximum concentration limit.

the vicinity of surface-water sampling location 526 (see Figures B.1.3 and B.4.12 through B.4.17). Water quality analyses from samples of Green River water upstream and downstream from its confluence with Brown's Wash show that the discharge of contaminated water from Brown's Wash to the Green River has no adverse affect on the water quality of the Green River (see Section B.1.4). This is because the contaminants are diluted by a factor of 10^5 to 10^6 once they mix with the Green River.

As part of the site characterization, monitor well 705 (on-site and completed in the alluvium) was sampled and analyzed for EPA priority organic pollutants. The analyses measured 13 parts per billion (ppb) of methylene chloride, but it is noted by the analytical laboratory that the elevated value may be a result of laboratory contamination. Two other unknown, semivolatile compounds were tentatively identified by the lab to have concentrations of 100 and 40 ppb. These analytical results are on file at the UMTRA Project Office in Albuquerque, New Mexico.

Contamination as ammonium was also identified in the top unit. Figure B.4.17 shows the extent of ammonium contamination in Brown's Wash alluvium and the channel of Brown's Wash. Ammonium was used in the milling process; there is no proposed EPA standard nor a state of Utah standard for ammonium in drinking water.

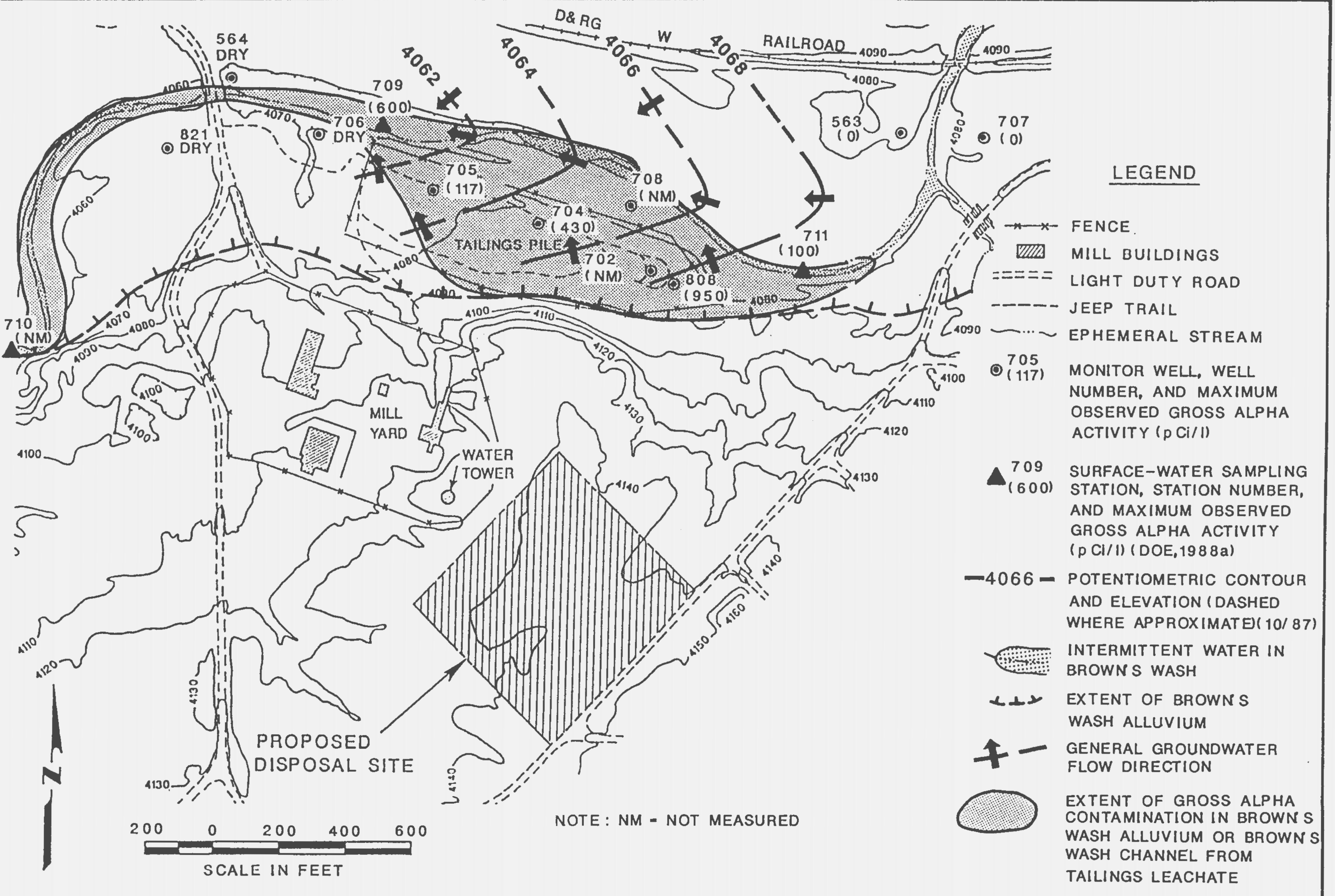


FIGURE B.4.12
MAXIMUM OBSERVED ACTIVITIES AND EXTENT OF GROSS ALPHA CONTAMINATION IN THE TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

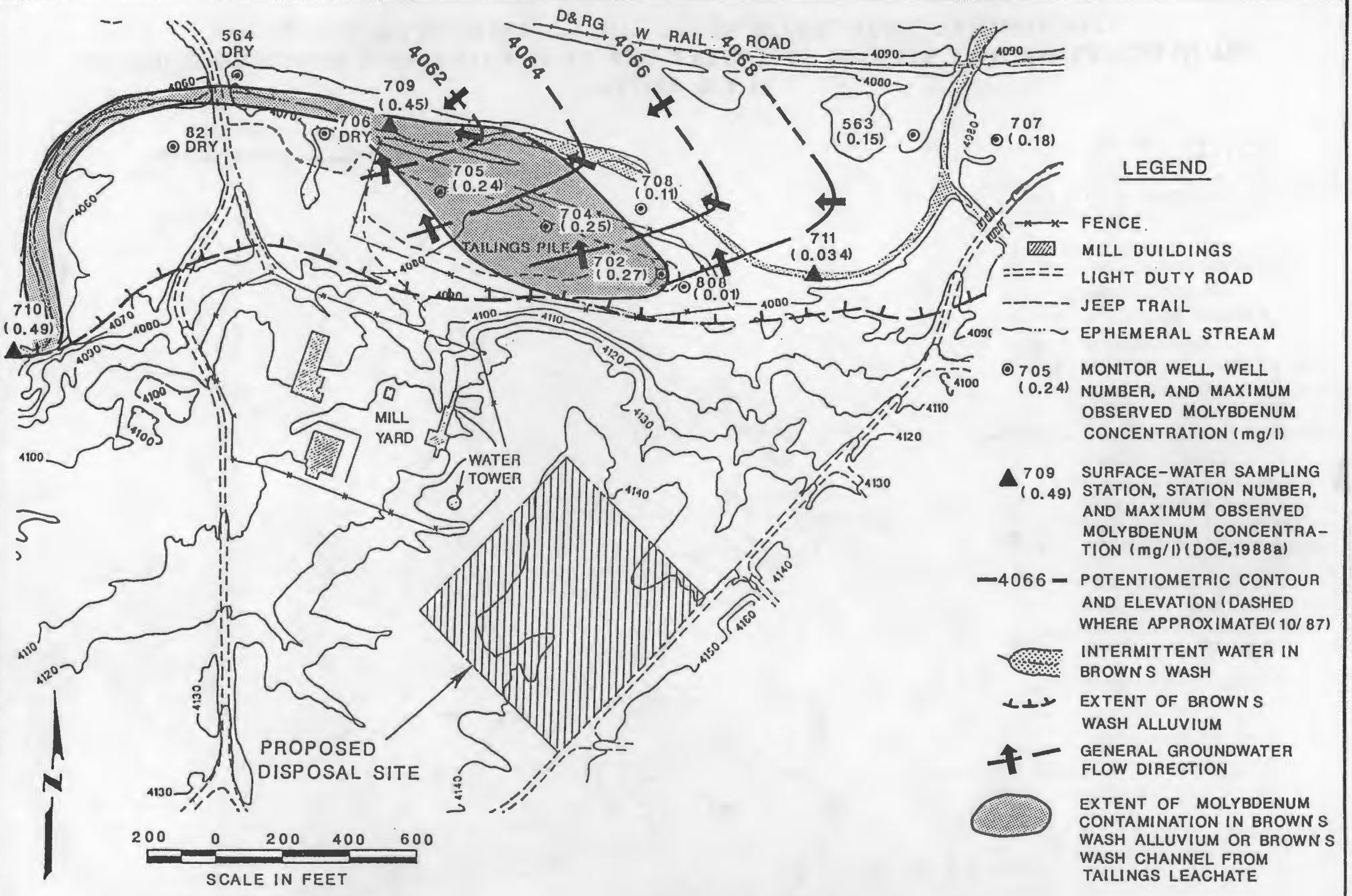


FIGURE B.4.13

MAXIMUM OBSERVED CONCENTRATIONS AND EXTENT OF MOLYBDENUM CONTAMINATION IN THE TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

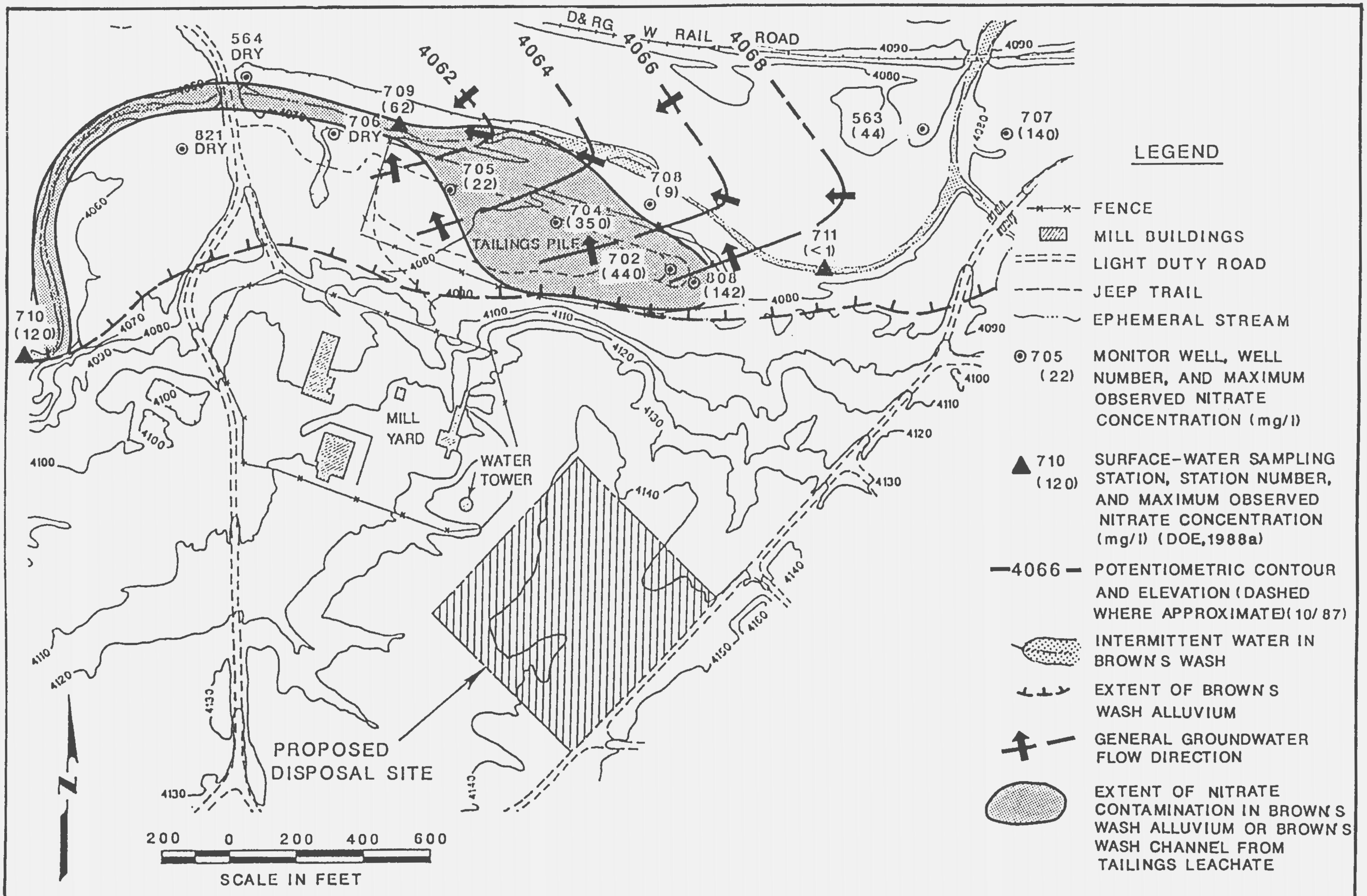


FIGURE B.4.14
MAXIMUM OBSERVED CONCENTRATIONS AND EXTENT OF NITRATE CONTAMINATION IN THE TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

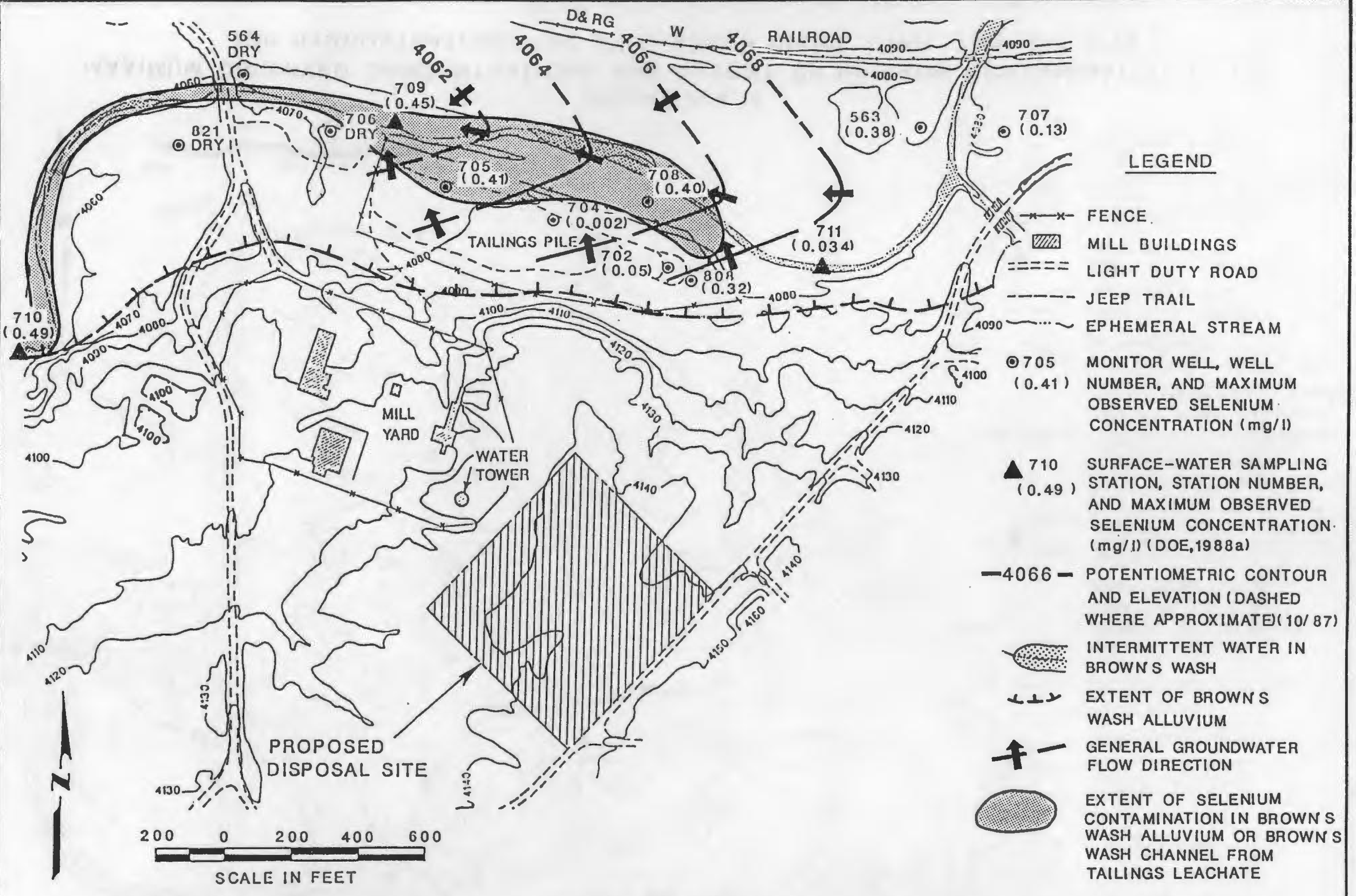


FIGURE B.4.15
MAXIMUM OBSERVED CONCENTRATIONS AND EXTENT OF SELENIUM CONTAMINATION IN THE TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

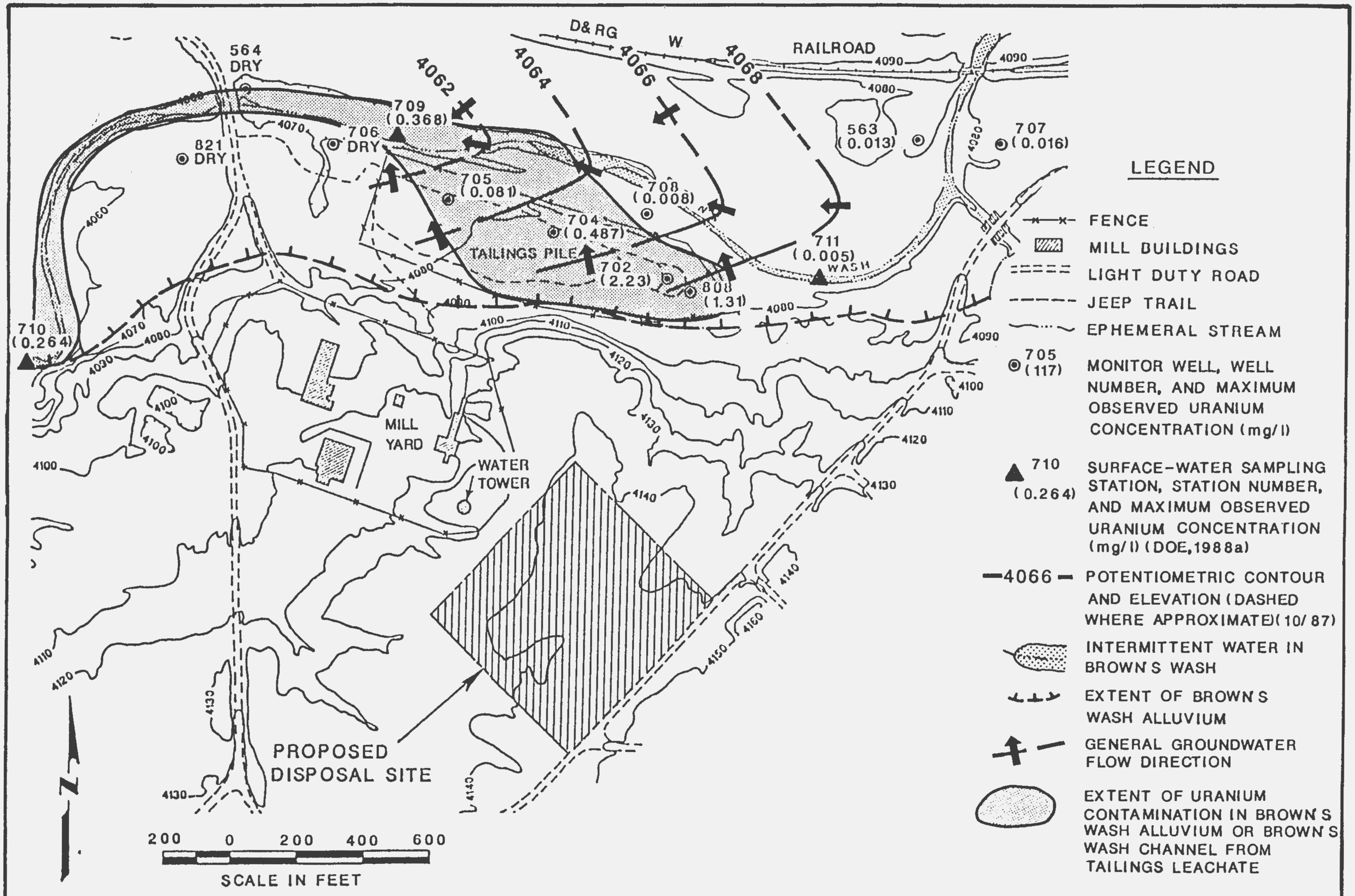


FIGURE B.4.16
MAXIMUM OBSERVED CONCENTRATIONS AND EXTENT OF URANIUM CONTAMINATION IN THE TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

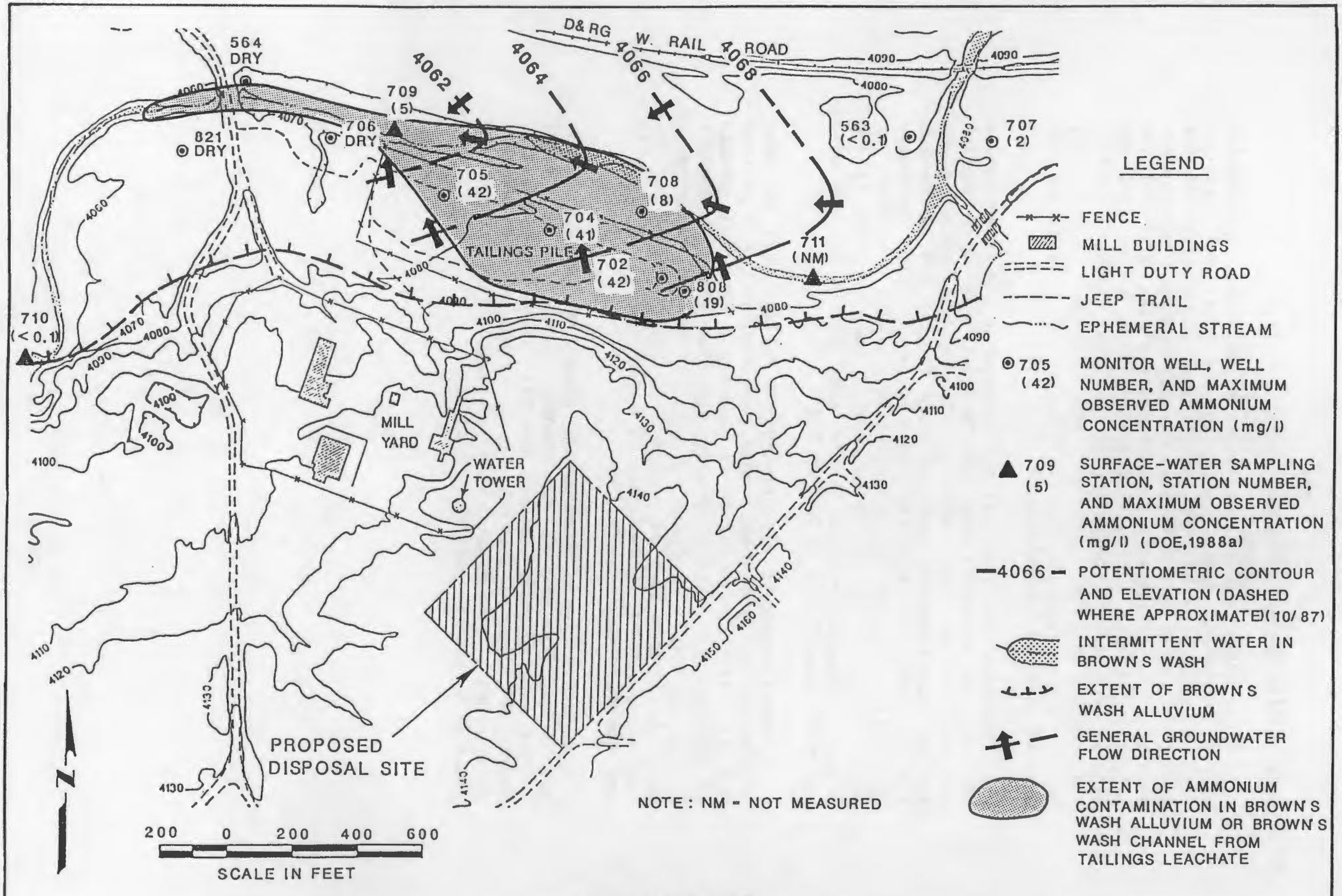


FIGURE B.4.17
MAXIMUM OBSERVED CONCENTRATIONS AND EXTENT OF AMMONIUM CONTAMINATION IN THE TOP HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

B.4.10.2 Upper-middle hydrostratigraphic unit

Gross alpha, molybdenum, nitrate, selenium, and uranium exceed background levels, proposed EPA MCLs, and state of Utah groundwater standards beneath and downgradient of the tailings. Table B.4.22 shows the maximum observed concentrations of contaminants in the upper-middle unit and the proposed EPA MCLs. Figures B.4.18 through B.4.22 show the lateral extent of contamination as gross alpha activity, molybdenum, nitrate, selenium, and uranium, respectively, in the upper-middle hydrostratigraphic unit, based on the maximum observed concentrations.

