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# ENVIRONMENTAL ASSESSMENT
# OF
# REMEDIAL ACTION AT THE GUNNISON
# URANIUM MILL TAILINGS SITE
# GUNNISON, COLORADO

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U.S. Department of Energy
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# ENVIRONMENTAL ASSESSMENT OF REMEDIAL ACTION AT THE GUNNISON URANIUM MILL TAILINGS SITE GUNNISON, COLORADO

U.S. DEPARTMENT OF ENERGY

## ABSTRACT

This document assesses and compares the environmental impacts of various alternatives for remedial action at the Gunnison uranium mill tailings site located 0.5 miles south of Gunnison, Colorado. The site covers 56 acres and contains 35 acres of tailings, 2 of the original mill buildings[,] and a water tower. The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), Public Law 95-604, authorizes the U.S. Department of Energy to clean up the site to reduce the potential health impacts associated with the residual radioactive materials remaining at the site and at associated [vicinity] properties off the site. The U.S. Environmental Protection Agency promulgated standards for the remedial actions (40 CFR 192). Remedial actions must be performed in accordance with these standards and with the concurrence of the Nuclear Regulatory Commission. [Four alternatives have been addressed in this document. The first alternative is to] consolidate the tailings and associated contaminated soils into a recontoured pile on the southern portion of the existing site. A radon barrier of silty clay would be constructed over the pile and various erosion control measures would be taken to assure the long-term integrity of the pile. Two other alternatives which involve moving the tailings to new locations are assessed in this document. These alternatives generally involve greater short-term impacts and are more costly but would result in the tailings being stabilized in a location farther from the city of Gunnison. The no action alternative is also assessed.

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# 1.0 SUMMARY

## 1.1 PROJECT SUMMARY

The Gunnison tailings site is located just outside the city limits of Gunnison in Gunnison County, Colorado (Figure 1.1). The site is situated on an alluvial terrace that forms the drainage divide between the Gunnison River and Tomichi Creek. The topography of the area consists of the Gunnison River Valley and the mountains of the surrounding Gunnison National Forest. Major topographic features are the Gunnison River and Tomichi Creek and the surrounding hills that rise to 1000 feet above the valley floor.

The Gunnison area has a cold desert climate with annual precipitation averaging 11 inches. Vegetation ranges from juniper, pinon pine, and sagebrush on the valley sides to cottonwoods, willows, and native grasses near the river in the valley bottom. The dominant land uses are agriculture and livestock grazing[; however] there is a trend to more urban uses (light industry and residences). Gunnison is the major urban center in the area with [an estimated 1982] population of [6,031].

The Gunnison site consists of a rectangular tailings pile, two of the original mill buildings, and a steel water tower. The pile covers about 35 acres and contains 492,000 cubic yards of tailings. The total volume of contaminated material including the tailings, contaminated soils beneath and around the pile, vicinity properties[,] and other associated materials is about 812,000 cubic yards. Fourteen vicinity properties (homes, vacant lots, commercial buildings) have been identified as possibly needing remedial action because they may have been contaminated by the use of tailings from the pile during [grading and/or] construction. These fourteen properties contain an estimated 1,400 cubic yards of contaminated material. **[Additional properties may be identified for possible remedial action before the end of the project.]**

The principal 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 may be inhaled by humans. **[Increased exposure to radon and its decay products in terms of concentration and exposure time will increase the possibility of cancer in persons living and working near the pile.]** If the tailings are not properly stabilized, erosion or human removal of the contaminated materials could spread the contamination over a much wider area and increase the potential public health impacts.

The Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), Public Law 95-604, authorizes the U.S. Department of Energy (DOE) to perform remedial action at the Gunnison tailings site (as well as at many other sites) to reduce the potential public health impacts from the residual radioactivity remaining in the pile. The U.S. Environmental Protection Agency (EPA) promulgated standards (40 CFR Part 192) for this remedial action.

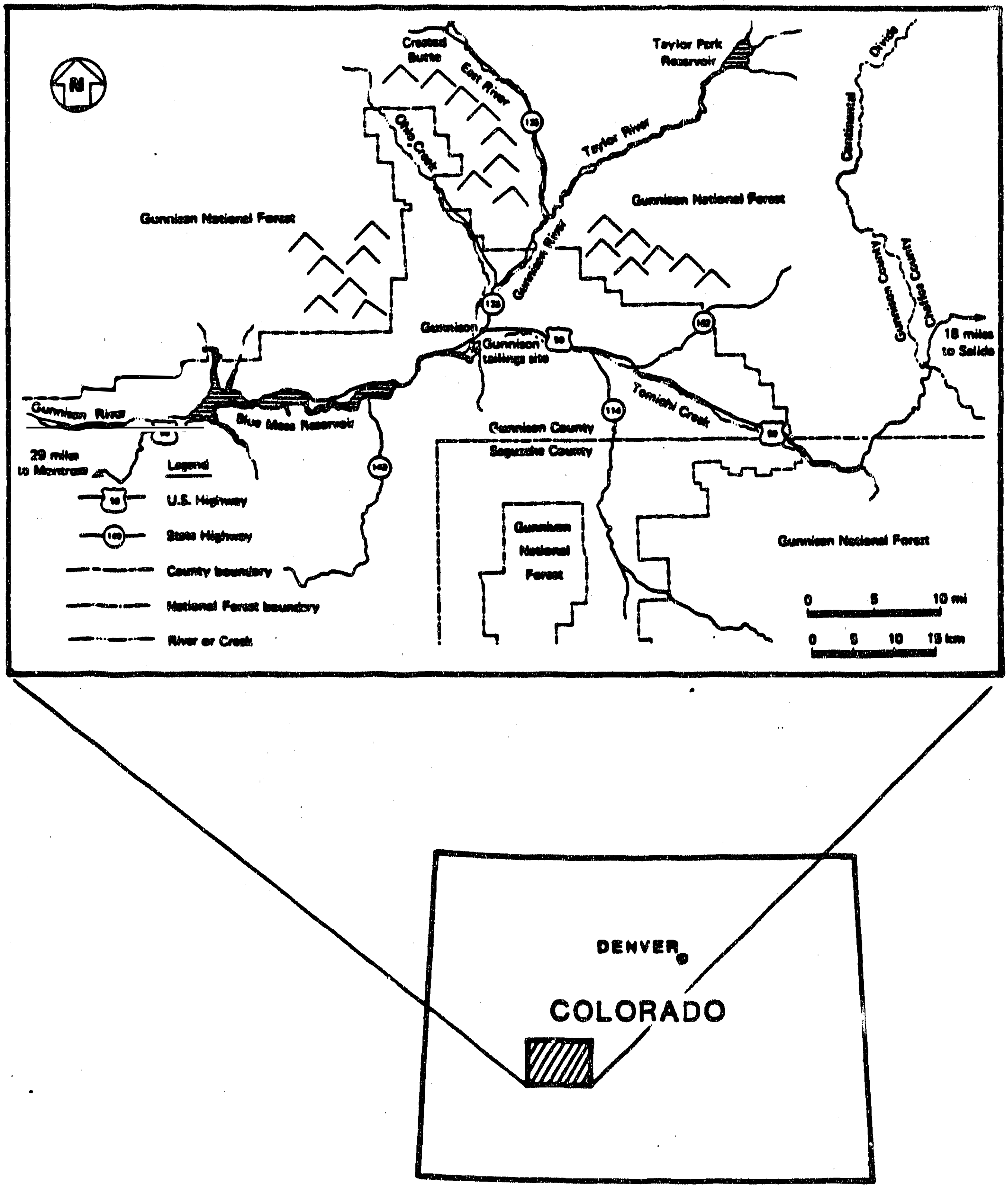


**FIGURE 1.1**
**GUNNISON SITE LOCATION MAP**

[Four alternatives are addressed in this document.] Alternative 1 is stabilization in place. All of the tailings and other contaminated materials would be consolidated and completely encapsulated in a rectangular above-grade embankment constructed in the southern portion of the existing location. The embankment would have 5:1 sideslopes (20 percent) and a slightly convex top (2 percent slopes). The consolidated tailings and contaminated materials would be covered with 5 feet of silty clay to inhibit radon emanation and water infiltration and to assure compliance with EPA standards. The top and sides of the embankment would be covered with 1-foot and 2-foot thick layers of graded rock, respectively, to protect the embankment against erosion, penetration by plants and animals, and inadvertent human intrusion. The top of the finished embankment would be approximately 45 feet above the surrounding terrain. The area surrounding the embankment would be graded to divert surface runoff around and away from the embankment. The remaining area at the tailings site would be restored to approximately the original ground level with uncontaminated soil, contoured for surface drainage, and revegetated.

The no action alternative (Alternative 2) would consist of taking no remedial action at the tailings site [or] vicinity properties. The tailings [pile] and [contaminated materials at the] vicinity properties would remain in their present [locations] and would continue to be susceptible to erosion and unauthorized human removal [and thereby present an increased health risk.]