Contamination from tailings seepage in the upper-middle unit extends northwest from the tailings pile (from monitor well 701, on the site), roughly following the "trough" shown by the potentiometric contours (see Figures B.4.18 through B.4.22). This trough probably is a result of higher secondary permeability in the shale caused by joints, fractures, or minor faulting that is oriented the same direction as the trough. Groundwater flow in the upper-middle unit is discussed in more detail in Section B.4.7

Contamination is also present in monitor well 583 west of the tailings and Brown's Wash (see Figures B.4.18 through B.4.22). This contamination is probably a result of seepage of contaminated water in Brown's Wash down into the bedrock channel bottom. As discussed previously, the contaminated water in Brown's Wash is a result of the discharge of contaminated alluvial groundwater into the channel adjacent to and downgradient of the tailings.

Contamination as ammonium was identified in monitor well 701 on the site; however, the ammonium appears to be limited to the area directly beneath the tailings because elevated levels of ammonium are not found in any of the off-site monitor wells. The maximum observed concentration of ammonium observed in monitor well 701 was 47 mg/l.

Table B.4.22 Summary of maximum and minimum observed concentrations in the upper-middle hydrostratigraphic unit from tailings seepage, Green River, Utah, tailings site

Constituent	Number of analyses[a]	Observed maximum	Observed minimum	Proposed EPA MCL[b]
Chromium (mg/l)	5	0.050	0.005	0.050
Molybdenum (mg/l)	8	0.200	0.010	0.100
Nitrate (NO_3) (mg/l)	8	2480	2	44
Selenium (mg/l)	8	0.370	0.0025	0.010
Radium-226 and 228 (pCi/l)	7	2.0	0.9	5.0
Uranium-234 and 238 (mg/l)	8	3.110	0.4370	0.0440
Gross alpha (pCi/l)	1	980	980	15

[a] Analyses from on-site monitor well 701.
[b] MCL = maximum concentration limit.

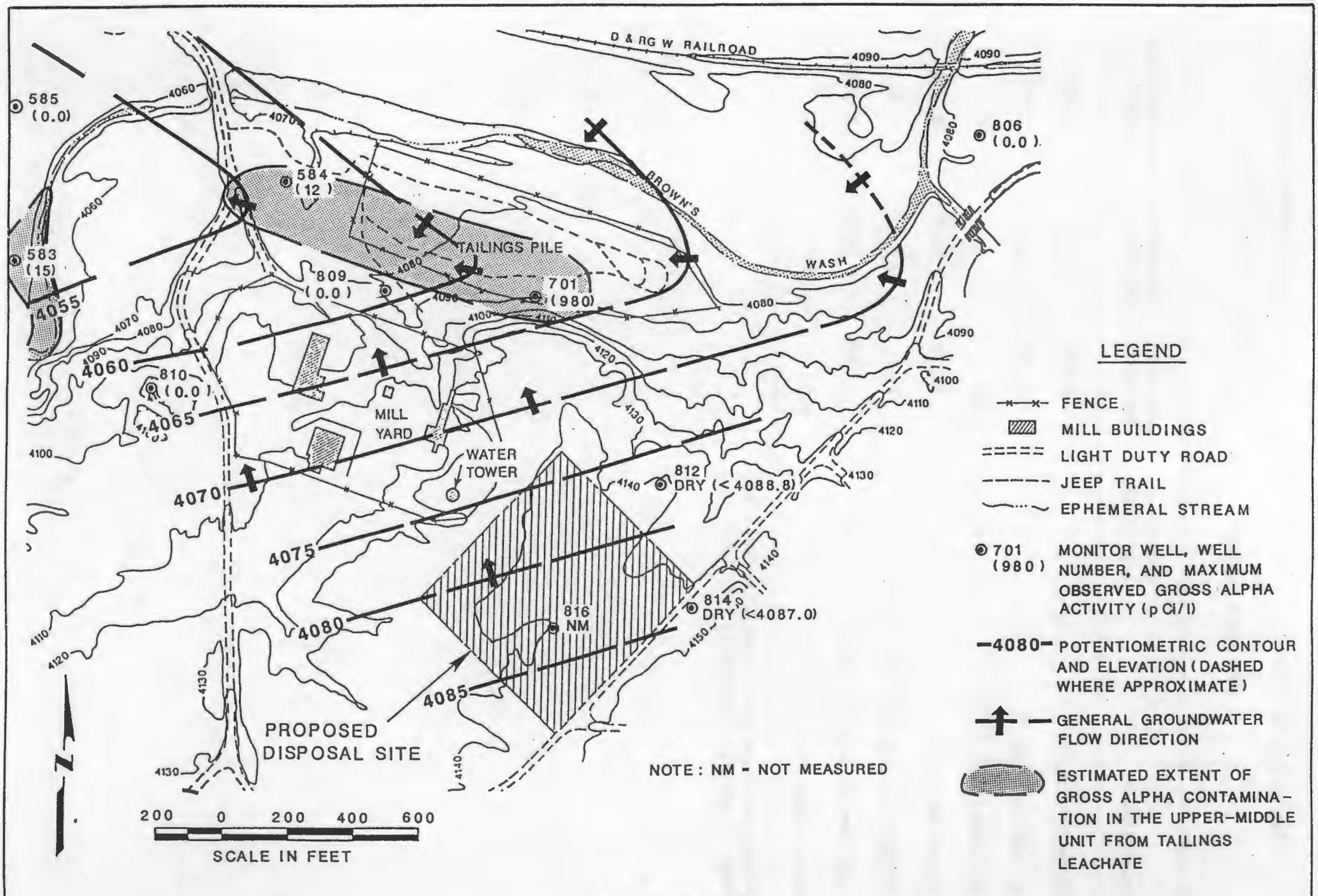


FIGURE B.4.18
MAXIMUM OBSERVED ACTIVITIES AND ESTIMATED EXTENT OF GROSS ALPHA CONTAMINATION IN THE UPPER-MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

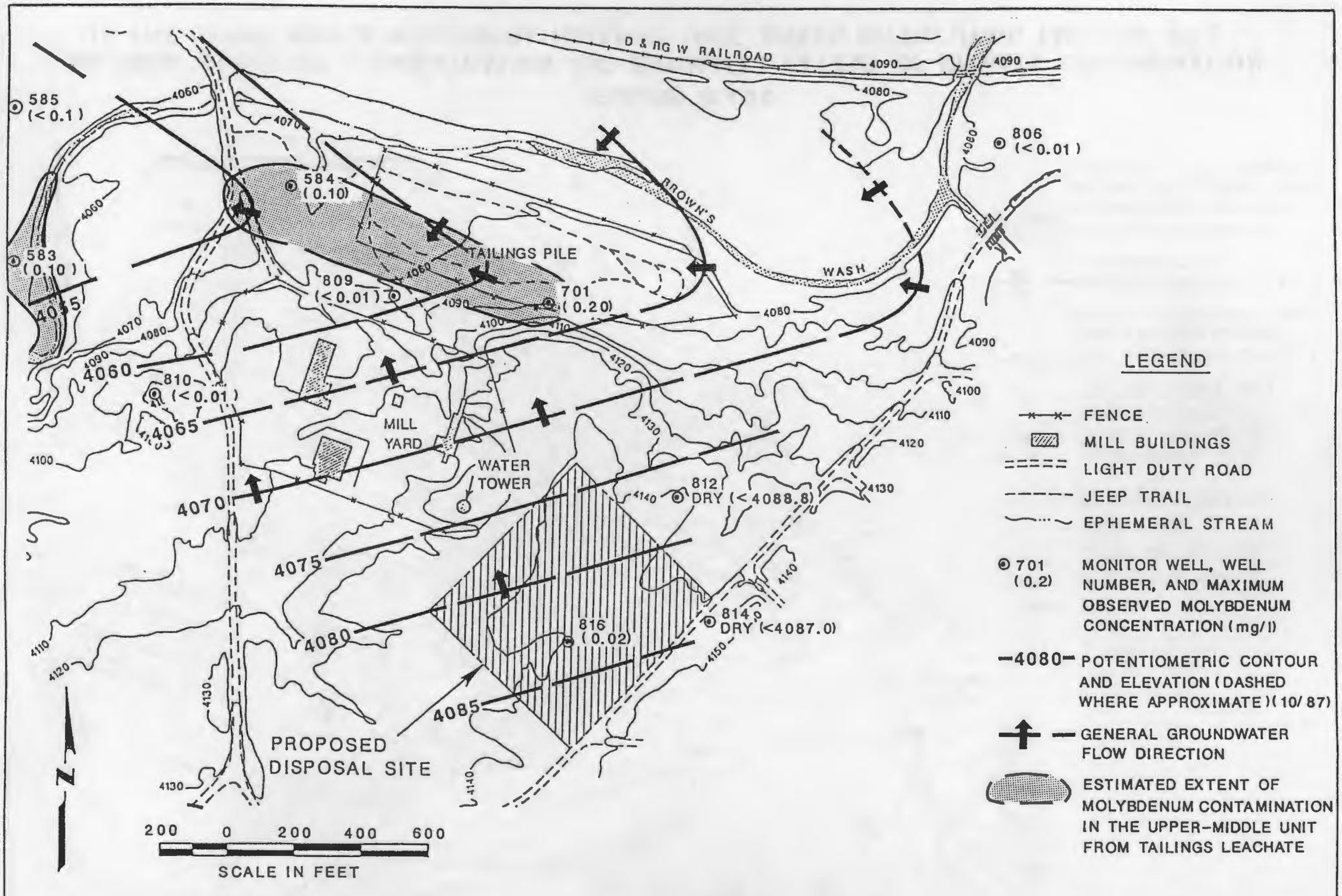


FIGURE B.4.19
MAXIMUM OBSERVED CONCENTRATION AND ESTIMATED EXTENT OF MOLYBDENUM CONTAMINATION IN THE UPPER-MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

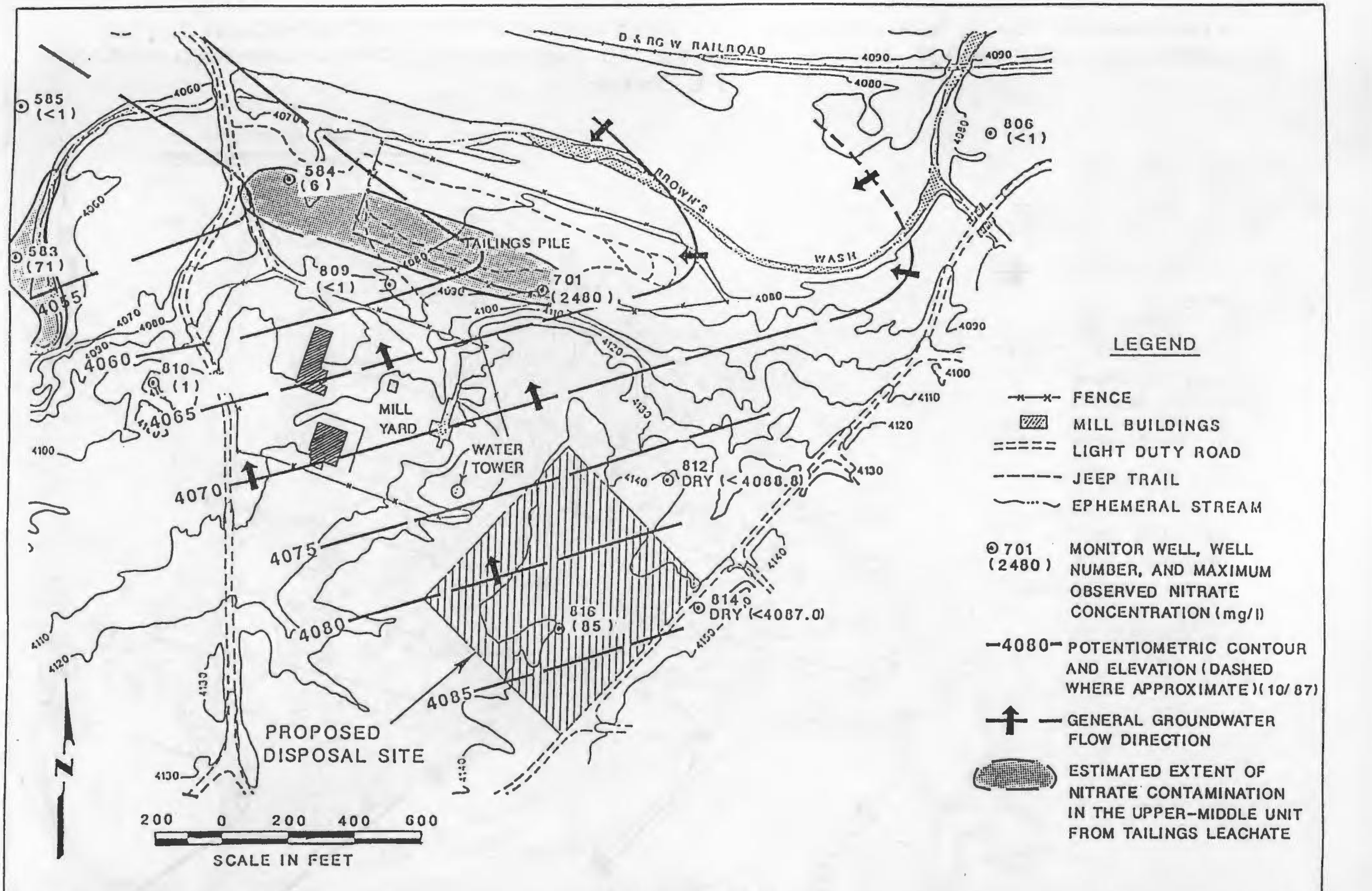


FIGURE B.4.20

MAXIMUM OBSERVED CONCENTRATION AND ESTIMATED EXTENT OF NITRATE CONTAMINATION IN THE UPPER-MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

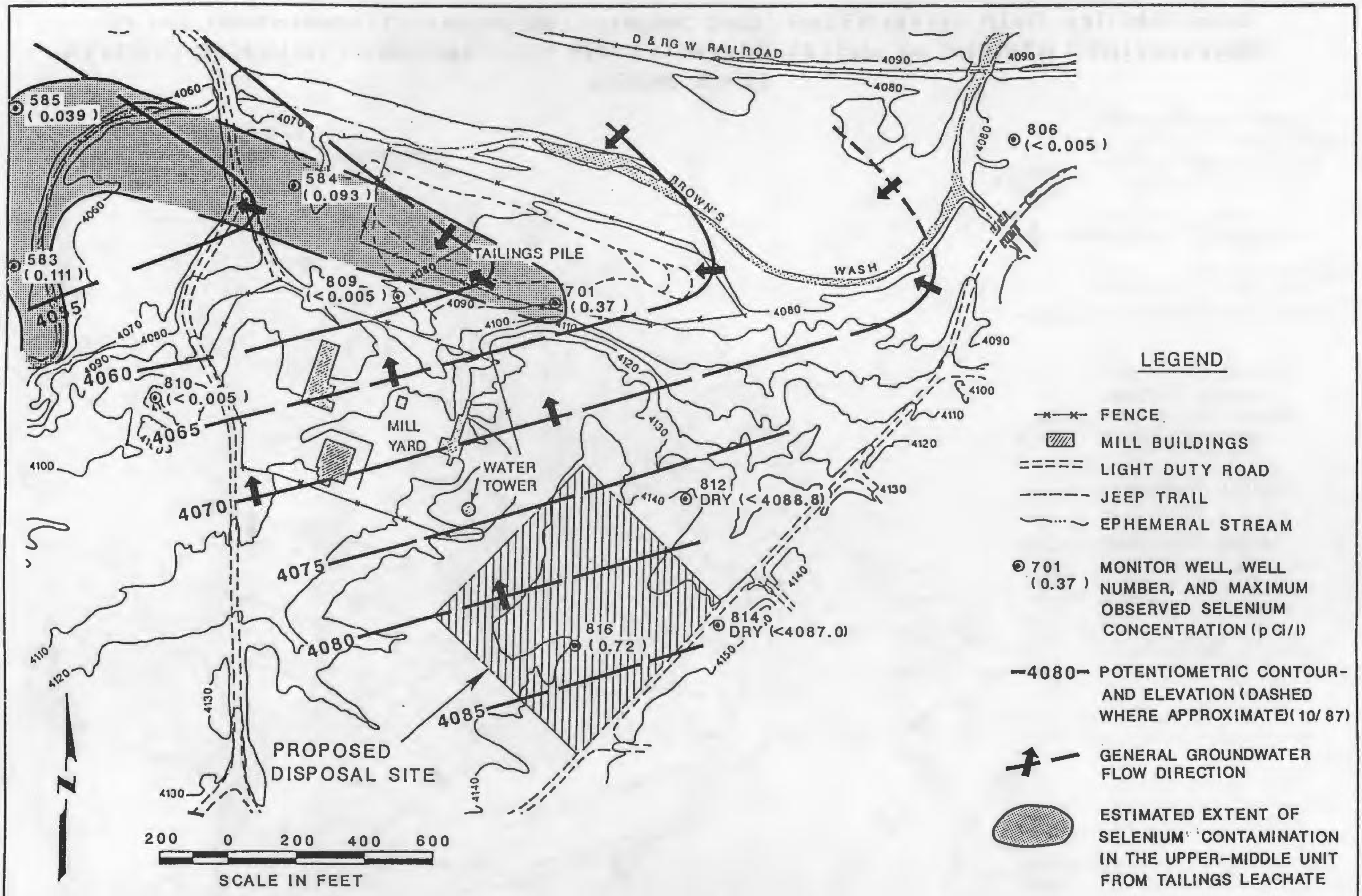


FIGURE B.4.21
MAXIMUM OBSERVED CONCENTRATION AND ESTIMATED EXTENT OF SELENIUM CONTAMINATION IN THE UPPER-MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

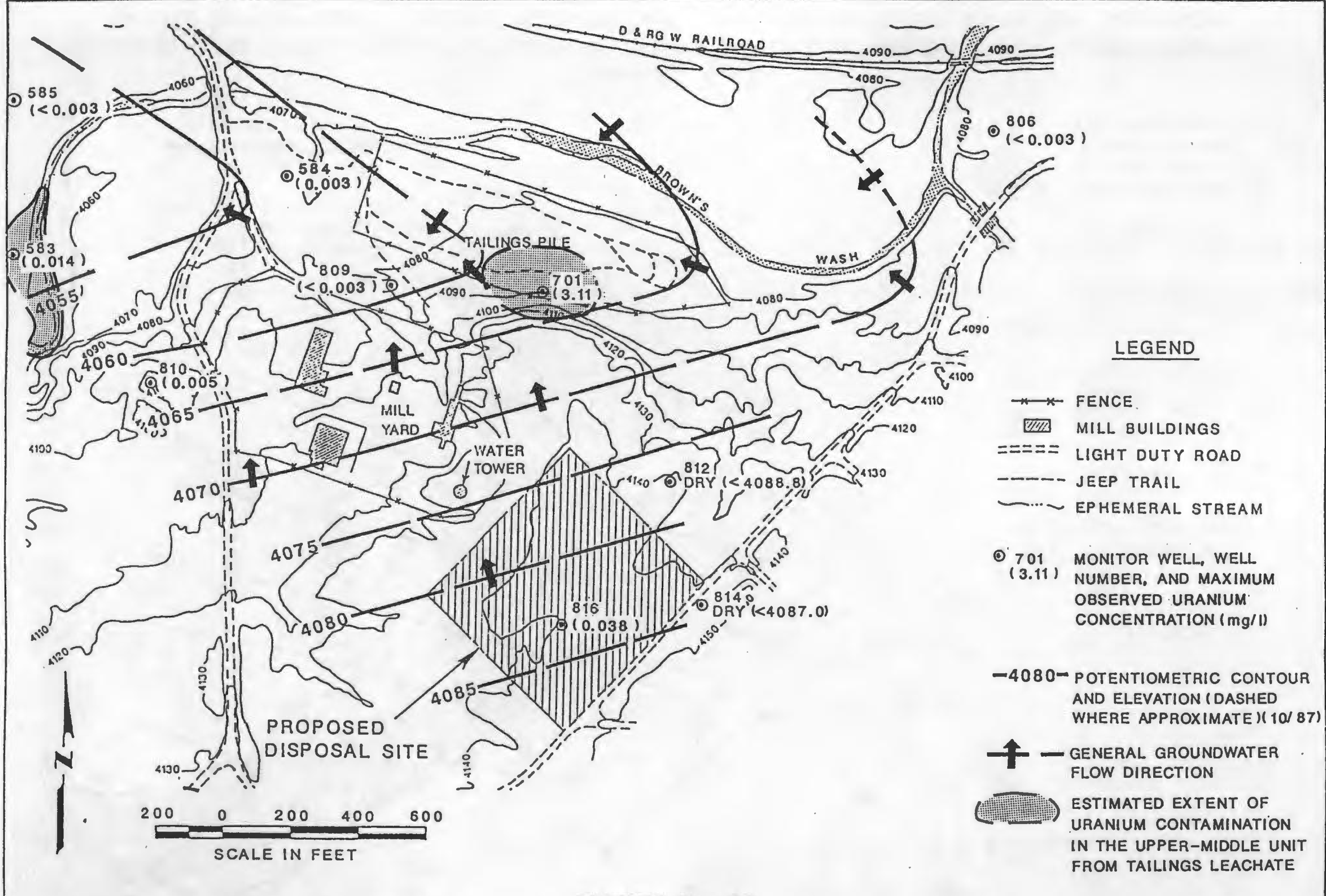


FIGURE B.4.22

MAXIMUM OBSERVED CONCENTRATION AND ESTIMATED EXTENT OF URANIUM CONTAMINATION IN THE UPPER-MIDDLE HYDROSTRATIGRAPHIC UNIT, GREEN RIVER, UTAH, TAILINGS SITE

B.5 GROUNDWATER IMPACTS RESULTING FROM THE PROPOSED ACTION--STABILIZATION ON SITE

B.5.1 DESIGN CONSIDERATIONS

The proposed disposal site is located in a topographically high area 600 to 1200 feet south of the present tailings pile. The present tailings surface is in the floodplain of Brown's Wash (elevation 4080 feet) and the proposed disposal site is 4140 feet in elevation at the existing grade. The tailings will be placed in a below-grade disposal cell; the base of the excavation will be at an elevation of about 4112 feet. The disposal cell foundation (unsaturated bedrock) will consist of moderately to highly fractured shale, mudstone, and limestone of the upper Cedar Mountain Formation to a depth of about 30 feet below the base of the excavation (elevation 4083 feet). Below this depth, the Cedar Mountain Formation is saturated and it consists of an additional ten to 40 feet of moderately to highly fractured silty sandstone and sandstone conglomerate of the Cedar Mountain Formation. A diagrammatic cross section of the proposed disposal cell and foundation is shown on Figure B.5.1.

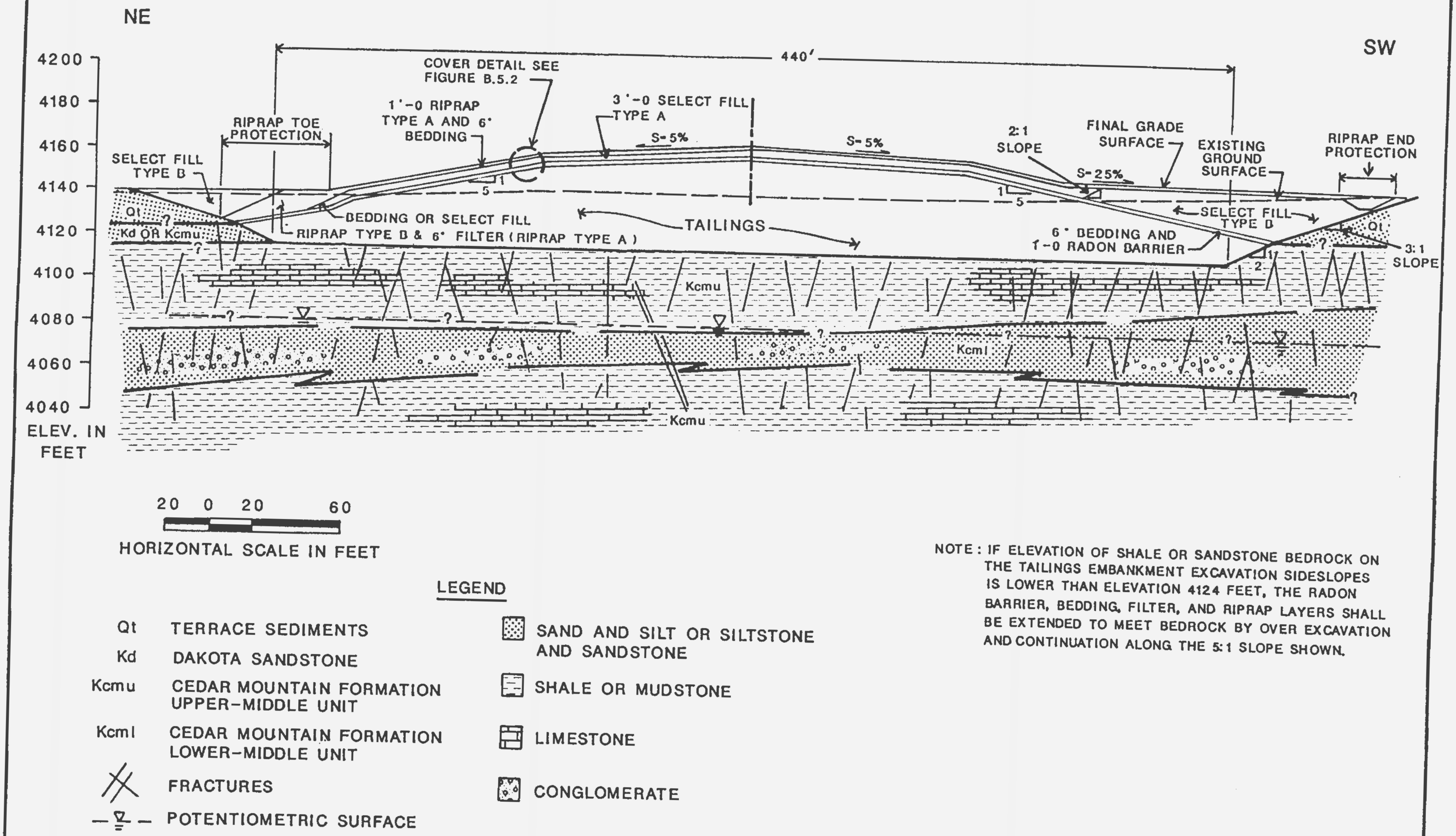
In terms of groundwater protection, the disposal cell design makes maximum use of favorable natural conditions at the site. Some of the design and disposal site features and considerations include the following:

- Below-grade disposal of the tailings to limit the exposed area of the stabilized pile, thereby maximizing evaporation and minimizing percolation of precipitation through the tailings.
- Consistent, uniform, vertical fracturing of the foundation bedrock to prevent ponding ("bathtubbing") in the tailings and promote drainage of runoff water from the toe of the cell.
- Abundant, desirable, secondary minerals on the foundation fracture surfaces to attenuate tailings seepage.
- Strong, upward, vertical hydraulic gradients in the saturated bedrock downgradient of the disposal site to inhibit downward migration of contamination.
- Flow direction in the shallow groundwater beneath the disposal site that is toward the present tailings pile and existing contamination.

Sections B.5.1.1 through B.5.2.4 provide a more detailed discussion of these features.

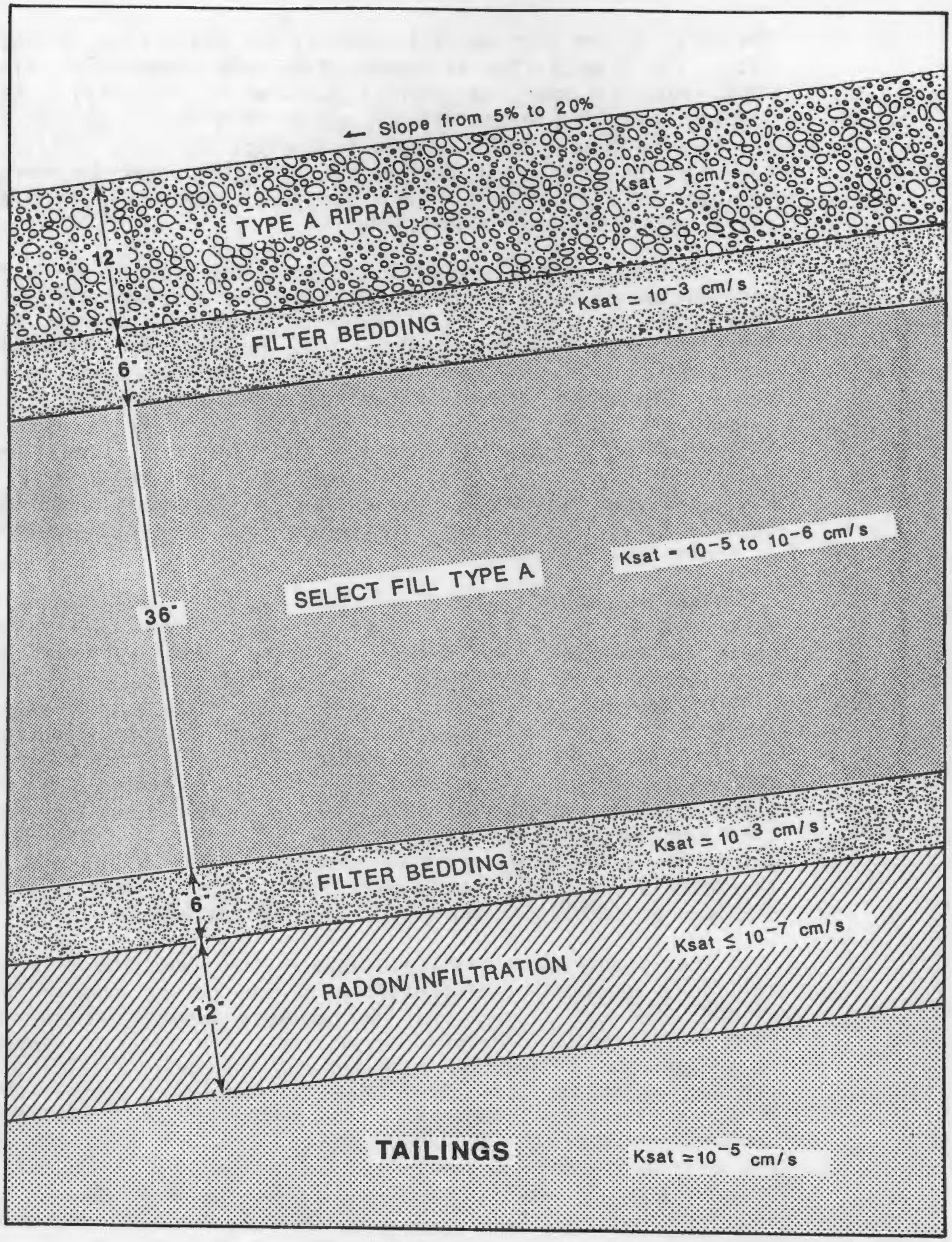
B.5.1.1 Tailings seepage

Tailings seepage is the water that percolates through the disposal cell and out the bottom. Figure B.5.2 is a detail of



NOTE: IF ELEVATION OF SHALE OR SANDSTONE BEDROCK ON THE TAILINGS EMBANKMENT EXCAVATION SIDESLOPES IS LOWER THAN ELEVATION 4124 FEET, THE RADON BARRIER, BEDDING, FILTER, AND RIPRAP LAYERS SHALL BE EXTENDED TO MEET BEDROCK BY OVER EXCAVATION AND CONTINUATION ALONG THE 5:1 SLOPE SHOWN.

FIGURE B.5.1
DIAGRAMMATIC CROSS SECTION OF PROPOSED DISPOSAL CELL AND FOUNDATION
GREEN RIVER, UTAH, TAILINGS SITE



NOTE: SEE SECTION D.4 FOR DETAILED DESCRIPTION OF COVER COMPONENT PROPERTIES; Ksat-SATURATED HYDRAULIC CONDUCTIVITY; cm/s-CENTIMETER PER SEC; SEE FIGURE B.5.1 FOR LOCATION OF THIS DETAIL IN RELATION TO THE DISPOSAL CELL.

FIGURE B.5.2
DISPOSAL CELL COVER SYSTEM
GREEN RIVER, UTAH, TAILINGS SITE

the cover system that would be used at the Green River disposal site. The cover system is comprised of five components: (1) a rock cover (riprap) to prevent surface erosion; (2) a sand bedding layer to prevent erosion and promote runoff of precipitation; (3) a select fill layer to protect the radon/infiltration barrier from frost action; (4) a filter layer to promote drainage of infiltration through the overlying layers; and (5) a radon/infiltration barrier.

The layer of select fill would be constructed using the uncontaminated material excavated from the disposal area; the layer would protect the radon/infiltration barrier from freezing (which would reduce the density and hydraulic conductivity) in case saturation extends to that depth in the cover. The compacted, saturated hydraulic conductivity of the select fill would be between 10^{-5} and 10^{-6} cm/s. The DOE is conducting a study to determine the effects of freeze-thaw cycles on cover materials; the need for this layer will be evaluated upon completion of the study in September, 1988 (see Section A.1.4.1, Radon/Infiltration Barrier Freezing, Appendix A, Conceptual Designs).

The radon/infiltration barrier would be constructed of a silty clay taken from a local alluvial borrow source, and would be ammended with sodium bentonite (three percent) and then compacted to assure the saturated hydraulic conductivity of the barrier is 10^{-7} cm/s (2.8×10^{-4} ft/day) or less. The barrier would be compacted at 100 percent standard proctor, and at a moisture content of optimum to three percent wet of optimum (degree of saturation of 90 to 95 percent). The in-place unsaturated hydraulic conductivity of the radon/infiltration barrier would be between 5×10^{-8} and 1×10^{-8} cm/s, given the compaction moisture content. See Section D.4 of the Remedial Action Plan (RAP) (DOE, 1988b) for detailed physical properties of the radon/infiltration barrier.

The steady-state tailings seepage rate from the disposal cell is a function of precipitation on the cover, evaporation, runoff from the cover, and the moisture content within the radon/infiltration barrier. In essence, the rate of seepage is a function of the flux rate through the radon/infiltration barrier, which has the lowest saturated hydraulic conductivity of any of the cover components. The degree to which the cover becomes and remains saturated will dictate the flux through the barrier. Under a worst-case condition, the radon/infiltration barrier would remain saturated for most or all of the year, and the long-term flux through the cover would be proportional to the saturated hydraulic conductivity of the radon/infiltration barrier, which is less than or equal to 1×10^{-7} cm/s. In Section B.4.8 it was estimated that as little as 0.06 cm/yr (1.95×10^{-9} cm/s) precipitation infiltrates (deeply percolates) through the present tailings, based on mixing of present tailings seepage with underflow in the underlying alluvial aquifer. In addition, one percent of the mean annual precipitation is estimated by Rush et al. (1982) to percolate to the groundwater system in Green River; this amounts to 0.15 cm (4.8×10^{-9} cm/s). Finally, the DOE (1983) showed that evaporation in the present tailings pile takes place from three to seven feet below the surface of the tailings. That is, during a dry period the moisture content decreases downward from the surface to between three to seven feet below the surface, and then increases to saturation at the water table.

Given the very high mean annual pan evaporation rate versus mean annual precipitation rate at Green River (10:1) (see Section B.4.4), it is unreasonable to assume that the cover system will be saturated, except when long periods of rainfall with high humidity occur, or when the cover is inundated by a melting, insulating snow cap (Walton, 1970). Neither of these situations is common at Green River where the bulk of the precipitation occurs as brief, intense thunderstorms in August and October (Rush et al., 1982) and the relative humidity does not remain at or near 100 percent for very long following these storms. The proposed cover system at the Green River disposal site would be capped by 12 inches of rock erosion protection, which may impede evaporation somewhat; however, since evaporation is known to take place in the soil profile as deep as seven feet at the site, the 12 inches of rock riprap should not abate evaporation from the cover system. In fact, evaporation within the proposed cover system should extend to similar depths found in the present tailings.

All factors considered, a conservative estimate of the long-term, unsaturated flux through the radon/infiltration barrier (and tailings) is 1×10^{-8} cm/s. This is considered conservative since groundwater recharge from direct precipitation has been estimated to be less than 5×10^{-9} cm/s. Assuming a long-term flux rate of 1×10^{-8} cm/s, a unit hydraulic gradient, and a total cell area of 4.4 acres (192,000 ft^2), the long-term steady seepage rate through the cover, tailings, and out the bottom of the disposal cell would be 6.4×10^{-5} cubic feet per second (0.029 gpm).

Considering that, with the proposed cover design, the vast majority of annual precipitation would evaporate back to the atmosphere at Green River (as it presently does) only a very small portion of the annual precipitation would run off the pile through the rock riprap or bedding layer(s). An extremely conservative assumption would be that one-half (7.4 cm/yr) of the annual precipitation that does not infiltrate through the radon/infiltration barrier would evaporate back into the atmosphere, and one-half (7.4 cm/yr) would run off the pile either through the rock riprap and upper bedding layer or through the lower bedding layer between the select fill and radon/infiltration barrier. Runoff through the rock riprap and upper bedding layer would likely occur during the higher-intensity storms (short duration), where the rainfall intensity exceeds the saturated hydraulic conductivity of either the upper bedding layer (1 x 10^{-3} cm/s; 1.4 inches per hour), or the select fill (1 x 10^{-6} cm/s; 0.0014 inches per hour) if the duration of the storm is long enough to fill voids in the bedding layer. Runoff in the lower bedding layer (below the layer of select fill) would likely occur in the longer-duration, frontal-type storms where the wetting front has time to advance through the common backfill and enter the lower bedding layer. In this type of event, infiltration may also occur through the radon/infiltration barrier.

B.5.1.2 Subsurface drainage

Drainage of tailings seepage into the foundation bedrock will occur as a result of percolation through the tailings. Drainage into bedrock will also occur at the toe of the cell where excess water may run off through the riprap or bedding. To determine if the foundation bedrock will be able to accept the rate of water delivered to it, an estimate of the bulk vertical hydraulic conductivity of the foundation bedrock was required.

Table B.4.8 shows that the horizontal hydraulic conductivity of the upper-middle unit (the foundation bedrock beneath the disposal cell) ranges from 0.2 to 17.0 ft/day (7.1 x 10^{-5} to 6.0 x 10^{-3} cm/s) and averages 1.6 ft/day (5.6 x 10^{-4} cm/s), based on slug or aquifer pumping tests from five monitor wells. All of these wells are north of the disposal area. Similar tests were not conducted beneath the disposal area because the upper-middle unit is either not saturated or is only saturated in the very lower portion of the unit (see Figure B.4.4). Rock core from monitor wells 807, 813, 816, and 818 beneath or peripheral to the disposal site indicate the upper-middle unit is very fractured (DOE, 1988b, 1987). The lower-middle sandstone unit is also very fractured, and these two units are probably hydraulically connected to some extent by the fractures. The horizontal hydraulic conductivity of the lower-middle unit is very similar to that of the upper-middle unit (see Table B.4.10).

The primary (matrix or unfractured) vertical saturated hydraulic conductivities of seven core samples of the upper- and lower-middle units of the Cedar Mountain Formation, from monitor wells 807, 813, 816, and 818, were calculated by the triaxial backpressure falling head method (Table B.5.1). Hydraulic conductivities ranged from 2.4 x 10^{-8} cm/s to 2.4 x 10^{-11} cm/s. The vertical fractures encountered in the rock core were so abundant that it was difficult to select rock core specimens to calculate primary vertical hydraulic conductivities. Because of the abundance and degree of

Table B.5.1 Triaxial hydraulic conductivities of selected rock core from monitor wells 807, 813, 816, and 818, Green River, Utah, tailings site[a]

Location ID	Sample ID	Depth (ft)	Test meth.	Moisture content (%)		Dry density (PCF)		Saturation (%)		Total pressure head (ft)	Hydraulic conductivity (cm/s)	Unit and visual description
				Init.	Final	Init.	Final	Init.	Final			
807	A	50 (Kcml)	TX	1.1	3.5	159.3	159.3	31.8	100	97.0	4.7×10^{-10}	Siltstone, light buff to gray, moderately well cemented, minor horizontal fracturing with iron staining.
807	B	80 (Kcmu)	TX	2.4	5.0	153.4	153.4	47.7	100	95.6	2.4×10^{-11}	Shale, medium gray, moderately well cemented, minor cemented horizontal fractures, layering, minor pyrite crystallization.
813	A	40 (Kcmu)	TX	7.6	14.9	137.8	120.7	89.7	100	95.7	1.3×10^{-9}	Shale, dark gray, fissle, moderately well cemented, secondary mineralization in horizontal joints as calcite or gypsum, iron staining.
813	B	65 (Kcml)	TX	0.8	4.8	149.2	149.2	17.0	100	4.3	7.0×10^{-9}	Sandstone, silty, very fine grained, soft, gray and light brown, minor iron staining.
816	A	40 (Kcmu)	TX	8.5	12.6	133.9	125.0	92.6	100	96.4	3.5×10^{-9}	Shale and mudstone, light gray micro-crystalline to dark gray fissle; secondary mineralization and iron staining on layered surfaces.
816	B	65 (Kcml)	TX	1.6	7.0	141.8	141.8	22.8	100	4.4	2.4×10^{-8}	Sandstone, medium brown to gray speckled, silty, fine to very fine grained, minor mud inclusions.
818	A	125 (Kcm)	TX	8.0	14.6	139.2	123.4	90.5	100	95.0	5.0×10^{-9}	Shale, fissle, moderately hard to soft, dark purple and medium gray.

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[a] See Figure B.4.1 for location of monitor wells; TX = Triaxial Backpressure falling head; Kcml = lower-middle unit Cedar Mountain Formation; Kcmu = upper-middle unit of Cedar Mountain Formation; Kcm = Cedar Mountain Formation between lower-middle and bottom unit; PCF = pounds per cubic foot (lb/ft^3).

vertical fracturing observed in the rock core beneath the disposal site, it is reasonable to assume the vertical hydraulic conductivity of the upper-middle shale unit is similar to the horizontal hydraulic conductivity. Also, if fracturing in the upper-middle unit was not the primary method of flow, the primary vertical hydraulic conductivity of the core samples would have to be more in the range that is suggested by Bouwer (1978) as being common; that is, vertical hydraulic conductivity of sedimentary aquifers is five to ten times less than horizontal hydraulic conductivity. Finally, if vertical fractures in the foundation bedrock beneath the disposal site were not present, a zone of saturation would exist on top of the bedrock/alluvium interface; triaxial tests on the foundation bedrock matrix hydraulic conductivity (Table B.5.1) shows the hydraulic conductivity is generally less than the estimated annual deep percolation of precipitation at the site.

For drainage considerations, a value of 0.2 ft/day (7.1×10^{-5} cm/s) was chosen to be a conservative value of bulk (fractured) vertical hydraulic conductivity of the fractured foundation bedrock beneath the disposal site. This value is equal to the lowest calculated bulk horizontal hydraulic conductivity of the upper-middle hydrostratigraphic unit (see Table B.4.8).

A conservative estimate of the quantity of runoff from the disposal cell cover system is 7.4 cm/yr (see Section B.5.1.1) multiplied by the total area of the cell (4.4 acres; 1.8×10^8 cm^2). Theoretically, this runoff could create a ring of ponding (below grade) around the toe of the pile. Should ponding occur, the minimum infiltration (drainage) rate would be proportional to the vertical hydraulic conductivity of the bedrock, under a gradient of unity. Therefore, the minimum drainage rate would equal 7.1×10^{-5} cm/s. Making allowances for the geometry of the cell and the porosity of the bedding layer (assumed to be 0.25), the ponding depth around the periphery of the cell would equal 23.7 cm (9.3 inches), or about three inches (maximum) ponding into the Type A riprap. The width of this ponding ring around the perimeter of the cell is very small and thus the ponding would have no affect on infiltration or leachate generation. Assuming a worst-case and somewhat unrealistic condition of year-round saturation of the radon/infiltration barrier (seepage flux equal to 10^{-7} cm/s and no evaporation), ponding would occur in a 100 cm (3.6 feet) skirt surrounding the disposal cell; the ponding depth (maximum) would be 37 cm (14.6 inches). The fraction of the disposal cell actually affected by this hypothetical ponding would be 0.8 percent, and would not significantly increase leachate generation from the disposal cell. A more realistic assumption is that the vast majority of average annual precipitation evaporates back into the atmosphere and long-term drainage off the pile would be negligible. Finally, since the long-term seepage rate through the tailings is estimated to be 1×10^{-8} cm/s (or 1×10^{-7} cm/s at the most), ponding or "bathtubbing" of seepage in the disposal cell would not occur. Detailed runoff and ponding calculations are on file at the UMTRA Project Office, Albuquerque, New Mexico.

B.5.2 SEEPAGE IMPACTS

Seepage impacts were calculated for the upper-middle and lower-middle hydrostratigraphic units only. The top unit, Brown's Wash alluvium, is not present beneath the disposal site; therefore, seepage from the stabilized tailings would not impact this unit. Although the lower-middle unit is not currently contaminated beneath the existing tailings site, for modeling purposes it was assumed that the tailings seepage from the disposal cell would mix with groundwater in the saturated upper portion of this unit beneath the disposal cell. The strong, vertically upward hydraulic gradients that exist between the bedrock units would resist the movement of any tailings seepage into the bottom hydrostratigraphic unit (see Section B.4.7.5).

B.5.2.1 Mixing and dilution

Following percolation downward through the fractured foundation bedrock, tailings seepage would contact and mix with groundwater flowing beneath the disposal cell. The upper-middle shale unit is probably not saturated beneath the southern sector of the disposal cell (See Figure B.4.4). For this reason it is assumed that tailings seepage would mix with groundwater in both the upper-middle and lower-middle units beneath the cell, and in approximately equal proportions. The mixing is assumed to take place in the saturated thickness of the upper-middle unit beneath the cell (maximum of ten feet), and in the saturated thickness of the lower-middle unit beneath the cell (20 feet).

Given these assumptions, lateral flow rates beneath the disposal cell were calculated to be 2.2 gpm for the upper-middle unit, and 1.6 gpm for the lower-middle unit (Section B.4.7). Further, assuming that the tailings seepage is divided equally into each unit, and the long-term steady state seepage rate through the tailings is 1×10^{-8} cm/s (0.029 gpm), the mixing ratio (tailings seepage to groundwater underflow) was calculated to be 0.0066 for the upper-middle unit and 0.0091 for the lower-middle unit. Assuming a saturated infiltration barrier for steady state conditions, the mixing ratios would be 0.066 and 0.091, respectively. The dilution of the tailings seepage by groundwater underflow is proportional to these mixing ratios.

Tailings seepage from the proposed disposal cell was mixed with groundwater in the Cedar Mountain Formation beneath the cell by using the following mixing formula:

$$C_rQ_r = C_tQ_t + C_uQ_u$$

where

C_r = Resulting concentration of water quality constituent beneath the disposal cell (mg/l).

Q_r = Resulting flow rate beneath the disposal cell; equal to tailings seepage rate plus groundwater underflow (gpm).

C_t = Concentration of water quality constitutent in tailings seepage (average pore water samples from lysimeter 714) (mg/l).

Q_t = Tailings seepage rate (gpm).

C_u = Concentration of water quality constituent in groundwater flowing beneath the disposal cell, prior to mixing with tailings seepage (mg/l).

Q_u = Rate of groundwater flowing beneath the proposed disposal cell; prior to mixing with tailings seepage (gpm).

Half of the tailing seepage was assumed to mix with groundwater in the upper-middle shale unit, and half was assumed to mix with the lower-middle sandstone unit.

Tables B.5.2 and B.5.3 show the results of the mixing calculations for the upper-middle and lower-middle units, respectively. The mixing calculations do not account for any geochemical reactions that may occur to attenuate contaminants in the tailings leachate.

Mixing results show that uranium, nitrate, and gross alpha concentrations would exceed the proposed EPA MCLs and background levels at the toe of toe disposal cell for both hydrostratigraphic units, assuming a tailings seepage rate of either 0.029 gpm (flux of 1 x 10^{-8} cm/s) or 0.29 gpm (flux of 1 x 10^{-7} cm/s). Chromium would also exceed the proposed EPA MCLs in the upper-middle unit with a tailings seepage rate of 0.29 gpm (flux of 1 x 10^{-7} cm/s); chromium and selenium will exceed the proposed MCLs and background, respectively, in the lower-middle unit with a tailings seepage rate of 0.29 gpm (flux of 1 x 10^{-7} cm/s). Pore water and background water quality data are very limited for both Ra-226 and 228 and gross alpha. Since gross alpha activity is primarily a result of uranium contamination, gross alpha is expected to behave similarly to uranium, and it would therefore exceed the proposed MCL. Radium does not exceed the proposed MCL beneath the present tailings pile, and it is expected that radium would not exceed the proposed MCL beneath the proposed disposal cell.