Disposal of the tailings at the East Gold Basin site (Alternative 3) would involve relocating all of the contaminated materials to Federal land administered by the [U.S.] Bureau of Land Management (BLM), 2 road miles southeast of the tailings site (Figure 1.2). This site [is currently] used primarily for low density grazing of livestock. The contaminated materials would be consolidated and encapsulated in a partially below-grade embankment and covered with silty clay and graded rock [in a manner] similar to stabilization in place. The top of the finished embankment would be approximately 45 feet above the surrounding terrain and approximately 2500 feet from a [developing] residential subdivision. The original tailings site would be backfilled with uncontaminated soil, recontoured to [approximate the original grade], revegetated, and released for unrestricted use.

Disposal of the tailings at the Chance Gulch site (Alternative 4) would be identical to Alternative 3 except that the site is located about 6 road miles southeast of the tailings site (Figure 1.2). The site is Federally owned, administered by the BLM and used for low density grazing of livestock. The finished embankment would be 2.5 miles from the nearest residence. The original tailings site would be backfilled, recontoured to [approximate the original grade], revegetated, and released for unrestricted use.

All of the alternatives[,] except Alternative 2 (no action)[,] include remedial action at the off-site vicinity properties.

## 1.2 IMPACT SUMMARY

This section contains a quantitative comparison of the impacts of the [various] alternatives (Table 1.1 at the end of this section) and a