Table 8.5.2 Summary of mixing calculations for the upper-middle hydrostratigraphic unit, proposed tailings disposal site, Green River, Utah

Constituent	C_u[a]	C_t[b]	Cr[c]	Cr[d]	Proposed EPA MCL[e]
			10^{-7} cm/s	10^{-8} cm/s	
As (mg/l)	<0.01	0.03	0.011	0.010	0.05
Ba (mg/l)	NM	<0.1	<1.0	<1.0	1.0
Cd (mg/l)	NM	0.032	<0.010	<0.01	0.010
Cr (mg/l)	<0.01	1.88	0.129[f]	0.023	0.05
Pb (mg/l)	NM	0.02	<0.05	<0.5	0.05
Hg (mg/l)	NM	0	<0.0002	<0.0002	0.0002
Mo (mg/l)	0.02	0.15	0.028	0.021	0.1
NO_3 (mg/l)	85	2251	223[f]	100[f]	44
Se (mg/l)	0.72	0.150	0.68	0.72	0.01
Ag (mg/l)	NM	<0.01	<0.05	<0.05	0.05
Ra-226 and 228 (pCi/l)	NM	NM	<5	<5	5
U (mg/l)	0.038	448	28.63[f]	3.07[f]	0.044
Gross alpha (pCi/l)	NM	NM	[f] [g]	[f] [g]	15

[a] Concentration of groundwater underflow; October, 1987 analysis for monitor well 816.

[b] Concentration of tailings pore water; average of pore water analyses from lysimeter 714 (see Table 8.4.14).

[c] Concentration beneath disposal cell assuming tailings seepage rate of 1 x 10^{-7} cm/s (0.29 gpm).

[d] Concentration beneath disposal cell assuming tailings seepage rate of 1 x 10^{-8} cm/s (0.029 gpm).

[e] Same as State of Utah Drinking Water standards.

[f] Exceeds either proposed EPA MCL or background or both. See Table 8.4.18 for background values.

[g] The majority of gross alpha activity is a result of uranium contamination. Gross alpha is expected to behave very similar to uranium.

Note: NM = not measured.

Table B.5.3 Summary of mixing calculations for the lower-middle hydrostructigraphic unit, proposed tailings disposal site, Green River, Utah.

Constituent	C_u[a]	C_t[b]	Cr[c]	Cr[d]	Proposed EPA MCL[e]
			10^{-7} cm/s	10^{-8} cm/s	
As (mg/l)	<0.01	0.03	0.011	0.010	0.05
Ba (mg/l)	0.20	<0.1	0.19	0.20	1.0
Cd (mg/l)	<0.001	0.032	0.003	0.001	0.010
Cr (mg/l)	0.018	1.88	0.178[f]	0.035	0.05
Pb (mg/l)	<0.01	0.02	0.011	0.010	0.05
Hg (mg/l)	<0.0002	0	<0.0002	<0.0002	0.0002
Mo (mg/l)	0.096	0.15	0.100	0.097	0.1
NO_3 (mg/l)	114	2251	297[f]	134[f]	44
Se (mg/l)	0.071	0.150	0.078	0.071	0.01
Ag (mg/l)	<0.01	<0.01	<0.01	<0.01	0.05
Ra-226 and 228 (pCi/l)	3.5	NM	<5	<5	5
U (mg/l)	0.071	448	38.46[f]	4.23[f]	0.044
Gross alpha (pCi/l)	63	NM	[f] [g]	[f] [g]	15

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[a] Concentration of groundwater underflow; June, 1986, September, 1986, February, 1987, and October, 1987 analyses from monitor well 562; October, 1987, analysis from monitor well 813; Cu is mean of all analyses.

[b] Concentration of tailings pore fluid; average of pore water analyses from lysimeter 714 (see Table B.4.14).

[c] Concentration beneath disposal cell assuming tailings seepage rate of 1 x 10^{-7} cm/s (0.29 gpm).

[d] Concentration beneath disposal cell assuming tailings seepage rate of 1 x 10^{-8} cm/s (0.029 gpm).

[e] Same as State of Utah Drinking Water standards.

[f] Exceeds either proposed EPA MCL or background or both. See Table B.4.18 for background values.

[g] The majority of gross alpha activity is a result of uranium contamination. Gross alpha is expected to behave very similarly to uranium.

Note: NM = not measured.

Geochemical reactions may take place in the fractured foundation bedrock beneath the proposed disposal cell, as well as in each of the two potentially contaminated aquifers, which will attenuate the tailings leachate. The type of reactions that could occur are discussed in Section B.5.2.3, Geochemical attenuation.

B.5.2.2 Dispersion

Migration of the equilibrated leachate through the groundwater is simulated using the appropriate analytical solution of the convection-dispersion equation formulated by Domenico and Robbins (1985). An expression was derived for concentrations downgradient from a uniform rectangular source in a uniform flow field. This expression relates the contaminant concentration of any point at any time to the source concentration, source dimensions, groundwater velocity, and the three principal components of the dispersion coefficient. However, solution T of the equation assumes a non-machine contaminant (such as nitrate) and does not take into account the effects of geochemical attentuation.

Nitrate was the only constituent modeled using the Domenico and Robbins (1985) two-dimensional dispersion model. Detailed input and results are on file at the UMTRA Project Office, Albuquerque, New Mexico. Modeling input and results are summarized in Table B.5.4. Nitrate concentration would disperse to a background level (currently beneath the proposed disposal site) of 99 mg/l at a distance of 435 feet downgradient of the mixing zone in the lower-middle unit. Since the mixing zone for the lower-middle unit is beneath the northern half of the disposal cell (see Section B.5.2.1), 435 feet downgradient of the mixing zone is approximately the downgradient toe of the disposal cell. This analysis assumes the tailing seepage is equal to 0.029 gpm (seepage flux of 10^{-8} cm/s). This analysis also assumes no geochemical attenuation. Dispersion estimates (assuming no geochemical attenuation) were also modeled for the lower-middle unit for a tailings seepage rate of 0.29 gpm (seepage flux of 10^{-7} cm/s); tailing seepage rates of 0.029 and 0.29 gpm for the upper-middle unit; and distances to disperse to the local background level as well as the proposed EPA MCL for nitrate (44 mg/l as NO_3).

Uranium and gross alpha dispersions were not modeled because of the high resultant concentrations of these constituents estimated by mixing calculations. The dispersion modeling would not be helpful in making a realistic estimate of the fate of the uranium and gross alpha. Geochemical attenuation is expected to be an important factor in removing these contaminants from the groundwater downgradient of the disposal cell. If uranium concentrations are not lowered to

Table B.5.4 Summary of nitrate dispersion modeling, proposed tailings disposal site, Green River, Utah

Upper-middle hydrostratigraphic unit	Lower-middle hydrostratigraphic unit
Input parameter: velocity = 0.20 ft/day (74 ft/yr) regional NO_3 background = 4 mg/l local NO_3 background = 85 mg/l longitudinal dispersivity = 100 ft transverse dispersivity = 100 ft source width = 830 ft maximum mixing thickness = 30 ft	Input parameter: velocity = 0.11 ft/day (40 ft/yr) regional NO_3 background = 1 mg/l local NO_3 background = 99 mg/l longtudinal dispersivity = 100 ft transverse dispersivity = 100 ft source width = 700 ft maximum mixing thickness = 20 ft

NO_3 source concentration (mg/l)[a]	D(ft)[b]		W(ft)[c]		NO_3 source concentration (mg/l)[d]	D(ft)[e]		W(ft)[f]	
	44 mg/l	85 mg/l	44 mg/l	85 mg/l		44 mg/l	99 mg/l	44 mg/l	99 mg/l
100	2430	440	460	205	134	1740	435	510	210
223	7900	2990	950	530	297	4250	1670	890	500

[a] A nitrate source concentration of 100 mg/l beneath the disposal cell is a result of mixing tailings seepage at the rate of 0.029 gpm (10^{-8} cm/s) with groundwater in the upper-middle unit; a source concentration of 223 mg/l is a result of mixing tailings seepage at the rate of 0.29 gpm (10^{-7} cm/s).

[b] D = distance downgradient of mixing zone that nitrate will disperse to either 85 mg/l (background) or 44 mg/l (proposed EPA MCL).

[c] W = width of plume at 1/2 D when nitrate disperses to either 85 mg/l or 44 mg/l.

[d] A nitrate source concentration of 134 mg/l beneath the disposal cell is a result of mixing tailings seepage at the rate of 0.029 gpm (10^{-8} cm/s) with groundwater in the lower-middle unit; a source concentration of 297 mg/l is a result of mixing tailings seepage at the rate of 0.29 gpm (10^{-7} cm/s).

[e] Distance downgradient of mixing zone that nitrate will disperse to either 99 mg/l (background) or 44 mg/l (proposed EPA MCL).

[f] Width of plume at 1/2 D when nitrate disperses to either 99 mg/l or 44 mg/l.

local background levels or the proposed EPA MCL of 0.044 mg/l 600 feet downgradient of the disposal site, the fate of the uranium plume will be the same as the fate of the uranium plume currently in the upper-middle shale unit. Any uranium in the lower-middle sandstone unit would also disperse, and since the lower-middle unit intertongues with the upper-middle unit west (downgradient) of the present tailings pile (see Figures B.4.2 and B.4.3), the fate of any uranium (and gross alpha) contamination in the lower-middle unit would likely be similar to that of the upper-middle unit.

B.5.2.3 Geochemical attenuation

Concentrations of arsenic, barium, lead, mercury, and silver within tailings pore fluid and the Cedar Mountain Formation aquifer are below the proposed EPA MCLs; therefore, these contaminants are not addressed. Concentrations of cadmium, chromium, nitrate, selenium, and uranium, however, exceed EPA MCLs within tailings pore fluid at the Green River UMTRA site. Uranium and nitrate are the major contaminants of concern, because of their relatively high concentrations within tailings pore fluid. The following discussion presents an overview of the geochemical properties that influence the mobility and attenuation of the above contaminants in the Cedar Mountain Formation aquifer. See Table B.4.14 for lysimeter pore water analyses.

Cadmium

The cadmium concentration in lysimeter sample 714 is 0.032 mg/l; the proposed EPA MCL for cadmium is 0.01 mg/l. Cadmium probably occurs as a $CdSO_4^0$ complex within tailings pore water and the Cedar Mountain Formation aquifer. Precipitation and adsorption reactions control cadmium concentrations, where otavite ($CdCO_3$) limits cadmium concentrations in the alkaline groundwater that is typical of the Cedar Mountain Formation aquifer. At low cadmium concentrations ($<10^{-5}$ M, 1.12 mg/l), cadmium is specifically adsorbed by iron oxyhydroxides (Rai and Zachara, 1984), which occur as surface coatings along fractures present within the Cedar Mountain Formation aquifer (DOE, 1987). Cadmium concentrations reported from monitor well 562 are below 0.001 mg/l.

Chromium

The average chromium concentration from two lysimeter samples (714) is 1.88 mg/l, whereas the proposed EPA MCL is 0.05 mg/l. Chromium exists as Cr^{3+} and its hydrolysis products under relatively reducing and moderately oxidizing conditions; under strongly oxidizing conditions it exists as Cr^{6+}. Trivalent chromium precipitates as $Cr(OH)_3$ and Cr^{3+}

is strongly adsorbed by iron oxyhydroxides. Conversely, Cr^{6+} occurs as CrO_4^{2-}, which can be specifically adsorbed by iron oxides under the acidic pH conditions ($pH<7$) that exist within the tailings pile. Chromate (CrO_4^{2-}), however, is mobile under relatively oxidizing, neutral, and alkaline pH conditions. Chromium concentrations within the Cedar Mountain Formation aquifer beneath the present tailings pile are below 0.05 mg/l.

Nitrate

Nitrate is a mobile species in tailings pore fluid and the Cedar Mountain Formation aquifer. Concentrations of nitrate within lysimeter samples vary from 2 to 4500 mg/l and nitrate concentrations in groundwater vary from less than one to 440 mg/l in the alluvium, and less than one to 2480 mg/l in the upper-middle shale. The EPA MCL for nitrate is 44 mg/l. Under relatively reducing conditions, ammonium (NH_4^+) is the dominant form of nitrogen that can undergo cation exchange with clay minerals present in the Cedar Mountain Formation aquifer.

Selenium

The average selenium concentration from two lysimeter samples is 0.15 mg/l, whereas the proposed EPA MCL for selenium is 0.05 mg/l. Selenium occurs as an anionic species between pH and Eh ranges of four to 10. Maximum adsorption of selenium in the form of selinite (Se^{4+}) and selenate (Se^{6+}) potentially can occur under acidic pH conditions within the tailings pile. Iron oxyhydroxides are important adsorbants for selenium removal, and occur as fracture coatings within the Cedar Mountain Formation aquifer (DOE, 1987). Selenium concentrations within the Cedar Mountain Formation aquifer range from less than 0.005 to 0.72 mg/l. Higher selenium concentrations generally are associated with relatively high sulfate concentrations, which suggests that sulfate may compete with selenium for adsorption sites on iron oxyhydroxides (Rai and Zachara, 1984).

Uranium

The average uranium concentrations from two lysimeter samples is 448 mg/l, whereas the proposed EPA MCL for uranium is 0.044 mg/l. Under the relatively oxidizing, acidic conditions of the tailings pile, uranium probably occurs as soluble uranyl sulfate complexes. Uranium concentrations within the Cedar Mountain Formation aquifer beneath the present tailings range from less than 0.003 to over three mg/l. Uranium may precipitate from solution, forming uraninite if relatively reducing conditions are encountered within the Cedar Mountain Formation aquifer. The presence of pyrite (FeS_2) (DOE, 1987) suggests that relatively reducing conditions exist in portions of the Cedar Mountain Formation aquifer.

B.5.2.4 Geochemical modeling

Geochemical modeling using the computer code PHREEQE (Parkhurst et al., 1980) were used to simulate possible equilibrium reactions that would reduce concentrations of contaminants in Green River tailings leachate and the Cedar Mountain Formation aquifer (DOE, 1987). Results of the PHREEQE simulations are on file in the DOE UMTRA Project Office in Albuquerque, New Mexico.

PHREEQE simulations indicate the tailings seepage from the Green River disposal site can be neutralized by calcite in the fractures of the Cedar Mountain Formation. Neutralization of tailings seepage would result in a decrease in the solubility of heavy metals and trace elements that may precipitate from solution, further reducing their concentration in groundwater. Aqueous species, which remain soluble after tailings seepage is neutralized (such as arsenic, selenium, and molybdenum), may be adsorbed by mineral assemblages present within fractures in aquifer materials. Uranium would remain in solution in groundwater following neutralization until it encounters reducing conditions within the Cedar Mountain Formation. The presence of pyrite in fractures in the Cedar Mountain Formation suggests that conditions may be sufficiently reduced to precipitate uranium.

Assumed Eh values for tailings leachate (0.400 V) and Cedar Mountain Formation groundwater (0.100 and -0.100 V) were used as PHREEQE model input parameters. These Eh values are only an estimation of the actual Eh value(s) that may exist for the two solutions. Measurement of dissolved oxygen concentration and analytically determined redox couples (including Fe^{3+}/Fe^{2+}, NO_3^-/NO_2^-, NO_2^-/NH_4^-, and SO_4^{2-}/HS^-), a field Eh, and possibly U^{6+}/U^{4+}, will be performed on Cedar Mountain Formation groundwater to determine if relatively reducing conditions exist beneath the proposed disposal site to precipitate uraninite and other uranium minerals.

Both the nitrate and uranium plumes in the upper-middle unit beneath the existing tailings pile appear to be attenuated (see Figures B.4.20 and B.4.22, respectively). Calculated groundwater velocities in this unit beneath the present pile (see Table B.4.9) indicate that the contaminants should be traveling at the rate of about 0.41 ft/day with the flow of groundwater. The tailings were deposited between 1958 and 1961 and it would be reasonable to assume that contamination would have been present in the underlying groundwater system since at least 1970. Given a velocity of 0.41 ft/day, nitrate and uranium should have traveled about 2500 feet. Figure B.4.20 shows that nitrate has probably not traveled much beyond about 1200 feet; Figure B.4.22 shows that uranium has not left the pile area (less than 600 feet of travel).

Chromium concentrations beneath the present tailings pile are well below the proposed EPA MCL (see Table B.4.16), indicating that the chromium within the tailing seepage is attenuated by the affected aquifers beneath the pile.

B.5.3 SUMMARY OF IMPACTS FOR THE PROPOSED ACTION

Impacts to the upper- and lower-middle hydrostratigraphic units from the proposed remedial action are summarized in Tables B.5.5 and B.5.6, respectively. These impacts account for mixing and dilution of the tailings seepage with groundwater, as well as dispersion downgradient of the cell and geochemical attenuation. Also, impacts are based on a tailings seepage rate of 0.029 gpm, which corresponds to an unsaturated flux rate through the radon/infiltration barrier of 1×10^{-8} cm/s. For reasons discussed previously in this chapter, this tailings seepage rate is realistic and conservative for the Green River site.

B.5.3.1 Human health risks

At present, there are no users of groundwater in the vicinity of the affected hydrogeologic environment and the probability of future use is low. Should ingestion of groundwater occur in the future, the concentrations of contaminants produced from the tailings would be less than or equal to existing concentrations outside the affected environment.

The consumption of water with contamination exceeding the primary standards can pose a threat to health. High nitrate concentrations are often associated with infant methemoglobinemia.

Primary and secondary drinking water standards for chloride, nitrate, selenium, sulfate, and TDS were exceeded in the top, upper-middle, and lower-middle units. In addition, the bottom unit has natural levels of fluoride and selenium that exceed acceptable levels; however, these concentrations appear to be uniform between upgradient and downgradient wells and are not a result of contamination from the tailings material. Since there are no existing groundwater users, a detailed health risk assessment has not been conducted at this time.

Table B.5.5 Summary of remedial action impacts to the upper-middle hydrostratigraphic unit, Green River, Utah, tailings site

Constituent	Proposed EPA MCL[a]	Background[b]	Distance to meet EPA MCL or background (feet)[c]	Remarks
As	0.05	<0.01	0	Source concentration in pore fluid is less than EPA MCL.
Ba	1.0	NM	0	Source concentration in pore fluid is less than EPA MCL.
Cd	0.01	NM	0	Source concentration in pore fluid is slightly higher than EPA MCL; Cd not present at tailings site.
Cr	0.05	<0.01	0	Source concentration will be diluted to below the EPA MCL by groundwater underflow.
Pb	0.05	NM	0	Source concentration in pore fluid is less than EPA MCL.
Hg	0.002	NM	0	Source concentration in pore fluid is reported by analytical lab as 0 mg/l.
Mo	0.1	0.02	0	Source concentration will be diluted to below the EPA MCL by groundwater underflow.
NO_3	44	85	440	NO_3 will mix and disperse to 85 mg/l a distance of 440 feet downgradient of the mixing zone for the upper-middle unit.

Green River, Utah, tailings site (Concluded)

Constituent	Proposed EPA MCL[a]	Background[b]	Distance to meet EPA MCL or background (feet)[c]	Remarks
Se (mg/l)	0.01	0.72	0	Source concentration in pore fluid is less than the background concentration.
Ag (mg/l)	0.05	NM	0	Source concentration in pore fluid is less than the detection limit for Ag.
Ra-226 and 228 (pCi/l)	5	NM	0	Ra-226 and 228 activities are below the EPA MCL at the present tailings site.
U (mg/l)	0.044	0.038	0-600	U will disperse and be attenuated downgradient between the disposal site and the current tailings site; U contamination does not extend beyond 600 feet downgradient of the present tailings pile.
Gross alpha (pCi/l)	15	NM	0-600	Gross alpha will behave like U contamination.

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[a] State of Utah Drinking Water Standard maximum concentration limits are the same as the proposed EPA MCLs.

[b] Existing concentration beneath the disposal site; concentrations were measured in monitor well 816. NM = not measured.

[c] Based on a tailings seepage rate of 0.029 gpm (flux of 1×10^{-8} cm/s).

Table B.5.6 Summary of remedial action impacts to the lower-middle hydrostratigraphic unit, Green River, Utah, tailings site

Constituent	Proposed EPA MCL[a]	Background[b]	Distance to meet EPA MCL or background (feet)[c]	Remarks
As	0.05	<0.01	0	Source concentration in pore fluid is less than EPA MCL.
Ba	1.0	0.2	0	Source concentration in pore fluid is less than the background level.
Cd	0.01	<0.001	0	Source concentration will be diluted to below the EPA MCL by groundwater underflow.
Cr	0.05	0.02	0	Source concentration will be diluted to below the EPA MCL by groundwater underflow.
Pb	0.05	<0.01	0	Source concentration in pore fluid is less than the EPA MCL.
Hg	0.002	0.002	0	Source concentration in pore fluid is reported by analytical lab as 0 mg/l.
Mo	0.1	0.12	0	Source concentration will be diluted to below the EPA MCL by groundwater underflow.
NO_3	44	99	0	NO_3 will mix and disperse to 99 mg/l a distance of 435 feet downgradient of the mixing zone for the lower-middle unit; the mixing zone for the lower-middle unit is about 450 feet upgradient of the toe of the cell.

Table B.5.6 Summary of remedial action impacts to the lower-middle hydrostratigraphic unit, Green River, Utah, tailings site (Concluded)

Constituent	Proposed EPA MCL[a]	Background[b]	Distance to meet EPA MCL or background (feet)[c]	Remarks
Se (mg/l)	0.01	0.088	0	Source concentration will be diluted to below local background concentration.
Ag (mg/l)	0.05	<0.01	0	Source concentration in pore fluid is less than the detection limit for Ag.
Ra-226 and 228 (pCi/l)	5	3.1	0	Ra-226 and 228 activities are currently below the EPA MCL at the present tailings site.
U (mg/l)	0.044	0.062	0-600	U will disperse and be attenuated downgradient between the disposal site and the current tailings site; U contamination does not extend beyond 600 feet downgradient of the present tailings pile.
Gross alpha (pCi/l)	15	82	0-600	Gross alpha will behave like U contamination.

[a] State of Utah Drinking Water Standard maximum concentration limits are the same as the proposed EPA MCLs.

[b] Average existing concentration beneath the disposal site; concentrations were measured in monitor well 562.

[c] Based on a tailings seepage rate of 0.029 gpm (flux of 1×10^{-8} cm/s).

Under the proposed action, health impacts could be minimized by using institutional controls to inhibit ingestion of contaminated water. Background water quality indicates the quality of the groundwater is naturally poor and should not be used for human consumption. The readily available water that can be obtained from the Green River minimizes the need to use this contaminated water in the future.

B.5.3.2 Damage to crops, vegetation, and wildlife

As of 1979, there were 2165 acres of irrigated cropland and 455 acres of irrigated pastureland in the Green River area (SEUAOG, 1979). If agriculture were to be affected by the tailings, it would be the result of windblown contaminants affecting plant material and from the use of contaminated water to irrigate crops. All of the agricultural lands are north and west of the site and at least three miles from the tailings material. This area is hydraulically upgradient from any contaminated groundwater and entirely away from where windblown contaminants could reach. The irrigation water presently used is obtained from a large network of canals in Emery County that brings water from the mountains (SEUAOG, 1979). This water is in no way affected by the tailings material. The proposed action would not affect agricultural production and there is very little agricultural vegetation that could possibly be affected in the immediate vicinity of the tailings site.

B.6 THE NO ACTION ALTERNATIVE

Under existing conditions, the volume of recharge to the tailings pile has dropped to only that produced during natural precipitation and infiltration. Both the quality and rate of seepage from the tailings pile has decreased significantly from the period of active milling. Both nitrate and uranium plumes in the upper-middle unit beneath the existing tailings pile appear to be attenuated. Given a velocity of 0.41 ft/day, nitrate and uranium should have traveled about 2500 ft downgradient. However, the naturally occurring geochemical attenuating capacity of the groundwater and fractured bedrock have inhibited the extent of the existing contamination. Nitrate has traveled approximately 1000 feet (Figure B.4.20) and uranium has traveled no more than 800 feet (Figure B.4.22).

If there is no remedial action, it may be expected that continued leaching of contaminants from the tailings piles would continue at a decreasing rate, and that discharge of groundwater contaminated by tailings leachate would ultimately cease.

Human health, crops, vegetation, and wildlife

Health impacts under this alternative would be the same as those discussed in Section B.5.3.1. Also, as discussed in Section B.5.3.2, there would be no impacts to crops or vegetation unless irrigation wells were completed in the contaminant plume. The only open water source near the existing tailings pile is Brown's Wash. As discussed in Section B.4.10, contaminated groundwater would eventually discharge into Brown's Wash. During periods of low flow, when relative concentrations of dissolved constituents are high, wildlife may be affected by using the contaminated water.

B.7 THE STABILIZATION IN PLACE ALTERNATIVE

This alternative would involve consolidation, reconfiguration, and compaction of the tailings and contaminated material at the existing tailings pile. This action would cause a slight temporary increase in drainage from the pile and a subsequent minor insurgence of contaminants into the top and upper-middle hydrostratigraphic units. This minor influx would be of short duration, during and immediately following remedial action. The tailings pile would be stabilized in a manner similar to the proposed action; thus, the leaching of contaminants into the underlying aquifers would be minimized similar to the proposed action unless shallow groundwater were to rise up and intercept the base of the stabilized pile. This scenario is unlikely since, at a minimum, the water table is about five feet beneath the base of the present tailings. The substantial decrease in generation and migration of contamination from the tailings pile would eventually reduce the concentrations of contaminants toward background levels as shown in Section B.5.

Human health, crops, vegetation, and wildlife

Impacts to human health, crops, vegetation, and wildlife would be the same as those under the proposed action.

B.8 GROUNDWATER USE, VALUE, AND ALTERNATIVE SUPPLIES

B.8.1 EXISTING USE AND VALUE

There are 15 registered wells in Township 21 South, Range 16 East (State of Utah, 1985). Thirteen of these wells are on the west side of the Green River; one well is on the east side of the river one mile northeast of the tailings site (Figure B.8.1). The final well, the Crystal Geyser well, is in the southeastern corner of Section 34, Township 21 South, Range 16 East on the east bank of the Green River. Most or all of these wells, except for Crystal Geyser, are shallow (less than 20 feet deep) and are completed in the Green River alluvium. Information was obtained regarding 10 of the 15 wells. The majority of the wells are not being used because of poor quality of the water, disrepair of the wells, and the availability of better-quality water from the city of Green River. This is consistent with Rush et al. (1982) on groundwater use on a regional basis.

The reported past use of water from these wells was for watering gardens or livestock. Groundwater in the Green River area is not considered potable (Rush et al., 1982). The city of Green River provides water to residents on the eastern side of the Green River. The nearest resident to the tailings site hauls potable water from a coin-operated outlet in the city of Green River (Casper, 1985). In summary, there are no known uses of groundwater within the potentially affected hydrogeologic setting of the tailings site.

It is difficult to assign an absolute value to water resources, especially those of lesser quality. Qualitatively, it can be stated that the shallow groundwater affected by the Green River mill tailings has a very low value due to its origin in an area affected by the Mancos Shale and other shale and limestone deposits of the Cedar Mountain Formation. The Utah Division of Water Resources (DWR, 1975) states, "Water originating from this [Mancos Shale] formation has little value . . . ."

B.8.2 FUTURE USE AND VALUE

Future use of shallow groundwater for domestic consumption in the site area is not expected due to the poor natural quality and low yield of aquifers in the area. Groundwater in the area of Green River is not considered to be potable (Rush et al., 1982).

Drill stem tests have indicated that the relative ability of the shallow groundwater system to yield fluid during testing is small and permeability values are low (Rush et al., 1982). Other studies in the region also report a lack of groundwater resources. The water found during oil and gas drilling corroborates these reports (DWR, 1975):

> "Most all wells that were drilled contacted water, but the quality of this water has been such that it was not fit to drink."

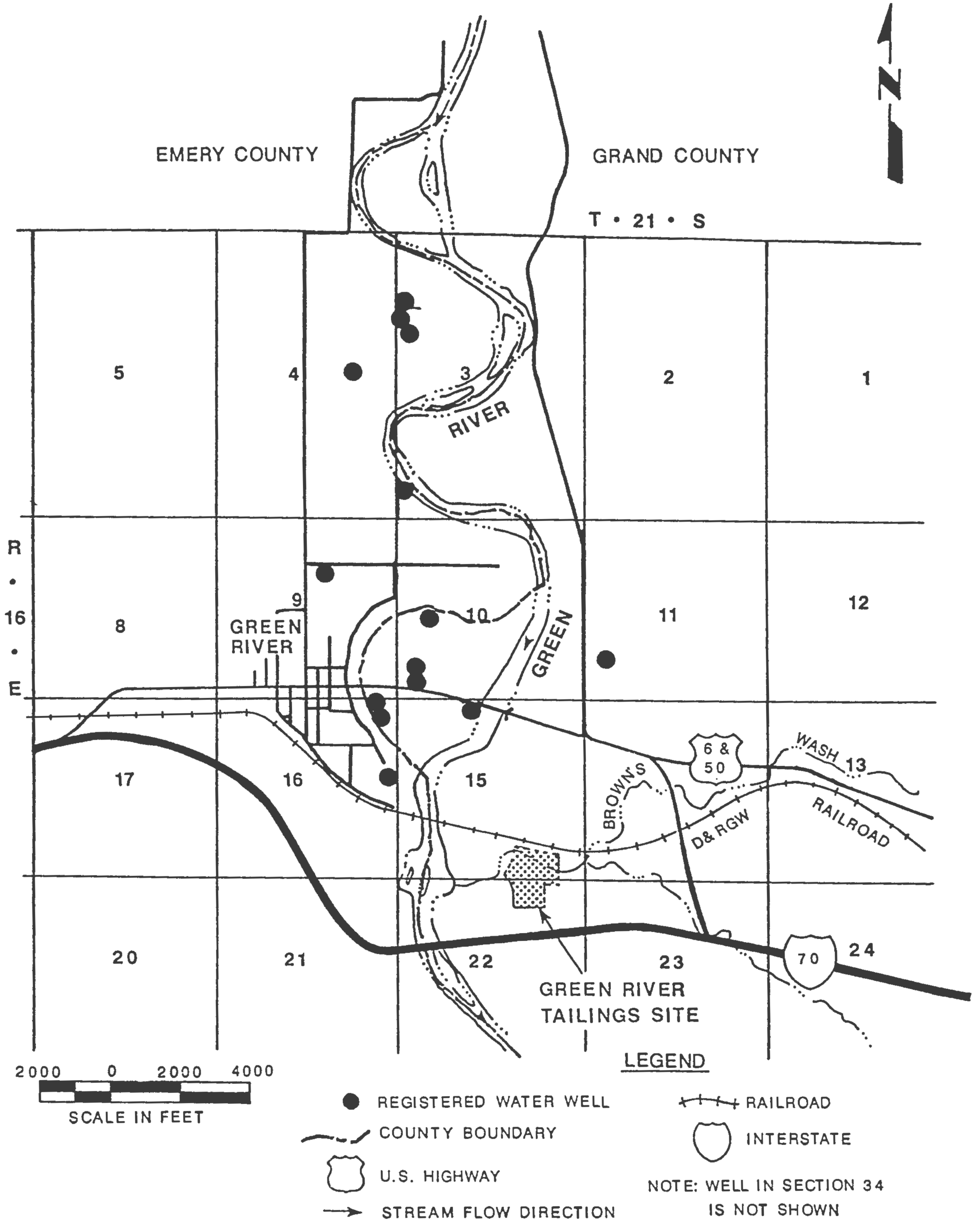

FIGURE B.8.1 LOCATIONS OF REGISTERED WATER WELLS IN TOWNSHIP 21 SOUTH, RANGE 16 EAST, NEAR GREEN RIVER, UTAH

The detrimental effects of the Mancos Shale on the availability of good-quality groundwater is one of the main factors limiting future development of groundwater in the area (DWR, 1976):

> "Groundwater development of fissured or fractured areas of the Mancos Formation has not been successful because most water located in fissures or by complete penetration into other strata has been of poor quality . . . ."

Present development of alluvial groundwater is limited because of natural and man-made degradation of the water, and these conditions will persist. The availability of better-quality water from the municipal supply has caused a decline in the use of alluvial groundwater. In spite of the poor water quality in the Brown's Wash alluvium and in the underlying shales and limestones of the Cedar Mountain Formation, water suitable for crop irrigation and livestock watering was found in a sandstone unit of the lower Cedar Mountain Formation beneath the tailings site (bottom hydrostratigraphic unit). The value of this potentially usable source of groundwater is very difficult to determine; however, an estimate of the value can be made by comparing the value of alternate sources of water for irrigation and stock watering. The city of Green River charges water users outside the city limits $23 for the first 6000 gallons per month, and $2 for each additional 1000 gallons per month (City of Green River, 1984).

The cost of municipally supplied water for users outside the city's limits is twice that for users within the city's limits. While groundwater obtained from the Buckhorn Conglomerate member of the Cedar Mountain Formation cannot replace current domestic supplies unless better-quality water can be found in this unit elsewhere, the value of municipally supplied water provides an upper limit for the value of the water available in these units. The ultimate value of the water in the Buckhorn Conglomerate will also be dependent upon the lateral extent of this unit, its recharge capacity, and the long-term availability of water from this unit.

In summary, the future usage of groundwater will be limited by the generally small supply and relatively poor quality of groundwater in the area, and the availability of a good quality municipal water supply.

B.8.3 ALTERNATIVE SUPPLIES

The tailings have not affected any groundwater currently being used. Alternate water supplies include Green River water as currently supplied by the city of Green River, and commercial water supply (e.g., delivery by tanker).

B.9 GROUNDWATER CLASSIFICATION

As part of the EPA's groundwater protection strategy, guidelines for consistency in its groundwater protection program were developed based on the policy that groundwater protection should consider the highest beneficial use to which groundwater having significant resource value can presently or potentially be put. Under this policy, protection policies were defined for three classes of groundwater based on their respective values and their vulnerability to contamination. The guidelines will be used by the EPA and the states to make decisions on, among other things, cleanup under existing regulations (EPA, 1984). The groundwater classes and their current definitions are provided in Table B.9.1.

Table B.9.1 U.S. EPA groundwater classification

Groundwater class/subclass	Potential value or use	Characteristics[a]
Class I	Special groundwater	Is highly vulnerable to contamination, an irreplaceable source of drinking water, and ecologically vital. The number of Class I groundwaters will be small.
Class II	Current and potential source of drinking water and water having other beneficial uses.	Cleanup will usually be to background or drinking water standards; alternative procedures may be applied for potential sources of drinking water or water used for agricultural or industrial purposes. Comprises the majority of groundwater resources and drinking water sources. Defined by the presence of one or more operating drinking water wells or springs within the classification review area (CRA), and/or the presence of a water supply watershed (or portion of) designated for water quality protection (by either state or local government) within the CRA.
Subclass IIA	Current source of drinking water	Capable of yielding a quantity of drinking water to a well or spring sufficient for the needs of an average family (150 gpd or more).
Subclass IIB	Potential source of drinking water	Has concentrations of TDS between 3,000 and 10,000 mg/l (defines drinking water that can be used without treatment or which can be treated using methods reasonably employed by public water supply systems).

Table B.9.1 U.S. EPA groundwater classification (Continued)

Groundwater class/subclass	Potential value or use	Characteristics[a]
Class III	Not a potential source of drinking water and of limited beneficial use.	Has TDS greater than 10,000 mg/l. Is so contaminated by naturally occurring conditions, or by the effects of broad-scale human activity, that it cannot be cleaned up using treatment reasonably employed in public water systems. Has insufficient yield at any depth (less than 150 gpd). Must not be connected to Class I or Class II groundwater or to surface water in an way that would allow contaminants to migrate to these waters and potentially cause adverse effects on human health or the environment.
Subclass IIIA		Has a high to intermediate degree of interconnection to adjacent groundwater units of a higher class or surface waters. Yield is insufficient from any depth within the CRA to meet the needs of the average family size (less then 150 gpd). May be managed at similar levels as Class II water depending on the potential for producing adverse effects in adjacent waters.
Subclass IIIB		Has a low degree of interconnection to adjacent surface waters or groundwaters of a higher class within the CRA. Has low resource value outside of mining, oil and gas recovery, or water disposal.

[a] TDS = total dissolved solids; gpd = gallons per day; mg/l = milligrams per liter.

Ref. EPA, 1984, 1986.

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APPENDIX C

FLORA AND FAUNA

TABLE OF CONTENTS

LIST OF TABLES

C.1 PLANT, WILDLIFE, AND FISH SPECIES

This section contains listings of plant (Table C.1.1), wildlife (Tables C.1.2, C.1.3, and C.1.4), and fish (Table C.1.5) species that were observed or are expected to occur at or in the vicinity of the Green River tailings and the proposed borrow sites. The sites and the general vicinity are sparsely vegetated with the exception of the riparian zone along the Green River. This riparian zone, 0.5 mile from the tailings site, is characterized by stands of cottonwood trees and willows with an understory of shrubs, forbs, and grasses. Both proposed borrow sites have been disturbed by previous borrow operations.

There is little diversity in the wildlife habitat at the tailings and borrow sites; small mammals and reptiles are the principal wildlife species observed or expected to occur. However, a higher diversity of wildlife species is expected to occur in the riparian zone. Fish species occur in the Green River and possibly in a limited section of Brown's Wash where it joins the Green River.

Table C.1.1 Plants observed in the general vicinity of the Green River, Utah, tailings and proposed borrow sites[a]

Common name	Scientific name
TREES AND SHRUBS	
Cottonwood	Populus fremontii
Willow	Salix exigus
Greasewood	Sarcobatus vermiculatus
Fourwing saltbush	Atriplex canescens
Shadscale	Atriplex confertifolia
Mat saltbush	Atriplex corrugata
Short saltbush	Atriplex cuneata
Bud sagebrush	Artemisia spinescens
Winterfat	Eurotia lanata
Blackbrush	Coleogyne ramosissima
Saltcedar	Tamarix pentandra
Plains prickly pear	Opuntia polyacantha
Fishhook cactus	Sclerocactus parviflorus
Big rabbitbrush	Chrysothamnus nauseosus
Sticky-leaved rabbitbrush	Chrysothamnus viscidiflorus
Broom snakeweed	Gutierrezia sarothrae
Torrey joint-fir	Ephedra torreyana
Pigweed	Amaranthus albus
Squaw bush	Rhus trilobata
GRASSES	
Galleta grass	Hilaria jamesii
Blue grama	Bouteloua gracilis
Indian ricegrass	Oryzopsis hymenoides
Cheatgrass	Bromus tectorum
Desert saltgrass	Distichlis spicata
Sand dropseed	Sporobolus cryptandrus
Red threeawn	Aristida longiseta
FORBS	
Textile onion	Allium textile
Desert lily	Eremocrinum albomarginatum
Desert trumpet	Eriogonum inflatum
Eriogonum	Eriogonum sp.
Five-hook bassia	Bassia hyssopifolia
Halogeton	Halogeton glomeratus
Russian thistle	Salsola kali
Seepweed	Suaeda sp.
Sand verbena	Abronia fragrans
Peppergrass	Lepidium densiflorum

Table C.1.1 Plants observed in the general vicinity of the Green River, Utah, tailings and proposed borrow sites[a] (Concluded)

Common name	Scientific name
FORBS (Concluded)	
Peppergrass	Lepidium montanum
African mustard	Malcomia africana
Tumble mustard	Sisymbrium altissimum
Desert globemallow	Sphaeralcea ambigua
Small-flowered globemallow	Sphaeralcea parvifolia
Yellow beeplant	Cleome lutea
Desert blazing star	Mentzelia multiflora
Stickleaf blazing star	Mentzelia pumila
Rushpea	Hofmanseggia repens
Milkvetch	Astragalus sp.
Evening primrose	Oenothera caespitosa
Fendler chimaya	Cymopterus fendlera
Dwarf gilia	Gilia pumila
Scorpionweed	Phacelia corrugata
Stickseed	Lappula redowski
Cryptantha	Cryptantha crassisepala
Bird beak	Cordylanthus sp.
Desert plantain	Plantago insularis
Indian wheat	Plantago patagonica
Ambrosia	Ambrosia sp.
Fleabane	Erigeron bellidiastrum
Spreading fleabane	Erigeron divergens
Blanket flower	Gaillardia pinnatifida
Machaeranthera	Machaeranthera linearis
Townsendia	Townsendia annua
Esteve pincushion	Chaenactis stevioides
Desert sunflower	Geraea canescens

[a] No observations were made in the riparian zone of the Green River.

Ref. Mulford, 1986; Williams, 1986; DOE, 1983, 1979; Anderson, 1977.

Table C.1.2 Mammals expected to occur in the general vicinity of the Green River, Utah, tailings and proposed borrow sites

Common name	Scientific name	Tailings site	Proposed borrow site 1	Proposed borrow site 2	Green River riparian zone
Merriam's shrew	Sorex merriami				X
Vagrant shrew	Sorex vagrans				X
Desert shrew	Notiosorex crawfordi	X	X	X	X
Yuma myotis	Myotis yumanensis	X			
Small-footed myotis	Myotis leibii	X			
Fringe-tailed myotis	Myotis thysanodes	X			
California myotis	Myotis californicus	X			X
Western pipistrel	Pipistrellus hesperus	X			X
Red bat	Lasiurus borealis				X
Hoary bat	Lasiurus cinereus				X
Townsend's big-eared bat	Plecotus townsendii	X			
Pallid bat	Antrozous pallidus	X			
Brazilian free-tailed bat	Tadarida braziliensis	X			
Black-tailed jackrabbit	Lepus californicus	X	X	X	
Desert cottontail	Sylvilagus audubonii	X	X	X	
White-tailed prairie dog	Cynomys leucurus	X	X	X	
Least chipmunk	Eutamias minimus	X	X	X	
Antelope ground squirrel	Ammospermophilus leucurus	X	X	X	
Rock squirrel	Citellus variegatus	X	X	X	X
Spotted ground squirrel	Citellus spilosoma	X	X	X	
Valley pocket gopher	Thomomys bottae	X	X		X
Great Basin pocket mouse	Perognathus parvus	X	X	X	
Northern grasshopper mouse	Onychomys leucogaster	X	X		
Ord's kangaroo rat	Dipodomys ordii	X	X	X	X
Great Basin kangaroo rat	Dipodomys microps	X	X	X	
Brush mouse	Peromyscus boylei	X	X	X	
Deer mouse	Peromyscus maniculatus	X	X	X	
Western harvest mouse	Reithrodontomys megalotis	X	X	X	X
Desert woodrat	Neotoma lepida	X	X	X	
Black rat	Rattus rattus	X			
Norway rat	Rattus norvegicus	X			
House mouse	Mus musculus	X			
Muskrat	Ondatra zibethicus				X
Coyote	Canis latrans	X	X	X	X
Raccoon	Procyon lotor				X
Long-tailed weasel	Mustela frenata				X
Mink	Mustela vison				X
Badger	Taxidea taxus	X	X	X	
Striped skunk	Mephitis mephitis				X
Spotted skunk	Spilogale putorius	X	X	X	
Bobcat	Lynx rufus	X	X	X	X
Mule deer	Odocoileus hemionus	X	X	X	X
Pronghorn antelope	Antilocapra americana	X	X	X	X

Ref. DOE, 1983; Sparks, 1981; Bernard and Brown, 1977.

Table C.1.3 Birds observed or expected to occur in the general vicinity of the Green River, Utah, tailings and proposed borrow sites[a]

Common name	Scientific name
MIGRATORY GAME BIRDS	
Whistling swan	*Olor columbianus*
Canada goose	*Branta canadensis*
Snow goose	*Chen caerulescens*
Ross' goose	*Chen rossii*
Mallard[b]	*Anas platyrhynchos*
Green-winged teal	*Anas crecca*
Cinnamon teal	*Anas cyanoptera*
American wigeon	*Anas americana*
Wood duck	*Aix sponsa*
Common goldeneye	*Bucephala clangula*
Hooded merganser	*Lophodytes cucullatus*
Common merganser	*Mergus merganser*
Red-breasted merganser	*Mergus serrator*
White-winged dove	*Zenaida asiatica*
Mourning dove	*Zenaida macroura*
UPLAND GAME BIRDS	
California quail	*Lophortyx californicus*
Gambel's quail	*Lophortyx gambelii*
Ring-necked pheasant	*Phasianus colchicus*
Chukar partridge[b]	*Alectoris chukar*
RAPTORS	
Turkey vulture[b]	*Cathartes aura*
Cooper's hawk	*Accipiter cooperii*
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Ferruginous hawk	*Buteo regalis*
Swainson's hawk	*Buteo swainsoni*
Golden eagle	*Aquila chrysaetos*
Bald eagle[c]	*Haliaeetus leucocephalus*
Prairie falcon	*Falco mexicanus*
Peregrine falcon[c]	*Falco peregrinus*
Merlin	*Falco columbaris*
American kestrel[b]	*Falco sparverius*
Barn owl	*Tyto alba*
Screech owl	*Otus asio*

Table C.1.3 Birds observed or expected to occur in the general vicinity of the Green River, Utah, tailings and proposed borrow sites[a] (Continued)

Common name	Scientific name
RAPTORS (Concluded)	
Great-horned owl	*Bubo virginianus*
Burrowing owl	*Speotyto cunicularia*
Long-eared owl	*Asio otus*
Short-eared owl	*Asio flammeus*
NON-GAME NESTING BIRDS[d]	
Yellow-billed cuckoo	*Coccyzus americanus*
Poor-will	*Phalanoptilus nuttallii*
Common nighthawk	*Chordeiles minor*
Lesser nighthawk	*Chordeiles acutipennis*
Broad-tailed hummingbird	*Selasphorus platycercus*
Belted kingfisher	*Megaceryle alcyon*
Common flicker	*Colaptes auratus*
Red-headed woodpecker	*Melanerpes erythrocephalus*
Lewis' woodpecker	*Asyndesmus lewis*
Downy woodpecker	*Dendrocopus pubescens*
Eastern kingbird	*Tyrannus tyrannus*
Ash-throated flycatcher	*Myiarchus cinerascens*
Black phoebe	*Sayornis nigricans*
Say's phoebe	*Sayornis saya*
Willow flycatcher	*Empidonax traillii*
Vermillion flycatcher	*Pyrocephalus rubinus*
Horned lark[b]	*Eremophilus alpestris*
Tree swallow	*Iridoprocne bicolor*
Bank swallow	*Riparia riparia*
Rough-winged swallow	*Stelgidopteryx ruficollis*
Barn swallow	*Hirundo rustica*
Cliff swallow	*Petrochelidon pyrrhonota*
House wren	*Troglodytes aedon*
Mockingbird	*Mimus polyglottis*
Gray catbird	*Dumetella carolinensis*
Bendire's thrasher	*Toxostoma bendirei*
Sage thrasher	*Oreoscoptes montanus*
American robin	*Turdus migratorius*
Swainson's thrush	*Catharus ustulatus*
Veery	*Catharus fuscescens*
Loggerhead shrike	*Lanius ludovicianus*
Starling	*Sturnus vulgaris*
Gray vireo	*Vireo vincinior*
Red-eyed vireo	*Vireo olivaceous*

Table C.1.3 Birds observed or expected to occur in the general vicinity of the Green River, Utah, tailings and proposed borrow sites[a] (Concluded)

Common name	Scientific name
NON-GAME NESTING BIRDS[d] (Concluded)	
Yellow warbler	Dendroica petechia
Common yellowthroat	Geothylpis trichas
American redstart	Setophaga ruticilla
House sparrow	Passer domesticus
Yellow-headed blackbird	Xanthocephalus xanthocephalus
Brewer's blackbird	Euphagus cyanocephalus
Brown-headed cowbird	Molothrus ater
Northern oriole	Icterus galbula
Blue grosbeak	Guiraca caerulea
Indigo bunting	Passerina cyanea
Fox sparrow	Passerella illiaca
Song sparrow	Melospiza melodia
Lincoln sparrow	Melospiza lincolnii
Brewer's sparrow	Spizella breweri
Sage sparrow	Amphispiza belli
American goldfinch	Spinus tristis
Lesser goldfinch	Spinus psaltria

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[a] The majority of the birds are concentrated in the Green River riparian zone.

[b] Bird species observed at or near the sites.

[c] These birds are endangered; detailed discussions are contained in Sections C.2.4 and C.2.5.

[d] Nesting raptors are not included.

Ref. Sparks, 1981; DOE, 1979; Eyre and Paul, 1973.

Table C.1.4 Reptiles and amphibians observed or expected to occur in the general vicinity of the Green River, Utah, tailings and proposed borrow sites

Common name	Scientific name	Tailings site	Proposed borrow site 1	Proposed borrow site 2	Green River riparian zone
	REPTILES				
Collared lizard	*Crotaphytus collaris*	X	X	X	
Leopard lizard[a]	*Crotaphytus wislizeni*	X	X	X	
Lesser earless lizard	*Holbrookia maculata*				X
Desert spiny lizard[a]	*Sceloporous magister*	X	X	X	X
Plateau fence lizard	*Sceloporous undulatus*	X	X	X	
Sagebrush lizard	*Sceloporous graciosus*	X	X	X	
Great Basin fence lizard	*Sceloporous occidentalis*	X			X
Side-blotched lizard[a]	*Uta stansburiana*	X	X	X	X
Great Basin whiptail lizard[a]	*Cnemidophorus tigris*	X	X	X	
Colorado tree lizard	*Urosaurus ornatus*				X
Short-horned lizard	*Phrynosoma douglassi*	X	X	X	X
Desert-horned lizard	*Phrynosoma platyrhinos*	X	X	X	
Desert-striped whipsnake	*Masticophis taeniatus*	X	X	X	X
Red racer	*Masticophis flagellum*	X	X	X	
Gopher snake	*Pituophis melanoleucus*	X	X	X	X
California kingsnake	*Lampropeltis getulus*	X	X	X	X
Western milksnake	*Lampropeltis triangulum*	X	X	X	X
Western long-nosed snake	*Rhinocheilus lecontei*	X	X	X	
Wandering garter snake	*Thamnophis elegans*	X	X	X	X
Red-sided garter snake	*Thamnophis sirtalis*				X
Night snake	*Hypsiglena torquata*	X	X	X	X
Western rattlesnake	*Crotalus viridis*	X			X
Great Plains ratsnake	*Elaphe guttata*				X
	AMPHIBIANS				
Western boreal toad	*Bufo boreas*				X
Great Plains toad	*Bufo cognatus*	X	X	X	X
Arizona toad	*Bufo microscaphus*				X
Woodhouse's toad	*Bufo woodhousei*				X
Canyon tree frog	*Hyla arenicolor*				X
Bull frog	*Rana catesbeiana*	X	X	X	X
Leopard frog	*Rana pipiens*				X

[a] Reptiles observed at or near the sites.