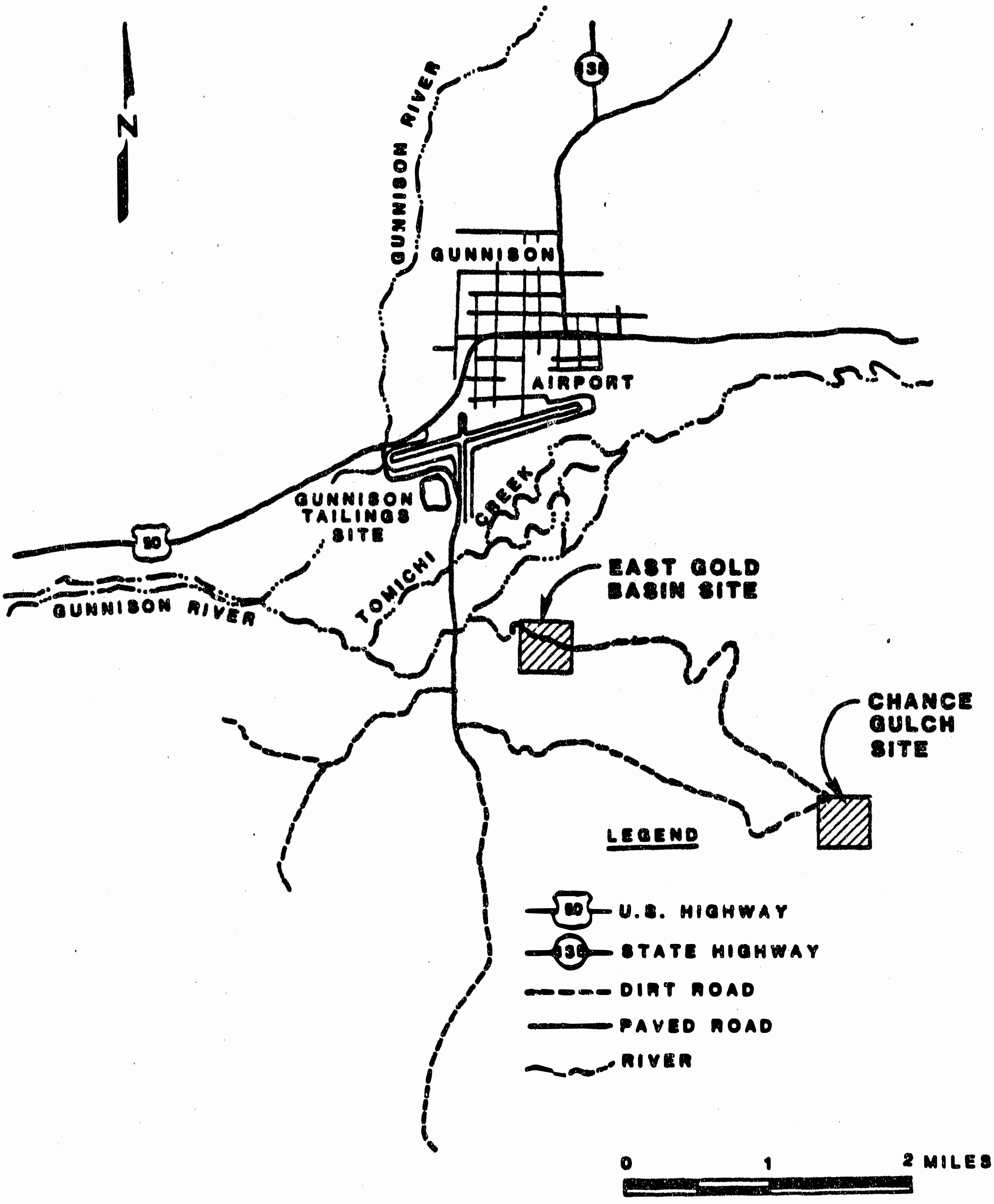


**FIGURE 1.2**
**LOCATIONS OF ALTERNATE DISPOSAL SITES**

brief discussion of the major differences between the alternatives. The impacts presented in Table 1.1 and the remainder of this chapter are based on conservative impact assessment methods and represent a realistic upper limit of the severity of the potential impacts of each alternative.

Stabilization in place - (Alternative 1)

The implementation of this alternative would reduce the radiological hazard of the site to a level consistent with EPA standards and would ensure the integrity of the site for a minimum of 1000 years. The tailings would remain just outside the city of Gunnison, and 32 acres of land would be subject to restricted use.

**[It should be noted that the primary hazard to the long-term integrity of stabilization in place is the potential impact from flooding and stream channel migration. A flood analysis was performed considering the geomorphic conditions of the site. The results of this analysis have been incorporated into the planned remedial action design to assure that adequate size and quantity of rock protection are provided to prevent undermining or erosion of the tailings embankment.]**

The shallow ground water beneath and adjacent to the Gunnison tailings pile **[has]** been contaminated by water filtering through the pile and **[possibly]** by seasonal rises **[of]** ground water into the pile. Data collection and modeling of the ground water are not complete. Following completion of these activities, a decision will be made on the need and cost effectiveness of ground-water restoration or other mitigative measures.