Ref. DOE, 1983; Sparks, 1981; Bernard and Brown, 1977.

Table C.1.5 Fish species expected to occur in the Green River near the Green River, Utah, tailings and proposed borrow sites

Common name	Scientific name
Bluehead sucker	*Catostomus discobolus*
Flannelmouth sucker	*Catostomus latipinnis*
Green sunfish	*Lepomis cyanellus*
Smallmouth bass	*Micropterous dolomieu*
Carp	*Cyprinus carpio*
Colorado squawfish[a]	*Ptychocheilus lucius*
Fathead minnow	*Pimephales promelas*
Roundtail chub	*Gila robusta*
Utah chub	*Gila artraria*
Red shiner	*Notropis lutrensis*
Sand shiner	*Notropis stramineus*
Speckled dace	*Rhinichthys osculus*
Black bullhead	*Ictalurus melas*
Channel catfish	*Ictalurus punctatus*

[a] The Colorado squawfish is an endangered species; see Section C.2.1 for a detailed discussion.

Ref. Tyus et al., 1982; Sparks, 1981.

C.2 THREATENED OR ENDANGERED SPECIES

According to the U.S. Fish and Wildlife Service (USFWS) and the Utah Division of Wildlife Resources, the endangered species that may occur at the tailings and proposed borrow sites are the Colorado squawfish, bonytail chub, humpback chub, black-footed ferret, bald eagle, and peregrine falcon (Livesay, 1986; Ruesink, 1986). Although the state of Utah does not have its own list of threatened or endangered species, it protects species listed by the USFWS. No Federally threatened or candidate species were listed by the two agencies.

C.2.1 COLORADO SQUAWFISH (PTYCHOCHEILUS LUCIUS)

The information presented on the Colorado squawfish in this section is derived from Tyus and McAda (1984) and Tyus et al. (1982), unless otherwise noted.

The Colorado squawfish is listed as endangered by the USFWS. This species is the largest minnow in North America and historically its range included the Colorado River from Wyoming to the Gulf of California and all of its larger tributaries such as the Green River. The Colorado squawfish is now rare and limited to the upper Colorado River basin (Valdez et al., 1982). The Green River and its two tributaries, the Yampa and White Rivers in Colorado and Utah, contain the largest known concentrations of Colorado squawfish.

Adult Colorado squawfish are rare and are usually collected singly or in pairs. Adult Colorado squawfish utilize a variety of habitats. In the Green River they were collected from or monitored in shoreline habitat with sandy substrate and observed in eddys, runs, backwaters, and pools.

Adult Colorado squawfish exhibit seasonal movements into preferred habitats including migrations of up to 200 miles to suitable spawning areas. Spawning habitat consists of a cobble (averaging eight centimeters in diameter) substrate over bedrock or sandbars in pool habitat, as evidenced by a spawning site found in the lower Yampa River. Another spawning site is suspected in the Gray Canyon area of the Green River, which is approximately 35 stream miles upstream from the city of Green River. The spawning areas are not used to any great extent other than during the July spawning season when adults appear to be relatively common in these sites.

The larvae (young-of-the-year or YOY) of the Colorado squawfish are thought to drift downstream from the spawning site to more suitable nursery habitat because the young squawfish are usually found in backwaters downstream of known or suspected spawning sites. The nursery habitats found in the Green River (below the mouth of the Yampa River) consist of shallow ephemeral backwaters with silt substrates that are rich in food organisms.

The Colorado squawfish is present in the Green River near the tailings site. A total of 627 YOY, 172 juvenile, and 47 adult Colorado squawfish were collected using a standardized sampling program in the Green River during a 1979 to 1981 sampling effort by the USFWS. Of this total, 106 YOY, 23 juvenile, and eight adult Colorado squawfish were collected between Labyrinth Canyon and Gunnison Butte. The tailings site is between these two locations. Also, Gray Canyon, a suspected spawning site, is approximately 35 stream miles upstream from the tailings site. Thus, the Green River in the vicinity of the tailings site would also be an important habitat for larvae that drift downstream from the suspected spawning site.

There would not be any direct impact to the Green River from the proposed remedial action at the Green River site. The only possible indirect impact on the Green River, and consequently on the Colorado squawfish, would be increased siltation in the Green River as a result of remedial action activities (removing contaminated materials) in Brown's Wash, an intermittent tributary of the Green River. This disturbance would be 0.5 mile from the confluence of Brown's Wash and the Green River; to avoid any impact on the Green River and the Colorado squawfish, erosion and sediment control measures would be constructed to control runoff during the disturbance of Brown's Wash.

C.2.2 BONYTAIL (GILA ELEGANS) AND HUMPBACK (G. CYPHA) CHUBS

The information presented on the bonytail and humpback chubs in this section is derived from Behnke and Benson (1982) and Tyus et al. (1982), unless otherwise noted.

The bonytail and humpback chubs are listed as endangered by the USFWS. Both of these species were historically distributed throughout the Colorado River basin in main river channels and larger tributaries. The bonytail chub was most common in the open river areas of large river channels while the humpback chubs were restricted to swift, deep water areas, mainly in canyons.

Presently, the bonytail chub is found in Lake Mohave of the lower Colorado River basin and in Gray Canyon (Coal Creek Rapids) of the Green River. Coal Creek Rapids was the only location in the upper Colorado River basin where fish resembling the bonytail chub were collected in 1981 and 1982. However, further examination indicated that these fish were the result of hybrid combinations between the bonytail, humpback, and roundtail chubs. The humpback chub occurs in the Grand Canyon of the lower Colorado River basin and in the upper Colorado River basin in Westwater Canyon to Ruby Canyon, and they were found in 1981 and 1982 in the Green and lower Yampa Rivers.

Bonytail and humpback chubs feed on invertebrates and surface debris. The humpback chub may also feed at different depths (bottom to surface) since its body is designed to facilitate up and down movements. Both species spawn in the spring at river temperatures of approximately 65°F. The habitat preference of the bonytail chub appears to be eddy and shoreline habitats over sand-silt substrate. The humpback chub prefers deep, swift runs and eddies with rocky substrate (Valdez and Clemmer, 1982). Young chubs prefer backwaters.

Both chub species remain in favorable habitats and rarely move or migrate to other areas.

The bonytail and humpback chubs do not occur in the Green River near the tailings site (Tyus, 1986); therefore, the remedial action activities at the tailings and borrow sites would not affect these species.

C.2.3 BLACK-FOOTED FERRET (MUSTELA NIGRIPES)

The black-footed ferret is listed as endangered by the USFWS. The tailings site overlaps the historic range of the black-footed ferret, but the species is not known to occur in Utah (Clark et al., 1984). However, since its activities are closely associated with prairie dogs, all prairie dog towns are considered potential black-footed ferret habitat. 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 tailings and proposed borrow sites; therefore, remedial action would not affect the black-footed ferret.

C.2.4 BALD EAGLE (HALIAEETUS LEUCOCEPHALUS)

The bald eagle is listed as endangered by the USFWS. The eagle is generally associated with river habitat where suitable perches and fish are available. It feeds mainly on fish; however, carrion, waterfowl, and rabbits may also be consumed. Large cottonwood trees growing in the riparian zone provide perching and roosting sites. Along the Green River, the bald eagle is a winter resident with no known concentration areas that are considered to be of high value or critical roosting sites in the vicinity of the tailings and borrow sites (Livesay, 1986).

Remedial action activities at the tailings and borrow sites would not directly affect the bald eagle since all activities would be conducted at the sites and away from known and potential habitats. Indirect impacts such as noise would be short term, lasting only for the duration of the remedial action.

C.2.5 PEREGRINE FALCON (FALCO PEREGRINUS)

The peregrine falcon is listed as endangered by the USFWS. The falcon typically prefers to nest on bare rock ledges of cliffs (Eyre and Paul, 1973). Falcons are usually found near bodies of water or marshes with a stream or river within a distance of one mile. Key hunting areas are those in which small to moderately sized prey (e.g., songbirds, woodpeckers, doves, ducks) are concentrated or especially vulnerable to predation. Examples of such areas are riparian zones, ponds, marshes, croplands, pastureland, and open valleys (Call, 1978; Eyre and Paul, 1973). The peregrine falcon is distributed along the Green River as well as throughout the agricultural areas associated with the city of Green River (Livesay, 1986).

Remedial action activities at the tailings and borrow sites would not directly affect the peregrine falcon since all activities would be conducted away from known and potential habitats. Indirect impacts such as noise would be short term, lasting only for the duration of the remedial action.

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APPENDIX D

RADIATION

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D.1 RADIATION

D.1.1 INTRODUCTION

This appendix addresses the increased radiation doses and health effects to the general population and remedial action workers for the alternatives under consideration for remedial action at the Green River tailings site. The slightly increased doses received by these individuals could, in a statistical sense, increase the potential for general population and individual health effects (excess cancers) above those expected to occur naturally. Assumptions made during the calculations of excess health effects for the general population and remedial action workers are realistic, but conservative, in order to derive an estimated upper limit for the excess effects that might occur because of exposures to low levels of radiation from the tailings.

D.1.2 BASIC FACTS ABOUT RADIATION AND ITS MEASUREMENT

Atoms that spontaneously transform, or decay, into new atoms are termed "radioactive." The decaying atom is called the parent, and the atom produced by the transformation is called the daughter. The rate at which atoms decay is the radioactivity, measured by the unit curie (Ci). A more convenient unit for measuring the radioactivity of tailings is the picocurie (pCi), which is one-millionth of one-millionth (1×10^{-12}) of a curie. The half-life of a radioactive substance is the time required for it to lose 50 percent of its radioactivity by decay. Each radionuclide has a unique half-life.

When atoms undergo radioactive decay, they emit radiation. The most common types of radiation are alpha, beta, and gamma. Alpha and beta radiation are tiny particles with kinetic energy, and gamma radiation is pure energy without mass. Radiation transmits energy to matter as it travels through matter. Alpha radiation penetrates only a few micrometers into matter, and beta radiation penetrates a few centimeters. Gamma radiation travels deeper into matter in the same way as X-rays. Alpha radiation will not penetrate through a layer of skin whereas gamma radiation can easily penetrate tissue and hence deliver a dose to any internal organ. However, alpha radiation, if inside the body, will deliver a larger dose to the immediate tissues since all of the alpha energy will be deposited in these living tissues.

The amount of radiation to which an individual is exposed may be expressed in terms of the amount of energy imparted to cells and tissue by the radiation and the degree of biological damage associated with the energy as it is absorbed. This absorbed energy is termed the absorbed dose and is given in units of rads, where one rad equals 100 ergs of energy absorbed per gram of material irradiated. When the irradiated material is living tissue, the damage per rad varies depending on the type of radiation. By applying a quality factor to each type of radiation, the degree of biological damage can be expressed independently of the type of radiation causing it. The biologically relevant absorbed energy is termed the dose equivalent, and the unit is the rem.

One rad is equal to one rem for less damaging radiations where the quality factor is equal to one (e.g., gamma rays). For comparison, one rad of internal alpha-deposited energy is equal to 20 rem because alpha particles are more damaging to tissue and the quality factor for alpha radiation is 20. The millirem equals one-thousandth (1×10^{-3}) of a rem and is in more common usage when expressing doses from environmental levels of radiation.

When radionuclides are deposited internally, they may be removed either by radioactive decay within the body or by biological elimination before radioactive decay occurs. During the period of time before total removal, the radionuclides are decaying and exposing the body and organs to radiation. The integrated dose equivalent over the entire residence period of the radioactive material in tissue is referred to as the committed dose equivalent. The sum of all committed dose equivalents from all internal depositions is referred to as the dose commitment. The committed effective dose equivalent is determined by summing the committed dose equivalents for each organ, weighted by a factor dependent on the susceptibility of that organ to certain health effects.

When a succession of radioactive parent atoms decays to radioactive daughter atoms, a radioactive decay series is formed. Uranium-238 (U-238) is such a radioactive parent atom, and the U-238 decay series is shown in Figure D.1.1. The U-238 decay series includes thorium-230 (Th-230), radium-226 (Ra-226), radon-222 (radon or Rn-222), short-lived radon daughters, and other long-lived radioactive atoms. The U-238 decay series ends with lead-206 (Pb-206), an atom that is stable and not radioactive. When the daughter products in a radioactive decay chain have shorter half-lives than the parent, the daughter radioactivities will increase, termed "ingrowth," until they equal the radioactivity of the parent.

Radon is the radionuclide of primary importance to the Uranium Mill Tailings Remedial Action (UMTRA) Project because it represents the largest radiation exposure to the general population. The half-life of radon (3.8 days) is short relative to the half-life of Ra-226 (1602 years). As Ra-226 decays, the newly produced radon will begin to decay; the radon radioactivity will ingrow to become equal to the Ra-226 radioactivity within 30 days. Similarly, the short-lived radon daughter radioactivities will ingrow within four hours to equal the radioactivity of radon and Ra-226. When the radioactivities of the parent and its daughters are equal, the daughters are said to be in 100 percent equilibrium or simply in equilibrium. If the daughters are diluted or carried away in the air as they are formed, they will not reach 100 percent equilibrium. If the daughters are at less than 100 percent equilibrium, then the potential radiation exposure is reduced from the maximum possible radiation exposure at a given radon concentration.

Radon is the only member of the U-238 decay series that does not readily combine with other materials to form solids. Radon is an inert gas and does not react chemically with other elements; therefore, it

Nuclide	Historical name	Half-life	Major radiation energies (MeV) and intensities†		
			α	β	γ
$^{238}_{92}U$	Uranium I	4.51×10^9 y	4.15 (25%) 4.20 (75%)	---	---
$^{234}_{90}Th$	Uranium X_1	24.1d	---	0.103 (21%) 0.193 (79%)	0.063c‡ (3.5%) 0.093c (4%)
$^{234}_{91}Pa^{m}$ 99.87% 0.13%	Uranium X_2	1.17m	---	2.29 (98%)	0.765 (0.30%) 1.001 (0.60%)
$^{234}_{91}Pa$	Uranium Z	6.75h	---	0.53 (66%) 1.13 (13%)	0.100 (50%) 0.70 (24%) 0.90 (70%)
$^{234}_{92}U$	Uranium II	2.47×10^5 y	4.72 (28%) 4.77 (72%)	---	0.053 (0.2%)
$^{230}_{90}Th$	Ionium	8.0×10^4 y	4.62 (24%) 4.68 (76%)	---	0.068 (0.6%) 0.142 (0.07%)
$^{226}_{88}Ra$	Radium	1602y	4.60 (6%) 4.78 (95%)	---	0.186 (4%)
$^{222}_{86}Rn$	Emanation Radon (Rn)	3.823d	5.49 (100%)	---	0.510 (0.07%)
$^{218}_{84}Po$ 99.98% 0.02%	Radium A	3.05m	6.00 (~100%)	0.33 (~0.019%)	---
$^{214}_{82}Pb$	Radium B	26.8m	---	0.65 (50%) 0.71 (40%) 0.98 (6%)	0.295 (19%) 0.352 (36%)
$^{218}_{85}At$	Astatine	~2s	6.65 (6%) 6.70 (94%)	? (~0.1%)	---
$^{214}_{83}Bi$ 99.98% 0.02%	Radium C	19.7m	5.45 (0.012%) 5.51 (0.008%)	1.0 (23%) 1.51 (40%) 3.26 (19%)	0.609 (47%) 1.120 (17%) 1.764 (17%)
$^{214}_{84}Po$	Radium C'	164 μs	7.69 (100%)	---	0.799 (0.014%)
$^{210}_{81}Tl$	Radium C"	1.3m	---	1.3 (25%) 1.9 (56%) 2.3 (19%)	0.296 (80%) 0.795 (100%) 1.31 (21%)
$^{210}_{82}Pb$	Radium D	21y	3.72 (.000002%)	0.016 (85%) 0.061 (15%)	0.047 (4%)
$^{210}_{83}Bi$ ~100% .00013%	Radium E	5.01d	4.65 (.00007%) 4.69 (.00005%)	1.161 (~100%)	---
$^{210}_{84}Po$	Radium F	138.4d	5.305 (100%)	---	0.803 (0.0011%)
$^{206}_{81}Tl$	Radium E"	4.19m	---	1.571 (100%)	---
$^{206}_{82}Pb$	Radium G	Stable	---	---	---

REF. BRH, 1970; LEDERER et al., 1967

FIGURE D.1.1 URANIUM-238 DECAY SERIES

can diffuse out of matter and into the atmosphere. The atmospheric radon concentration is measured in units of picocuries per liter (pCi/l). In the uranium milling process, Ra-226, the parent of radon, is left in the tailings and becomes the source from which radon diffuses into the atmosphere. Once in the atmosphere, radon is transported downwind and, in accordance with its 3.8-day half-life, decays into the short-lived radon daughters which can attach to particulates in the air. Since radon is an inert gas, it is inhaled and exhaled, contributing very little radiation exposure to the lung. The radon daughters are solids, however, and once inhaled can deposit in or attach to the lung and then decay, transmitting alpha energy to the lung. Because of their short half-life, these daughters may decay before being removed from the lung, contributing significant radiation exposure to the lung.

Trace amounts of U-238 and its daughters are found everywhere on the earth; therefore, radon and its short-lived daughters contribute significantly to the natural background radiation exposure of the general population. Human exposure to radiation originates from both natural and man-made sources. The major natural radiation originates from external cosmic and terrestrial sources and from naturally occurring radionuclides that are deposited inside the body via inhalation and ingestion.

Medical usage of radiation is responsible for the highest man-made contribution to man's radiation exposure, accounting for 45 percent of man's total radiation exposure. Other man-made contributors, including airline travel, atmospheric weapons tests, the nuclear industry, and consumer and industrial products together account for four percent. The remaining 51 percent of man's total radiation exposure results from exposure to natural radiation sources (Shleien and Terpilak, 1984).

D.2 METHOD OF ANALYSIS

Radiation and its associated health effects have been studied more thoroughly than health effects from other carcinogenic agents. The evaluation of health effects caused by low-level radiation is, however, a difficult task, and many uncertainties are associated with the estimation of risks from radiation. The traditional approach for estimating risk from low-level radiation exposures is to extrapolate from effects observed at high radiation exposures using linear-dose response and no threshold assumptions.

There are five principal pathways that could potentially result in the exposure of man to radiation from the tailings. These are (1) inhalation of radon daughters; (2) direct exposure to gamma radiation emitted from a contaminated area; (3) inhalation and ingestion of airborne radioactive particulates; (4) ingestion of surface water or groundwater contaminated with radioactive materials; and (5) ingestion of contaminated food produced in areas contaminated by radioactive material (such as uranium mill tailings).

For detailed calculations of health effects in this appendix, only the two most important radiation exposure pathways are considered; these are the inhalation of radon daughters and direct exposure to gamma radiation. Analyses of excess health effects due to airborne radioactive particulates have been performed for other UMTRA Project sites (DOE, 1985a,b; 1984a,b; 1983) with results indicating that inhalation of suspended particulates from the tailings results in relatively small radiation exposures for remedial action workers and negligible exposures for the general population. To control releases of airborne radioactive particulates during remedial action, mitigative measures would include surficial wetting of the materials and haul roads and protective clothing such as dust masks or respirators. The dose to the hypothetical, maximally exposed adult individual from the ingestion of contaminated drinking water or food has been calculated for health effects assessments at other UMTRA Project sites (DOE, 1985a,b; 1984a,b; 1983). Results of these conservative assessments show that the health effects to individuals who might consume water or food contaminated by the tailings are very minor with respect to the doses from exposures to radon daughters and gamma radiation.

In this appendix, when risk estimates were calculated for the various remedial action alternatives, the following rules were used regarding significant figures. Any estimates that were to be used in further calculations, such as summations of risk, were rounded to two significant figures. Final estimates, such as total risk estimates, were rounded to one significant figure.

Health risk estimates in this appendix make use of recommendations published in scientific reports and journals. Quantitative risk estimation of somatic effects (e.g., cancers) for various organs of the body can be obtained using available human radiation exposure data. The manifestation of a cancer caused by radiation exposure would occur after a latent period of up to 25 years or more, depending on the type of cancer and the age of the exposed person. The risks from exposure to radiation vary with age and sex but are presented here as average values assuming that the variation due to age and sex is small.

D.2.1 HEALTH EFFECTS FROM THE INHALATION OF RADON DAUGHTERS

The health effects caused by radon from tailings arise from inhalation of the short-lived radon daughters, which deposit alpha energy in the lung. For radiation protection purposes, the International Commission on Radiological Protection (ICRP, 1977) proposed an individual lung cancer risk factor of 20 x 10^{-6} per rem, or 20 excess fatal cancers, where one million individuals each receive a one-rem lung dose equivalent commitment from radon daughters.

Excess health effects from the inhalation of radon daughters can also be expressed as an excess risk of lung cancer based on the collective lung dose equivalent commitment in person working level months (person-WLM). The unit of working level (WL) is defined as any combination of short-lived radon daughters in one liter of air which, on complete decay, gives a total emission of 1.3 x 10^{5} million electron volts of alpha radiation. One WL is equivalent to 100 pCi of radon per liter of air with the short-lived radon daughters in 100 percent equilibrium. At equilibrium levels less than 100 percent, the WL corresponding to a given radon concentration is reduced. The working level month (WLM) is the unit defined as the exposure resulting from the inhalation of air with a concentration of one WL of radon daughters for 170 working hours. The total dose of one or more persons is the product of the number of persons and the average dose they receive; the unit for the measurement of such a population dose is the person-WLM.

The following are estimates of excess lung cancers given in terms of person-WLM. The United Nations Scientific Committee on the Effects of Atomic Radiation quoted a range of 200 to 450 x 10^{-6} lung cancers per person-WLM (UNSCEAR, 1977) while the U.S. Nuclear Regulatory Commission (NRC) in its environmental impact statement on uranium milling quoted 360 x 10^{-6} lung cancers per person-WLM (NRC, 1980a). The BEIR-III report (NAS, 1980) indicated 850 x 10^{-6} lung cancers per person-WLM. The ICRP (1981) has adopted 150 to 450 x 10^{-6} as the risk of lung cancer per person-WLM. Evans et al. (1981) reviewed the BEIR-III study, lung cancer risk estimates published by other authors, and epidemiological evidence; they concluded that the most defensible upper bound to the lifetime cancer risk for the general population is 100 x 10^{-6} lung cancers per person-WLM.

The National Council on Radiation Protection (NCRP, 1984) reported a conversion factor of one WLM approximately equal to a 12.6- to 25-rem dose equivalent commitment to the lung. Using the previously mentioned ICRP (1977) individual lung cancer risk factor of 20 x 10^{-6} per rem, the NCRP dose conversion factors correspond to 250 to 500 x 10^{-6} lung cancers per person-WLM. A risk factor of 300 x 10^{-6} lung cancers per person-WLM was used in this appendix for calculating excess health effects due to exposure to radon daughters. This is equivalent to a conversion factor of one WLM, approximately equal to a 15-rem dose equivalent commitment to the lung. The risk factor of 300 x 10^{-6} is reasonable relative to the risk factors just mentioned and provides the consistency needed to compare the remedial action alternatives in terms of excess health effects.

D.2.2 HEALTH EFFECTS FROM EXPOSURE TO GAMMA RADIATION

Uranium mill tailings emit gamma radiation, which delivers an external exposure to the whole body of persons near the tailings. The BEIR-III report contains several models for estimating cancer risk resulting from exposure to gamma radiation (NAS, 1980). In this appendix, excess health effects estimates for gamma radiation exposure are based on a risk factor of 120 x 10^{-6} cancers per person-rem (Cohen, 1981; NAS, 1980). This is equivalent to 120 excess cancers in an exposed population for each 1,000,000 person-rems of collective dose equivalent. A person-rem is the product of the radiation dose commitment multiplied by the number of people receiving that dose.

Excess health effects estimates for gamma radiation exposure were calculated for remedial action workers and for the general population within 0.3 mile of the tailings. The contribution from the tailings to gamma radiation levels becomes negligible beyond 0.3 mile from the tailings pile perimeter. An excess health effects analysis was performed for the remedial action workers and the general population at the Green River tailings site to determine gamma radiation excess health effects during remedial action.

For gamma radiation, one rem is approximately equal to one roentgen (R) which is the unit for measuring gamma radiation in air. A microroentgen (microR) is 1 x 10^{-6} R, and typical environmental gamma radiation levels are expressed in microR per hour (microR/hr).

The health effects attributed to gamma radiation are categorized into two general types: somatic and genetic. Somatic effects are manifested in the exposed individual (e.g., cancer), and genetic effects are manifested in the descendants of the exposed individual. The ICRP (1977) reported that the average risk estimated for genetic effects, as expressed in the first two generations and considered genetically significant, is 40 x 10^{-6} per rem. For all subsequent generations, the risk is estimated to be equal to that expressed in the first two generations. The total genetic risk (all generations) is, therefore, 80 x 10^{-6} per rem. Remedial action measures taken to reduce the somatic effects would also reduce the genetic effects; thus, the calculations in this appendix reflect only the somatic risk.

D.3 CALCULATIONS OF EXCESS HEALTH EFFECTS

The computation of excess health effects begins by determining the additional amount of radiation that a tailings site contributes to an area. Only this additional amount is used to estimate excess health effects. For each radiation type, there is a risk factor that associates a health effect with a specific amount of that radiation. Multiplying the additional amount of radiation in an area, the time spent in that area, the number of people in that area, and the risk factor for the radiation type of concern gives the estimated number of excess health effects that might occur in the people being exposed to the additional radiation. This estimated number of excess health effects is the number of cancers that might occur due only to the radiation from the tailings.

D.3.1 PROPOSED ACTION

General population excess health effects from the inhalation of radon daughters

The population distribution around the Green River tailings site was used to calculate the excess health effects to the general population during the proposed action (stabilization on site). Approximately 800 people live within a two-mile radius of the tailings site and are distributed in the sectors shown in Table D.3.1.

To develop the radon source term for the existing tailings site and the disposal site during the proposed action, the radon flux was calculated using the RAECOM model (NRC, 1984) assuming that no cover exists on the tailings and other contaminated materials. The radon flux values for each site component, as well as the total area-weighted flux for the site, are presented in Table D.3.2 along with the radon source term for the various contaminated areas at the Green River tailings site.

The proposed action would involve the relocation of the tailings pile (Area A) and the excavation of contaminated materials in the mill yard (Area C), ore storage areas (Area B), and windblown and waterborne tailings (Area D and portions of Area E) (See Figure D.3.1). These contaminated materials would be placed on top of the relocated tailings at the disposal site; the resulting stabilized embankment would then be covered as a single pile with a surface area of 7.7 acres.

The proposed action at the Green River tailings site is expected to take 15 months, of which only 14 months would involve construction. During that period, exposure and disturbance of the tailings would occur for a maximum of 10 months; radon releases would increase during this period. It was assumed that 114,000 cubic yards (cy) of tailings would be handled and moved one time during remedial action and that all the radon in the tailings pore spaces would be released to the atmosphere when the tailings were moved. Using the tailings pile average Ra-226 concentration of 98 picocuries per gram (pCi/g) from Table D.3.2, an emanation fraction of 0.21, a tailings volume of

Table D.3.1 Estimated 1986 population distribution, Green River, Utah, tailings site

Direction	Distance from tailings site center (miles)				
	0.0-0.5	0.5-1.0	1.0-1.5	1.5-2.0	Totals
N	0	6	0	6	12
SW	0	3	0	0	3
W	3	9	0	0	12
WNW	3	0	178	45	226
NW	0	6	178	297	481
NNW	0	9	9	48	66
Totals	6	33	365	396	800

114,000 cy, a conversion factor of 1.6 grams per cubic centimeter (g/cm^3), and 7.64 X 10^5 cubic centimeters per cubic yard (cm^3/cy), the total number of curies of radon released from the tailings pile during remedial action was calculated as follows:

(114,000 cy) (98 pCi/g) (1.6 g/cm^3) (7.64 x 10^5 cm^3/cy)
(10^{-12} pCi/Ci) (0.21) = 2.9 Ci

Similarly, to calculate the radon released from the off-pile contamination, it was assumed that 100 percent of the off-pile contamination would be handled and moved and that all radon would be released from the tailings pore spaces. Using an off-pile, volume-weighted Ra-226 concentration of 41 pCi/g, an emanation fraction of 0.21, and an off-pile tailings volume of 71,200 cy, the total number of curies of radon released was calculated as follows:

(71,200 cy) (41 pCi/g) (1.6 g/cm^3) (7.64 x 10^5 cm^3/cy)
(10^{-12} pCi/Ci) (0.21) = 0.75 Ci

The total amount of radon released from stabilization of the Green River tailings on the site would be the sum of the site source term (69 Ci per year from Table D.3.2 x 10 months of remedial action 12 months per year = 57.5 Ci) and the radon releases calculated above for the disturbance and relocation of the tailings (2.9 and 0.75 Ci). Thus, for the tailings exposure and disturbance period of 10 months, the total site radon source term would be 61 Ci, equivalent to a radon flux of 9.6 picocuries per square meter per second (pCi/m^{2}s). During the proposed action, the flux from the tailings pile (Area A) would

Table D.3.2 Summary of radiological concentrations of contaminated materials, Green River, Utah, tailings site

Contaminated area	Surface area (acres)	Average depth (feet)	Contaminated volume (cubic yards)	Average Ra-226 concentration (picocuries per gram)	Radon release rate (picocuries per square meter per second)	Radon source term (curies per year)
Tailings pile (Area A)	7.7	9.2	114,000	98	36.6	36
Windblown and waterborne tailings (Areas D & E)	30.0	1.0	46,000	50	5.0	19
Mill yard (Area C)	12.8	0.9	18,000	24	4.9	8
Ore storage (Area B)	9.2	0.5	7,200	30	5.1	6
Totals	59.7	2.0	185,200	76	9.1[a]	69

[a] Area weighted flux.

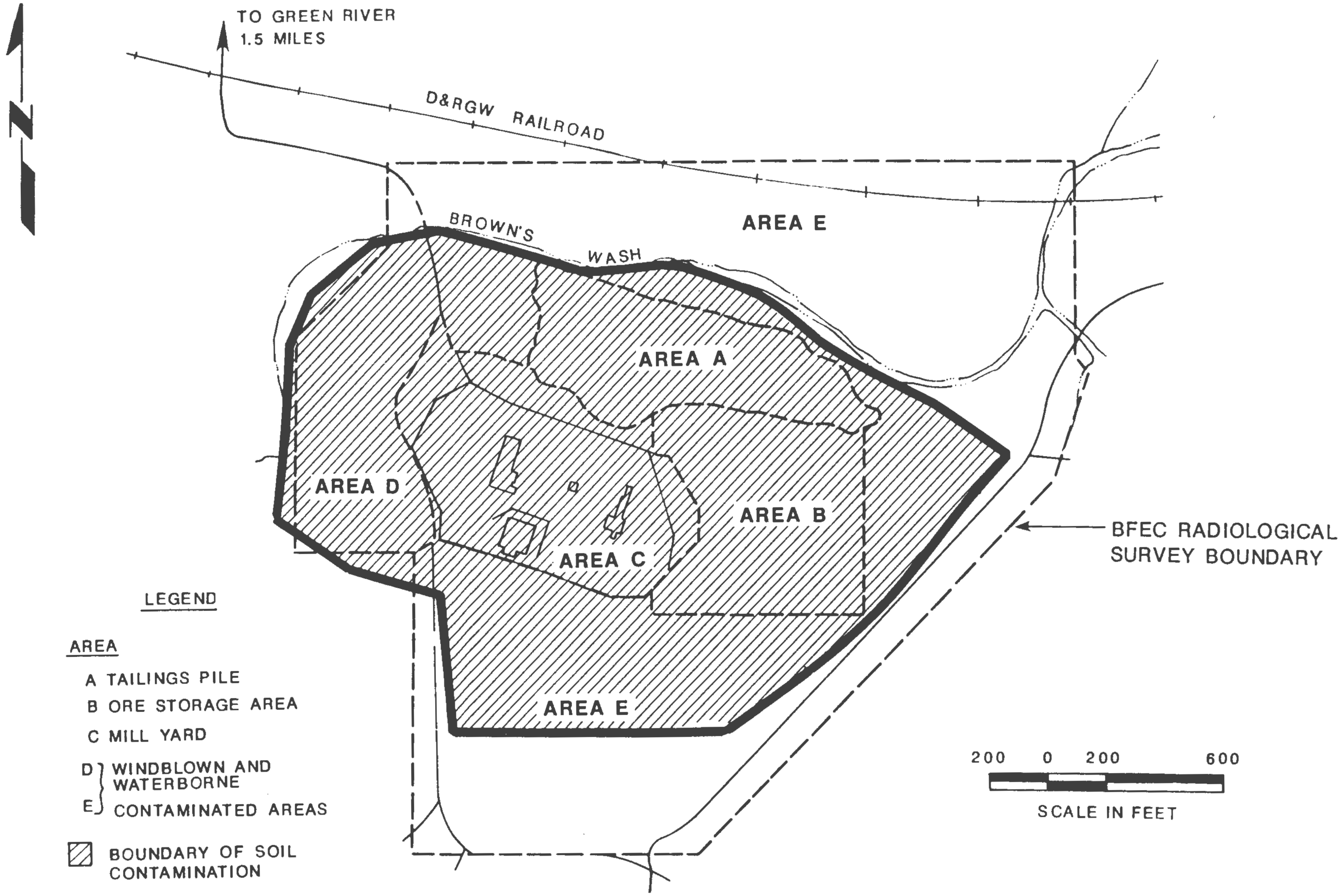

FIGURE D.3.1
AREAL EXTENT OF RADIUM-226 CONCENTRATION EXCEEDING 5 PICOCURIES PER GRAM, GREEN RIVER, UTAH, TAILINGS SITE

decrease as the pile was covered with the off-pile contamination (Areas B, C, D, E). To be conservative in calculating the following health effects, it was assumed that the radon flux would remain at 9.6 pCi/m^2s.

The radon concentration at the site during remedial action was determined using the 9.6 pCi/m^2s radon flux, an average wind speed of two meters per second (calculated by weighting each wind speed by its frequency of occurrence), and an approximate site radius of 280 meters. For calculation purposes, a conservative distribution of stability classes was used based upon the stability class characteristics of Grand Junction, Colorado, because no meteorological data were available to accurately assess the stability class distribution at Green River, Utah.

The site geometry was assumed to be circular. The radon concentration at the center of the circular site was estimated by calculating the concentration for each of the six standard stability classes, weighting each by the frequency of occurrence, and summing the weighted values. The concentration at the site center for each stability class was calculated by integrating the functional form of sigma Z as a function of distance from the site center back to the site edge, ignoring crosswind dispersion. This is similar to assuming that the center of the site is always at the edge of an infinite strip of area source, with the width equal to the site radius. The average radon concentration at the center of the site during remedial action was calculated to be 1.0 pCi/l.

To estimate the radon concentrations and working levels downwind from the tailings site, annual average radon concentrations and working levels as a function of distance from the site were calculated using a sector-averaged form of the Gaussian diffusion equation (Turner, 1969) and a calculation of the ingrowth of radon daughters as a function of time (Evans, 1980). The area source (i.e., entire designated tailings site) was treated as a point source located at the site center with a source strength of 73 Ci per year. The calculated radon concentration is a function of wind speed and stability class for the distance downwind. A conservative distribution of wind speed and stability class was assumed that would result in maximized radon and radon daughters concentrations downwind from the site for a sector, as summarized in Table D.3.3. This bivariate joint frequency distribution was then used to time-weight the radon concentration calculated at a given downwind distance according to the percent of the time that each wind speed and stability class pair occurs. Similarly, the percent ingrowth of radon daughters at a given downwind distance was calculated based on the transit time of the radon from the area source center.

The working levels at varying distances from the site are dependent on the percent ingrowth of radon daughters. Between a transit time of one and 40 minutes, the working level as a function of radon daughter ingrowth can be represented within plus or minus five percent by the following approximate analytical expression (Evans, 1980):

Table D.3.3 Joint frequency distribution between wind speed and stability class for the southeast sector at the Green River, Utah, tailings site

Stability class	Wind speed (miles per hour) 0-3	4-7	8-12	13-18	19-24	>24	Totals
A	0.0070	0.0077	0.0215	0.0085	0.0046	0.0000	0.0493
B	0.0039	0.0254	0.0314	0.0215	0.0077	0.0023	0.0922
C	0.0140	0.0721	0.0637	0.0468	0.0123	0.0039	0.2128
D	0.5334	0.5977	0.3372	0.1832	0.0514	0.0177	1.7206
E	0.6623	0.3671	0.2545	0.1349	0.0200	0.0070	1.4458
F	1.5061	0.7912	0.1488	0.0269	0.0077	0.0000	2.4807

Note: The distribution of frequencies in the table refers to the percentage of time that the wind blew for each class from the southeast sector.

Equation D.3.1

$$WL = 0.023\ T^{0.85}$$

where

WL = working level.
T = transit time in minutes.

The use of the sector-averaged model, with the area source replaced by a point source, tends to overpredict the radon concentrations at distances close to the source. At distances greater than several source diameters from the edge of the source, the model is reasonably accurate; however, overprediction can be up to a factor of two at distances less than several source diameters. To estimate radon concentrations within this overprediction area, interpolation was performed on a log-log basis between the previously calculated on-pile radon concentration (1.0 pCi/l) and the modeled radon concentrations beyond 0.5 mile of the edge of the site. Similarly, the working level exposures within 0.5 mile of the site were determined by extrapolating on a semilogarithmic basis from the modeled working levels beyond this distance.

For the general population excess health effects calculations, assumptions were made which resulted in a conservative estimate of working levels as a function of distance from the edge of the pile. For the southeast sector, a wind direction frequency of six percent was used. The entire population was assumed to live in this sector. These assumptions provide a reasonable upper bound for the general population excess health effects estimates.

The percent ingrowth formula (Equation D.3.1) used to derive working levels assumes that no daughter products are removed from the air by plate-out. Plate-out occurs when the electrically charged radon daughters attach to surfaces and are removed from the air, thereby reducing the percent equilibrium of radon daughters in the air inhaled. To account for plate-out in health effects calculations for outdoor conditions, the working level was assumed to be one-half of that calculated from the ingrowth formula; that is, 50 percent plate-out was assumed. For indoor working levels, the outdoor radon concentration as a function of distance was multiplied by a 50 percent equilibrium factor for radon daughters. This is applied in Equation D.3.2 to both indoor and outdoor inhalation through the parameters I and O. It was assumed that people spend 75 percent of their time in the immediate vicinity of their residences (25 percent outdoors and 50 percent indoors) and 25 percent of their time beyond a distance from the site where radon daughters health effects are negligible. For each distance, the number of working level months was calculated using the following equation:

Equation D.3.2

$$\text{WLM}(r) = \frac{R(r)}{100} \times I + (\text{WL}(r) \times O) \; \frac{H}{(170 \text{ hours/WLM})} \times T$$

where

$\text{WLM}(r)$ = working level months at distance r.
$R(r)$ = radon concentration at distance r (pCi/l).
I = fraction of time spent indoors multiplied by the radon daughters equilibrium factor (0.5 x 0.5).
$\text{WL}(r)$ = working level at distance r.
O = fraction of time spent outdoors multiplied by the radon daughters plate-out factor (0.25 x 0.5).
H = hours per year (8760 hours).
T = duration of exposure (years).

The results of the above calculations are presented in Table D.3.4. Excess health effects were calculated by multiplying the working level months by the population at each distance and by the conversion factor of 300×10^{-6} excess health effects per person-WLM. The excess health effects were then summed over the distances.

For exposure from the inhalation of radon daughters, the estimated number of excess health effects due to the 10-month tailings disturbance for the general population within two miles of the Green River site was calculated to be 89×10^{-6}, or 0.00009 excess health effect for the proposed action.

Table D.3.4 Radon daughters excess health effects to the general population during the proposed action, Green River, Utah, tailings site

Distance from site center (miles)	Number of people	Modeled outdoor radon concentration (pCi/l)	Modeled outdoor WL x 10^{-6}	Calculated WLM x 10^{-6}	Excess health effects x 10^{-6}
0.5	6	0.015	34	1800	3
1.0	33	0.0053	25	700	7
1.5	365	0.0029	19	410	50
2.0	396	0.0019	16	290	30
Totals	800				90

General population excess health effects from exposure to gamma radiation

The estimated population distribution (Table D.3.1) and an aerial radiological survey report (EG&G, 1982) were used to calculate the excess health effects to the general population from gamma exposure during the proposed action.

An aerial radiological survey was flown in November, 1980, over a 16-square-mile area surrounding the Green River site. The highest radiation levels (normalized to three feet above the ground) were 165 microR/hr over the tailings pile and 400 microR/hr over the mill yard (BFEC, 1985). The elevated concentrations of Ra-226 and Th-232 in the site area resulted in radiation levels higher than background levels. Average background levels in the area ranged from 12 to 17 microR/hr. The nearest residents, five people, are 0.5 mile from the tailings pile; gamma radiation levels at this distance are reduced to background levels (EG&G, 1982) due to the interaction of the gamma rays with air. Therefore, there would be no excess health effects to the general population from exposure to gamma radiation originating from the site.

Remedial action worker excess health effects from the inhalation of radon daughters

The radon concentration during remedial action was calculated to be 1.0 pCi/l at the Green River site. An average of 46 workers would be required during the 14 months for the proposed action. To estimate an upper bound for excess health effects to remedial action workers, it was assumed that each worker would spend eight hours per day, 16.5 days per month, over 10 months (1320 hours) outside on the tailings pile.

Each worker would be exposed to a radon concentration of 1.0 pCi/l as calculated previously for the 10-month period when the pile is uncovered. The radon daughters percent equilibrium on the pile was conservatively assumed to be 20 percent based on percent equilibrium measurements made near the Grand Junction, Colorado, uranium mill tailings pile (Borak and Inkret, 1983). For 46 remedial action workers, the estimated excess health effect from the inhalation of radon daughters during the remedial action period (10 months) is 2×10^{-4}, or 0.0002.

Remedial action worker excess health effects from exposure to gamma radiation

Remedial action workers at the site also would be exposed to gamma radiation from the tailings. The greatest exposure rate (400 microR/hr) on the site (in the mill yard) was used to calculate the excess health effects (BFEC, 1985). On a partially covered portion of the final tailings pile, the exposure rate would be reduced by a factor of 10 for each foot of cover material. Also, the majority of workers would be enclosed in cabs of earthmoving equipment, which also would provide shielding. Thus, the maximum exposure rate of 400 microR/hr would be reduced to approximately 40 microR/hr. Based on 40 microR/hr, the external gamma radiation exposure that a worker could be expected to receive from working 1320 hours over a 10-month period would be 0.053 rem, which is within the standard limit of five rem per year for occupational exposure (NRC, 1980b). For 46 remedial action workers, the estimated excess health effect from exposure to gamma radiation is 3×10^{-4}, or 0.0003.

The total estimated health excess effect to remedial action workers during the proposed action from radon daughter inhalation and exposure to gamma radiation would be 5×10^{-4}, or 0.0005.

Structures on the Green River site

There are four primary habitable structures on the Green River tailings site: the office, mill, roaster, and crusher buildings. Surveys within the buildings indicate only loose surface contamination that is removable by standard cleaning practices. Analysis of concrete cores indicates that the substructures of the buildings are not contaminated. However, borehole logs show marginal contamination beneath the office, mill, and crusher buildings. Gamma exposure rate and working level surveys indicate no health risks associated with these levels of contamination; therefore, no excess health effects estimates were calculated.

D.3.2 NO ACTION

General population excess health effects from the inhalation of radon daughters

The estimated population distribution around the Green River site (Table D.3.1) was used to calculate the excess health effects to the general population if remedial action did not occur. For this analysis, it was again assumed that people spend 75 percent of their time in the immediate vicinity of their residences (25 percent outdoors and 50 percent indoors) and 25 percent of their time at a distance from the tailings site at which radon contribution from the tailings is negligible.

The radon flux source term under no action conditions at the site was calculated using the RAECOM model (NRC, 1984) and the methods described in Section D.3.1. For the no action alternative at the Green River site, the average radon flux over the site is 9.1 pCi/m^2s. Annual average radon concentrations and working levels as a function of distance from the site, however, were calculated as described for the proposed action (i.e., using the average radon flux of 9.1 pCi/m^2s).

The sector-averaged model described in Section D.3.1 was applied to estimate the radon concentrations and working levels downwind of the site. A conservative distribution of wind speeds and stability classes was assumed that would result in maximized radon daughter concentrations downwind for a sector (Table D.3.3).

To estimate radon concentrations close to the edges of the pile, an interpolation was performed on a log-log basis between the calculated on-pile radon concentration of 1.0 pCi/l using the previously described method and the modeled radon concentrations beyond 0.5 mile. Similarly, the working level exposures within 0.5 mile of the edge of the pile were calculated by extrapolating on a semilogarithmic basis for the modeled working levels beyond 0.5 mile.

For the general population excess health effects calculations, assumptions were made that resulted in conservative estimates of working levels as a function of distance from the center of the site. A wind direction frequency, in a conservative sector, of six percent was used for the Green River site. All of the population around the site was assumed to live in the conservative sector. These assumptions provide an upper bound for the general population excess health effects estimates.

The radon concentrations and working levels due to the tailings at varying distances from the site center are presented in Table D.3.5. The percent ingrowth formula used in the model to derive working levels assumed that no daughter products were removed from the air by attaching themselves to nonrespirable particles or to other surfaces (plate-out). Table D.3.5 presents modeled outdoor working levels assuming zero percent plate-out of radon daughters. A 50 percent plate-out factor was employed to adjust the modeled working level results outdoors for

Table D.3.5 Radon daughters excess health effects to the general population for the no action alternative, Green River, Utah, tailings site

Distance from site center (miles)	Number of people	Modeled outdoor radon concentration (pCi/l)	Modeled outdoor WL x 10^{-6}	Calculated WLM per year x 10^{-6}	Excess health effects per year x 10^{-6}
0.5	6	0.014	33	2000	4
1.0	33	0.0050	18	750	8
1.5	365	0.0027	15	440	50
2.0	396	0.0018	11	300	40
Totals	800				100

plate-out. For indoor working levels, the outdoor radon concentration as a function of distance was multiplied by a 50 percent equilibrium factor for radon daughters. These conditions and the previously employed residential occupancy factors were applied in Equation D.3.2 for outdoor and indoor inhalation to determine working level month exposures; therefore, for each distance, the number of working level months was calculated using Equation D.3.2.

The results of the above calculations for the no action alternative are presented in Table D.3.5. The excess health effects were calculated by multiplying the working level months by the population at each distance and by the conversion factor of 300 x 10^{-6} excess health effect per person-WLM. The excess health effects were then summed over the distances.

Under the no action alternative, the estimated number of yearly excess health effects from the inhalation of radon daughters for the general population within two miles of the site were combined to yield a total of 100 x 10^{-6}, or 0.0001 excess health effect per year of exposure.

<u>General population excess health effects from exposure to gamma radiation</u>

The estimated population distribution (Table D.3.1) and an aerial radiological survey report (EG&G, 1982) were used to calculate the gamma radiation excess health effects to the general population for the no action alternative.

The nearest residents, five people, are 0.5 miles from the tailings pile; gamma radiation levels at this distance are at background levels. Therefore, for the no action alternative, there would be no excess health effects to the general population from exposure to gamma radiation originating from the site.

Remedial action worker excess health effects

No remedial action workers would be exposed to radon daughters or gamma radiation for the no action alternative.

Structures on the Green River site

The structures on the tailings site are not permanently contaminated but could not be released for use because the remainder of the site is extensively contaminated and would pose a health risk to people using the buildings.

General population excess health effects from tailings dispersion

For the no action alternative, another potential contribution to excess health effects is the continued dispersion of the tailings by wind and water. Flooding of Brown's Wash could transport great quantities of tailings down Brown's Wash and subsequently into the Green River. This would result in contamination of the water and sediments in Brown's Wash and the Green River. Additionally, water from Brown's Wash and rains could cause contamination of shallow groundwater in the alluvium of Brown's Wash. Further dispersion of the tailings could arise from the present cover on the tailings being eroded and subsequently dispersed by severe weather. Inadvertent intrusion by man and animals is another potential dispersion mechanism. It is impossible to accurately predict the contribution of the above dispersion mechanisms to an estimated number of excess health effects; however, it is almost certain that these mechanisms would increase the total number of excess health effects (0.0001, the sum of radon daughters and gamma radiation health effects) calculated for the general population for the no action alternative.

D.3.3 STABILIZATION IN PLACE ALTERNATIVE

General population excess health effects from the inhalation of radon daughters

Under the stabilization in place alternative, the entire tailings pile would not be moved and the tailings would be uncovered for a shorter amount of time than for the proposed action. It can then be assumed that the radon release from the site would steadily decrease as the less-contaminated material is consolidated on top of the existing tailings pile. Therefore, the resulting downwind radon concentrations would be lower than concentrations predicted for either the proposed action or the no action alternatives. The anticipated result would then be a smaller calculated number of excess health effects from the inhalation of radon daughters.

General population excess health effects from exposure to gamma radiation

As stated previously, the gamma radiation levels at the nearest residence are at background levels. Therefore, for the stabilization in place alternative, there would be no excess health effects to the general population from exposure to gamma radiation originating from the site.

Remedial action worker excess health effects from the inhalation of radon daughters

As described above for the general population, the radon concentrations would be smaller and the exposure time would be shorter for this alternative compared to the proposed action. Also, since the pile would probably be reshaped instead of moved, fewer remedial action workers would be exposed to radon daughters inhalation. Therefore, the excess health effects calculated for remedial action workers from radon daughters inhalation would be lower than those calculated for the proposed action.