No action (Alternative 2)

Selection of the no action alternative would not be consistent with the intent of Congress in UMTRCA (PL95-604) and would not result in DOE's compliance with the EPA standards (40 CFR Part 192). This alternative would result**[, in time,]** in the dispersion of the tailings over a wide area by wind and water erosion. Ground water would continue to be contaminated**[, and]** tailings would not be protected against unauthorized removal by humans. Unauthorized removal and use of the tailings could cause significant radiological contamination of other areas and could result in significant public health impacts.

East Gold Basin (Alternative 3)

The major differences between the disposal at the East Gold Basin site and stabilization in place are:

o The East Gold Basin site is **[a]** more remote **[location on]** Federal land**[,]** 2 road miles southeast of Gunnison and about 2500 feet from a growing residential development.

- o The East Gold Basin alternat[ive] would result in fewer predicted public health impacts over the next 1000 years[, (0.29] versus [0.66] excess cancer deaths [for stabilization in place.]

- o The East Gold Basin [alternative] would have a slightly greater impact on remedial action worker health, water consumption, non-radiological air quality, population, employment, and traffic volumes.

- o The East Gold Basin [alternative] would have a much greater impact on energy consumption but less of an impact on mineral resources.

- o The East Gold Basin [alternative] would cost almost $3 million more than stabilization in place ($11,500,000 versus $8,850,000).

Chance Gulch (Alternative 4)

The impacts and benefits of the Chance Gulch alternative are about the same as the East Gold Basin alternative except that:

- o The Chance Gulch site is [a] more remote [location on] Federal land[,] approximately 6 road miles from Gunnison and 2.5 miles from the nearest residence.

- [o **The Chance Gulch alternate site would result in fewer predicted public health impacts over the next 1000 years (0.14 versus 0.66 excess cancer deaths for stabilization in place.)]**

- o The Chance Gulch [alternative] would have a less intense impact on traffic volumes[, but [these impacts would occur] over a longer period of time.]

- o The cost of the Chance Gulch alternative is about $3 million more than the East Gold Basin alternative and [about] $6 million more than the cost of stabilization in place.

Table 1.1 Quantitative comparison of alternatives (Continued)

| Environmental component[/] [alternative] | 1 [S]tabilization in place | 2 No action | 3 East Gold Basin | 4 Chance Gulch |
|---|---|---|---|---|
| Water resources | Gradual reduction in existing contamina[nt] levels; additional study needed to determine need for aquifer restoration | [Continued] degradation of the local surface and ground waters - reduced use of ground water | No impact at East[a] Gold Basin site - Gradual reduction in contaminant levels at Gunnison site[;] additional study needed to determine need for aquifer restoration | No impact at[a] Chance Gulch site - Gradual reduction in contaminant levels at Gunnison site; additional study need to determine need for aquifer restoration |
| Water consumption | 23,320,000 gallons | None | 27,028,000 gallons | 33,450,000 gallons |
| Air quality (non-radiological) (24 hr. maximum) | 91 ug/m$^3$ increase in TSP - slight increase in fuel combustion pollutants - slightly exceeds TSP standards [during] [construction period] | None | 108 ug/m$^3$ increase in TSP - small increase in fuel combustion pollutants - exceeds TSP standards [during construction] [period] | 171 ug/m$^3$ increase in TSP - small increase in fuel combustion pollutants - exceeds TSP standards [during construction] [period] |
| Wildlife | Permanent loss of 32 acres of habitat | None | Permanent loss of 33 acres of habitat | Permanent loss of 38 acres of habitat |
| Vegetation | Same as above | None | Same as above | Same as above |

[[a]Site specific ground water data collection would be conducted to verify the absence of shallow ground water if either of these sites is selected.]

Table 1.1 Quantitative comparison of alternatives

| Environmental component[/] [alternative] | 1 [S]tabilization in place | 2 No action | 3 East Gold Basin | 4 Chance Gulch |
|---|---|---|---|---|
| Site worker health | 0.00[43] deaths from cancer 13.4 equipment use injuries | None | 0.00[68] deaths from cancer 20.8 equipment use injuries | 0.00[81] deaths from cancer 24.8 equipment use injuries |
| *Public health | [0.027] deaths in 10 years and [0.66] deaths in 1000 years from cancer | [0.105] deaths in 10 years and [10.5] deaths in 1000 years from cancer - assumes no dispersion of tailings | 0.0[23] deaths in 10 years and 0.2[9] deaths in 1000 years from cancer | 0.0[20] deaths in 10 years and 0.1[4] deaths in 1000 years from cancer |

*Health impacts are calculated for a constant population (See Section 4.1.4).

| | | | | |
|---|---|---|---|---|
| Mineral resources | Consumption of 841,000 cy of cover materials (silty clay, pit run rock) | None | Consumption of 680,000 cy of cover materials (silty clay, pit run rock) | Consumption of 716,000 cy of cover materials (silty clay, pit run rock) |
| Soils | 88 acres disturbed | Continuously increasing area of contaminated soils | 135 acres disturbed | 140 acres disturbed |

Table 1.1 Quantitative comparison of alternatives (Continued)

| Environmental component[/ [alternative] | 1 [S]tabilization in place | 2 No action | 3 East Gold Basin | 4 Chance Gulch |
|---|---|---|---|---|
| Threatened and endangered species | None | None | None anticipated[b] | None anticipated[b] |
| Archaeological resources | None | None | None anticipated[b] | None anticipated[b] |
| Aesthetic resources | Pile noticeable to persons passing by but subordinate to regional view - can not be seen from town of Gunnison | None | Pile noticeable to persons passing by and to a growing housing development - subordinate to regional view - visible to elevated portions of the town of Gunnison | Pile not visible to populated areas - subordinate to regional view |
| Cultural/historic resources | None | None | None | None |

[b]Site-specific surveys would be conducted to verify the absence of threatened and endangered species and archaeological resources if either of these sites is selected.

Table 1.1 Quantitative comparison of alternatives (Continued)

| Environmental component[/ [alternative] | 1 [S]tabilization in place | 2 No action | 3 East Gold Basin | 4 Chance Gulch |
|---|---|---|---|---|
| Noise | 67 dB at nearest residence during daytime - annoyance but no hearing impacts | None | 61 dB [during daytime] at nearest residence to East Gold Basin site - same impact as SIP at Gunnison site - 84 dB along transportation route during truck passage [- annoyance] | Background level at nearest residence to Chance Gulch site same impact as SIP at Gunnison site - 84 dB along transportation route during truck passage [- annoyance] |
| Land use | Restricted use of 32 acres near the town of Gunnison; no limitation on development of adjacent lands | Restricted use of 56 acres; continuously increasing area unsafe for human use | Restricted use of 32 acres; present use is low-density grazing and wildlife habitat - release of [current tailings] site for unrestricted use | Restricted use of 32 acres; present use is low-density grazing and wildlife habitat - release of [current tailings] site for unrestricted use |
| Population | Short-term increase of 87 persons; 1.4% of Gunnison's population | None | Short-term increase of 114 persons; 1.9% of Gunnison's population | Short-term increase of 111 persons; 1.7% of Gunnison's population |
| Employment | [Direct employment:] average of 65 persons for 1.5 years[;] peak of 102 persons - indirect employment of 71 persons | None | [Direct employment:] Average of 78 persons for 2 years[;] peak of 111 persons - indirect employment of 78 persons | [Direct employment:] Average of 74 persons for 2.5 years[;] peak of 108 persons - indirect employment of 76 persons |