Remedial action worker excess health effects from exposure to gamma radiation

Due to the shorter exposure time to remedial action workers, the excess health effects from exposure to gamma radiation for the stabilization in place alternative would be lower than for the proposed action.

Structures on the Green River site

Health effects for the structures on the Green River site during stabilization in place would be the same as those described for the proposed action (see Section D.3.1).

General population excess health effects from tailings dispersal

The potential for groundwater contamination is greater for the stabilization in place alternative because the stabilized pile would be closer to a shallow aquifer. This situation would give rise to an unquantifiable number of excess health effects that would not be present for the proposed action.

D.3.4 EXPOSURES AFTER REMEDIAL ACTION

The only radiation exposure pathway of importance after remedial action would be the inhalation of radon daughters emitted from the stabilized tailings pile. Following remedial action, there would be essentially no gamma radiation exposure. Thus, excess health effects to the general population from exposure to gamma radiation would still be considered negligible.

Regardless of which alternative is chosen, the EPA has established an upper limit for the radon concentration at the site boundary of 0.5 pCi/l above background (40 CFR Part 192). Table D.3.6 gives maximum radon and radon daughters concentrations downwind of the stabilized pile and calculated excess health effects following the proposed remedial action. Since the final disposal sites for both action alternatives are so close, the excess health effects calculated for radon daughters inhalation would be the same for both action alternatives (i.e., those shown in Table D.3.6). The values in Table D.3.6 are based upon a radon flux of 20 pCi/m^2s and a stabilized tailings pile surface area of 7.7 acres. The excess health effect to the general population within two miles of the site following stabilization of the tailings was calculated to be 0.00003 per year. This is lower by a factor of three than the estimated excess health effect calculated for the no action alternative.

Table D.3.6 Radon daughters excess health effects to the general population after the proposed action, Green River, Utah, tailings site

Distance from site center (miles)	Number of people	Modeled outdoor radon concentration (pCi/l)	Modeled outdoor WL x 10^{-6}	Calculated WLM per year x 10^{-6}	Excess health effects per year x 10^{-6}
0.5	6	0.0041	11.0	600	1
1.0	33	0.0015	7.0	240	2
1.5	365	0.00081	5.0	140	20
2.0	396	0.00053	4.0	96	10
Totals	800				30

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APPENDIX E

PERMITS, LICENSES, AND APPROVALS

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E.1 INTRODUCTION

This appendix contains a listing of the permits, licenses, and approvals that would be required for various aspects of the proposed remedial action at the Green River, Utah, uranium mill tailings site.

In most cases, regulatory permits, licenses, and approvals would be obtained by the Remedial Action Contractor or the U.S. Department of Energy, whichever is appropriate.

Table E.1.1 Permits, licenses, and approvals for remedial action at the Green River, Utah, tailings site

Permit, license, or approval	Granting or approving agency	Statute or regulation	Activity
NRC License	U.S. Nuclear Regulatory Commission	Public Law 95-604, Section 104(f)	Surveillance and maintenance at the disposal facility after completion of the remedial action.
National Pollutant Discharge Elimination System (NPDES) Permit	U.S. Environmental Protection Agency, State of Utah	Clean Water Act of 1977	Controlled surface discharge of waste water.
Air Quality Permit	U.S. Environmental Protection Agency	Air Quality Act of 1967	Construction or modification of a temporary source of air pollution.
Threatened or Endangered Species Consultation	U.S. Fish and Wildlife Service	Endangered Species Act of 1973, Section 7	Any action that might affect threatened or endangered species.
Cultural Resource Clearance	Utah State Historic Preservation Officer	National Historic Preservation Act	Any action that might affect cultural resources.

Table E.1.1 Permits, licenses, and approvals for remedial action at the Green River, Utah, tailings site (Concluded)

Permit, license, or approval	Granting or approving agency	Statute or regulation	Activity
Approval of Well Plugging	Utah State Engineer's Office, Utah Division of Water Rights	Water Laws of Utah and Regulations for Water Well Drillers	Abandonment of water wells.
Notice of Intent to conduct mining operation	Utah Division of Oil, Gas, and Mining	Utah Code Annotated Mined Land Reclamation Act of 1975	Mining of borrow sites.
Conditional Use Permit	Emery County Planning Department	Emery County Zoning Ordinances	Excavations at proposed borrow site 2.

APPENDIX F

FLOODPLAIN ASSESSMENT

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F.1 PROJECT DESCRIPTION

Materials contaminated by uranium mill tailings from the Green River, Utah, inactive processing site are present in the floodplain of Brown's Wash. However, the proposed disposal site does not lie within the floodplain of Brown's Wash.

The primary feature of each remedial action alternative is the consolidation and stabilization of the tailings and other contaminated materials at either the existing tailings site or at the proposed disposal site. The remedial action would require the following major construction activities regardless of which alternative is selected:

- Removal of portions of the existing tailings pile from its present location within the 100-year floodplain of Brown's Wash.
- Disturbance of 12.5 acres containing 20,500 cubic yards (cy) of contaminated soil within the 100-year floodplain of Brown's Wash.
- Disturbance of four acres containing 33,000 cy of tailings and contaminated soil within the 500-year floodplain of Brown's Wash.
- Restoring, grading, and revegetating the floodplain of Brown's Wash where necessary, including adding any required soil conditioners to promote vegetation growth.

Upon completion of the remedial action, radioactive contamination within the floodplain of Brown's Wash would be reduced to levels that comply with the U.S. Environmental Protection Agency (EPA) standards for inactive uranium processing sites (40 CFR Part 192). The disturbed areas would then be released for any use consistent with local land use controls.

F.2 FLOODPLAIN ASSESSMENT

The alteration of the floodplain of Brown's Wash during and after remedialaction is of concern due to the potential for changes in river elevations during flood events and the resulting impacts to nearby properties. These impacts are discussed in this appendix.

Other temporary impacts of 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 could 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 4.3, 4.4, and 4.5 of the text of this environmental assessment (EA). Mitigative measures for these short- and long-term impacts are discussed in Section F.2.2 of this appendix and in Section 4.15 of the text of this EA.

The effects of flooding resulting from changes in flood elevations during construction and after completion of the remedial action were analyzed. Results of these analyses are summarized in Sections F.2.1 through F.2.3.

On the basis of this floodplain assessment, the U.S. Department of Energy (DOE) has determined that there is no practicable alternative to the proposed activities and that the proposed remedial action has been designed to minimize potential harm to or within the floodplain.

F.2.1 FLOOD ANALYSIS UNDER EXISTING CONDITIONS

The Green River

In order to determine whether a detailed flood analysis of the Green River would be required, the U.S. Geological Survey (USGS) log-Pearson estimates of the 500-year flood event and an estimate of expected peak flows for the river in the vicinity of the tailings site were analyzed for comparison to historical peak flows and to the discharge required to inundate the base of the stabilized pile. Paleoflood research has shown that estimates of flood frequency for semiarid environments are difficult to determine and may be unreliable due to negatively skewed annual flood distributions, large maximum discharge to mean discharge ratios, and short-term and widely dispersed gaging records (Kochel and Baker, 1982). However, the USGS log-Pearson estimates are the best flood frequency data available. The USGS log-Pearson estimate for the 500-year flood is 88,000 cubic feet per second (cfs). Using an extrapolation of actual flow data as outlined by Crippen and Bue (1977), an estimated peak flood flow of 140,000 cfs was determined for the Green River in the vicinity of the tailings site. Based on this determination, the estimated discharge would overflow the present banks of the Green River. However, due to the broad, flat floodplain on both overbank areas, the difference in elevation, and the distance from the present tailings pile and the proposed disposal site areas, flood flows would not reach either area. An estimated discharge in excess of 2,000,000 cfs would be required to inundate the base of the stabilized pile assuming conservative conditions. This flow is approximately 30 times the recorded maximum flow of 68,100 cfs, 23 times the expected 500-year flood, and 15 times the peak flow estimated by Crippen and Bue (1977). Therefore, a detailed flood analysis for the Green River was not required.

Brown's Wash

The USGS log-Pearson estimates of expected peak flow rates (Q) for the 100- and 500-year flood events for Brown's Wash just upstream of the existing tailings pile are 12,000 and 17,500 cfs, respectively (Figure F.2.1). The 100-year flood event would result in a maximum water-surface elevation of 4075 feet above mean sea level (MSL) at the existing tailings pile and a mean velocity of 11 feet per second (fps). Along the northern perimeter of the tailings pile, 0.25 acre would be inundated to a depth of up to one foot. The 500-year flood event would result in a water-surface elevation of 4078 feet above MSL at the existing tailings pile and a mean velocity of 10.5 fps at the pile. One-half acre of the northern perimeter of the existing tailings area would be under three feet of water and two acres at the northwestern edge of the pile would be under four to five feet of water. Using the method outlined by Crippen and Bue (1977), an expected peak flood flow of 24,000 cfs is estimated at the existing tailings pile.

The principal topographic features affecting the 100- and 500-year floodplains are the existing banks of Brown's Wash, the slope of the south overbank areas upstream and downstream of the existing tailings pile, and the broad, flat area between the wash and railroad tracks along the north overbank area (Figure F.2.1). Since the tailings area is flat and only slightly higher in elevation than the surrounding terrain, the existing tailings pile does not significantly constrict either floodplain. Thus, the tailings pile has a minimal impact on the capacity of the 100- and 500-year flood flows in Brown's Wash.

The Probable Maximum Flood (PMF) flow rates for Brown's Wash at the tailings site were calculated for various hydrological settings (DOE, 1988). The PMF discharge estimates ranged from 35,000 to 98,000 cfs for general-storm and local-storm Probable Maximum Precipitation (PMP) events, respectively. The floodplain relative to the maximum PMF discharge is shown in Figure F.2.2. Flood levels would rise to a maximum of 4090 feet above MSL (Figure F.2.3), which would inundate portions of the existing tailings pile south to the base of the exposed Mancos Shale bluff overlooking the southern border of the tailings pile. Velocities across the existing tailings pile would range from 10 to 18 fps. The proposed disposal site area would remain approximately 45 feet above PMF flows.

F.2.2 FLOOD CONDITIONS DURING REMEDIAL ACTION

During the action alternatives (stabilization on site or stabilization in place) at the Green River tailings site, 12.5 acres within

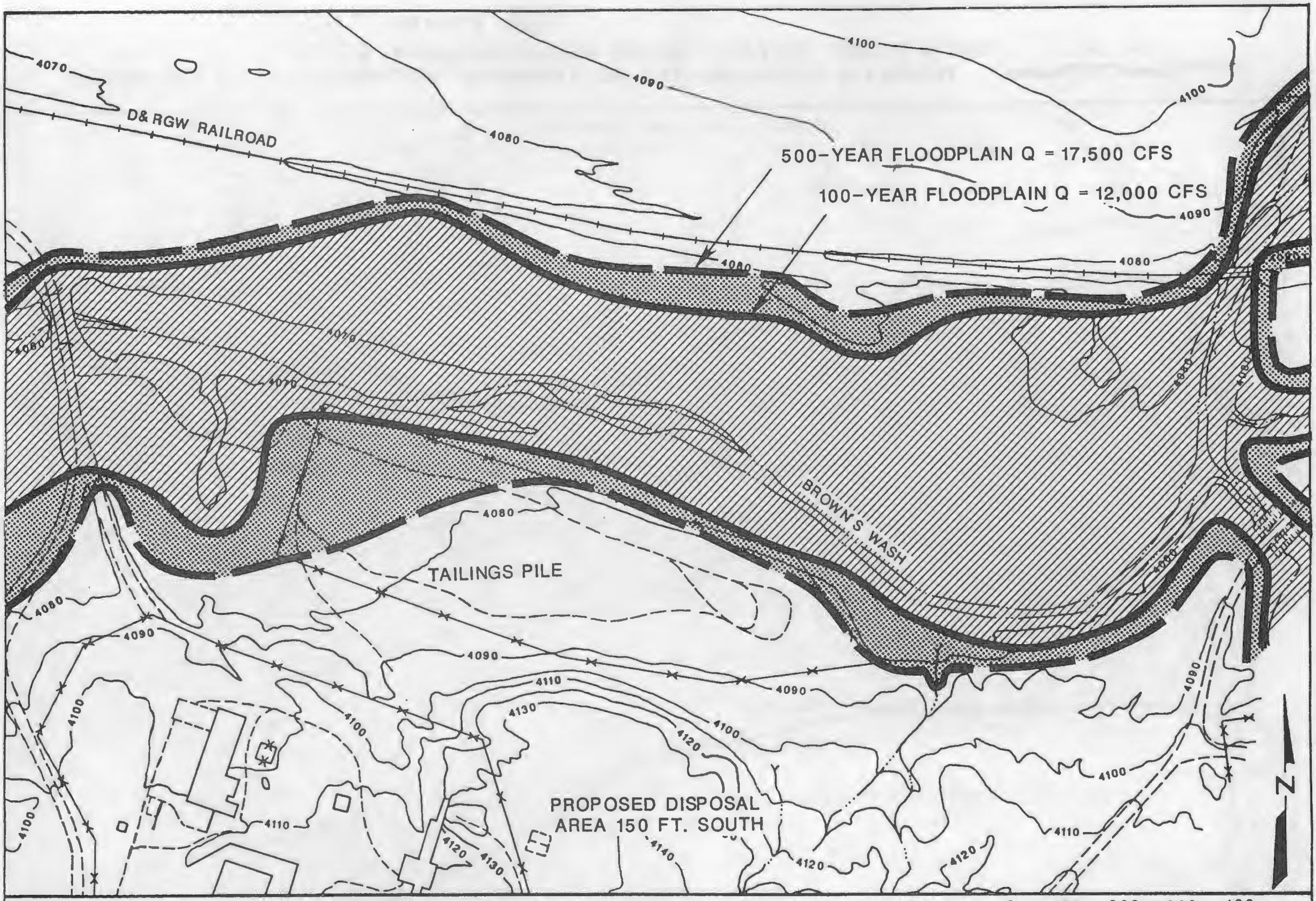

FIGURE F.2.1 FLOODPLAIN BOUNDARIES OF THE 100-YEAR AND 500-YEAR FLOOD EVENTS FOR BROWN'S WASH, GREEN RIVER, UTAH, TAILINGS SITE

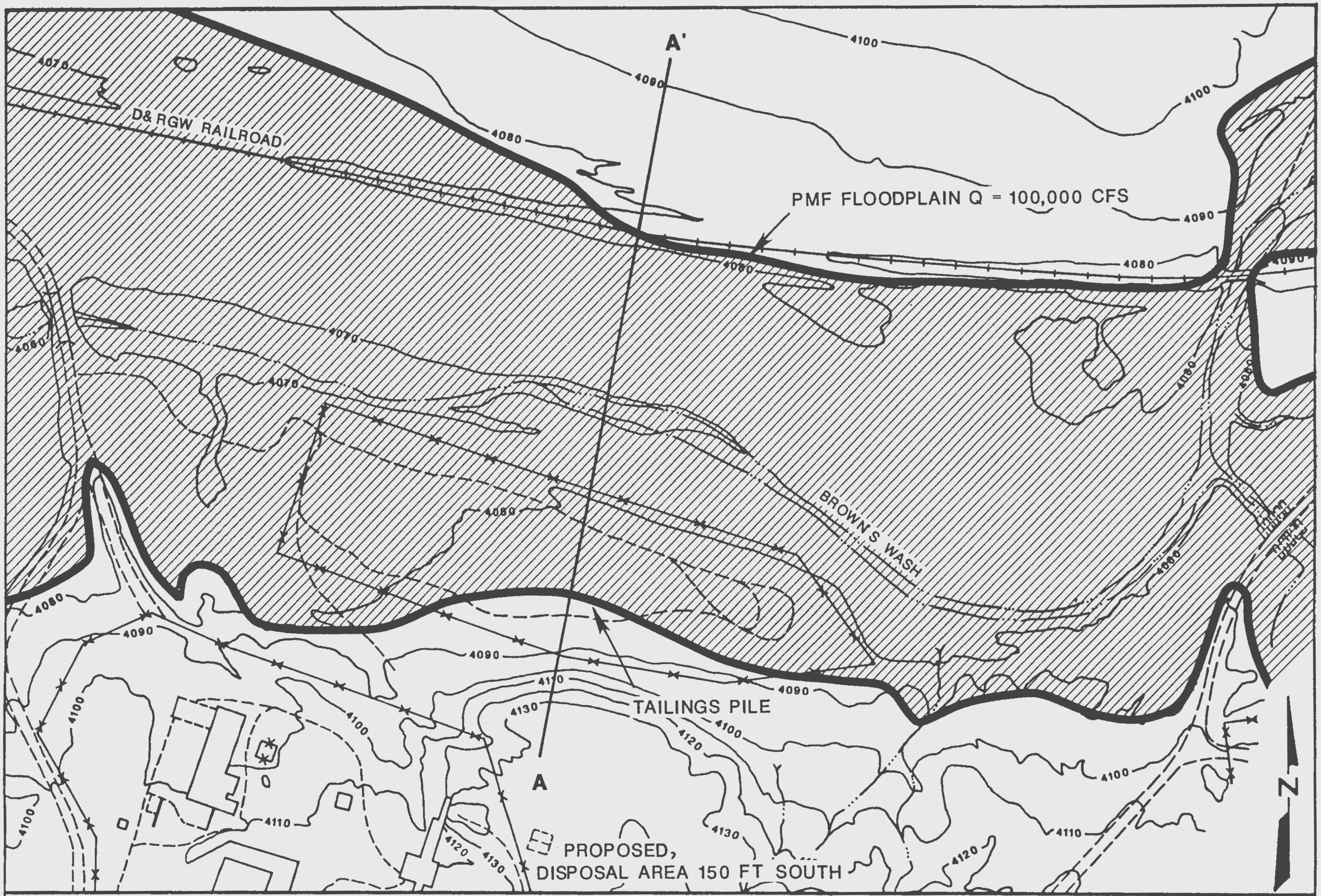

FIGURE F.2.2 FLOODPLAIN BOUNDARY OF THE PROBABLE MAXIMUM FLOOD (PMF) EVENT FOR BROWN'S WASH, GREEN RIVER, UTAH, TAILINGS SITE

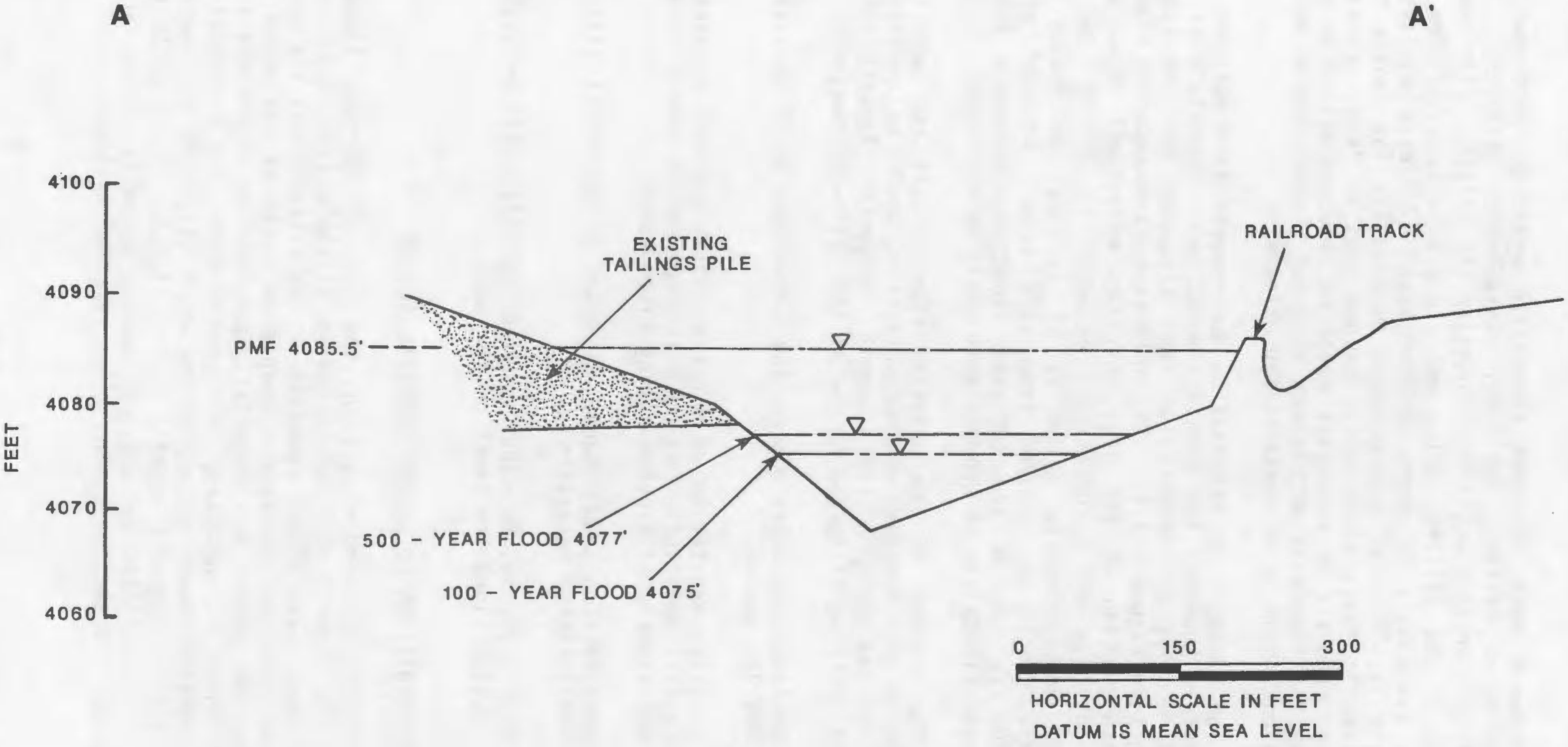

FIGURE F.2.3 CROSS SECTION A-A' : MAXIMUM WATER LEVELS DURING THE 100-YEAR, 500-YEAR, AND PROBABLE MAXIMUM FLOOD (PMF) EVENTS FOR BROWN'S WASH, GREEN RIVER, UTAH, TAILINGS SITE the Brown's Wash 100-year floodplain would be disturbed by removing 20,500 cy of tailings and other contaminated materials. The majority of the disturbance would occur outside the tailings pile boundary, downstream of the tailings pile, and along both banks of the wash. These areas constitute 12 acres of the total 12.5-acre disturbed area and contain 16,500 cy of contaminated materials. The depths of excavation required in these areas would be one foot or less. Excavation depths ranging from six to nine feet would be required within an 0.5-acre area of the tailings pile within the 100-year floodplain and would remove an additional 4000 cy of contaminated materials.

The quantity of material to be removed from outside the 100-year floodplain boundary but within the 500-year floodplain of Brown's Wash would be slightly larger than that discussed for the 100-year floodplain (see Figure F.2.1). The only exception would be along the northwestern portion of the pile where an additional three acres of the tailings pile and surrounding area would be affected by the 500-year flood. Approximately 33,000 cy of tailings and other contaminated material would be removed from this area. A total of four acres (34,000 cy) outside the 100-year floodplain boundary but within the 500-year floodplain of Brown's Wash would be disturbed.

The changes in the existing flood levels and velocities attributable to the remedial action activities would be undetectable during the 100- and 500-year flood events. Potential impacts during remedial action would be mitigated by use of the following measures:

- Contaminated materials in the floodplain would be excavated during the dry season.

- 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.

- Berms, riprap, or other erosion controls would be used to minimize erosion along the banks of the wash.

F.2.3 FLOOD CONDITIONS FOLLOWING REMEDIAL ACTION

Following remedial action, the 100- and 500-year floodplain boundaries for Brown's Wash would change slightly from those under existing conditions. For either remedial action alternative, the disturbed areas in the 100- and 500-year floodplains would be reclaimed by restoring excavations with clean material, recontouring to promote surface drainage, adding any necessary soil conditioners, and revegetating the area. The reestablishment of vegetation would stabilize the overbank areas of the wash and prevent erosion during floods. There would be no impacts to the floodplains or any surrounding property within or adjacent to the Brown's Wash floodplains after remedial action.

F.3 REMEDIAL ACTION ALTERNATIVES

The remedial action alternatives are discussed in Sections 2.2 and 2.3 of the text of this EA. The impacts of these alternatives are discussed in Sections 4.1 through 4.14. Mitigative measures that are likely to be used are described in Sections 4.15 and F.2.2.

The no action alternative, which entails leaving the site in its present condition, would not be consistent with the intent of Congress in Public Law 95-604 and would not result in compliance with the EPA standards. For the stabilization in place alternative, the construction activities and impacts that would occur are discussed in Sections F.2.2 and F.2.3.

REFERENCES FOR APPENDIX F

Crippen, J. R., and C. D. Bue, 1977. Maximum Floodflows in the Conterminous United States, U.S. Geological Survey Water-Supply Paper 1887, U.S. Government Printing Office, Washington, D.C.

DOE (U.S. Department of Energy), 1988. Technical Approach Document, UMTRA-DOE/AL-050425.0000, prepared by the U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico.

Kochel, R. C., and V. R. Baker, 1982. "Paleoflood Hydrology," Science, Vol. 215, No. 4531, pp. 353-361.