Table 1.1 Quantitative comparison of alternatives (Concluded)

| Environmental component[/] [alternative]/ | 1 [S]tabilization in place | 2 No action | 3 East Gold Basin | 4 Chance Gulch |
|---|---|---|---|---|
| Social services | **[Negligible** | **Negligible** | **Negligible** | **Negligible]** |
| Transportation networks | Average 543 trips per day on Gold Basin Rd. (2-lane, lightly travelled) during 18 months - 1,020 trips per day during peak month; 0.01 traffic fatalities; 0.20 traffic injuries | None | Average 695 trips per day on Gold Basin Rd. (2-lane, lightly travelled) during 24 months - 1,272 trips per day during peak month; 0.03 traffic fatalities; 0.44 traffic injuries | Average 586 trips per day on Gold Basin Rd. (2-lane, lightly travelled) during 30 months - 1,067 trips per day during peak month; 0.07 traffic fatalities; 1.11 traffic injuries |
| Energy resources | Consumption of 800,000 gallons of fuel and 216,000 kwh electricity | None | Consumption of 1,434,000 gallons of fuel and 293,000 kwh electricity | Consumption of 1,894,000 gallons of fuel and 621,000 kwh electricity |
| Costs ($) | $8,850,000 | None | $11,500,000 | $14,600,000 |

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## 2.0 [STABILIZATION IN PLACE] AND THE ALTERNATIVES TO IT

### 2.1 NEED FOR THE ACTION

#### 2.1.1 Background

In response to public concern over the potential public health hazards associated with uranium mill tailings and the associated contaminated material 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, which was enacted into law on November 8, 1978. In UMTRCA, Congress acknowledged the potential health hazards associated with uranium mill tailings and identified 22 sites that were in need of remedial action. The Gunnison site is one of these 22 sites.

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

Effective October 19, 1981[,] the DOE and the State of Colorado entered into a cooperative agreement under UMTRCA. The cooperative agreement sets forth the terms and conditions for the DOE and State cooperative remedial action efforts including the DOE's development of a remedial action plan (with the concurrence of the State), the 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 192) and issued final standards (48 FR 590-604) on January 5, 1983, to become effective on March 7, 1983. In developing these standards, 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." Appendix A contains a detailed discussion of the EPA standards.

All remedial actions performed under the UMTRCA must be done in accordance with these 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 licenses for the long-term maintenance and surveillance (including monitoring) of the disposal site after the cleanup work is complete. These licenses may require the DOE or other Federal agency having custody of the site to perform such surveillance, maintenance, and contingency measures as necessary to ensure continued compliance with the EPA standards.

### 2.1.2 The remedial action process

The remedial action process for the Gunnison site began with site characterization and will conclude with a long-term maintenance and surveillance program. Preliminary radiological investigations and engineering assessments have been completed and published. Currently, a series of six related studies that address the site-specific engineering concepts, maintenance and surveillance requirements, and licensing are under preparation. The anticipated publication schedule for each of these documents is shown in Table 2.1.

Table 2.1 Document publication schedule - Gunnison

| Document | Scheduled publication date |
|---|---|
| Processing Site Characterization Report | September, 1984 |
| Remedial Action Plan (including Health and Safety Plan, Radiological Support Plan, and Site Conceptual Design) | [July, 1985] |
| Site Design Criteria | [July, 1985] |
| Final Design and Specifications | [March, 1986] |
| Site Licensing Plan | 1987[a] |
| Site Maintenance and Surveillance Plan | 1987[a] |

[a]Assumes construction start in April, 1986.

### 2.1.3 The Gunnison site

The Gunnison site is located on private land adjacent to the Gunnison County airport just outside the city [limits] of Gunnison, Colorado (Figures 2.1 and 2.2). The site is located on alluvial deposits of the Gunnison River and Tomichi Creek, 1.5 miles east of their confluence. The designated site covers approximately 56 acres.

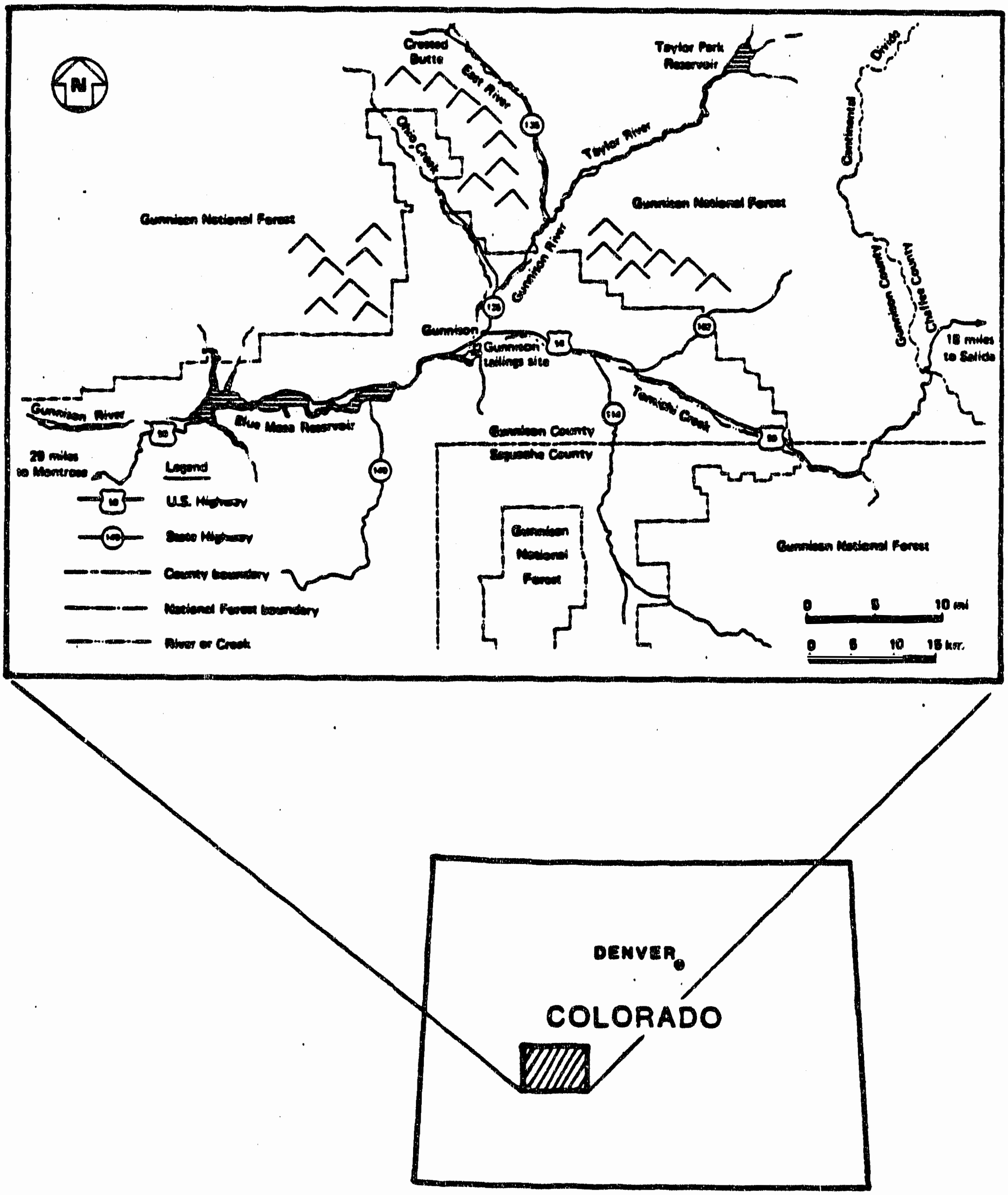



**FIGURE 2.1**
**GUNNISON SITE LOCATION MAP**

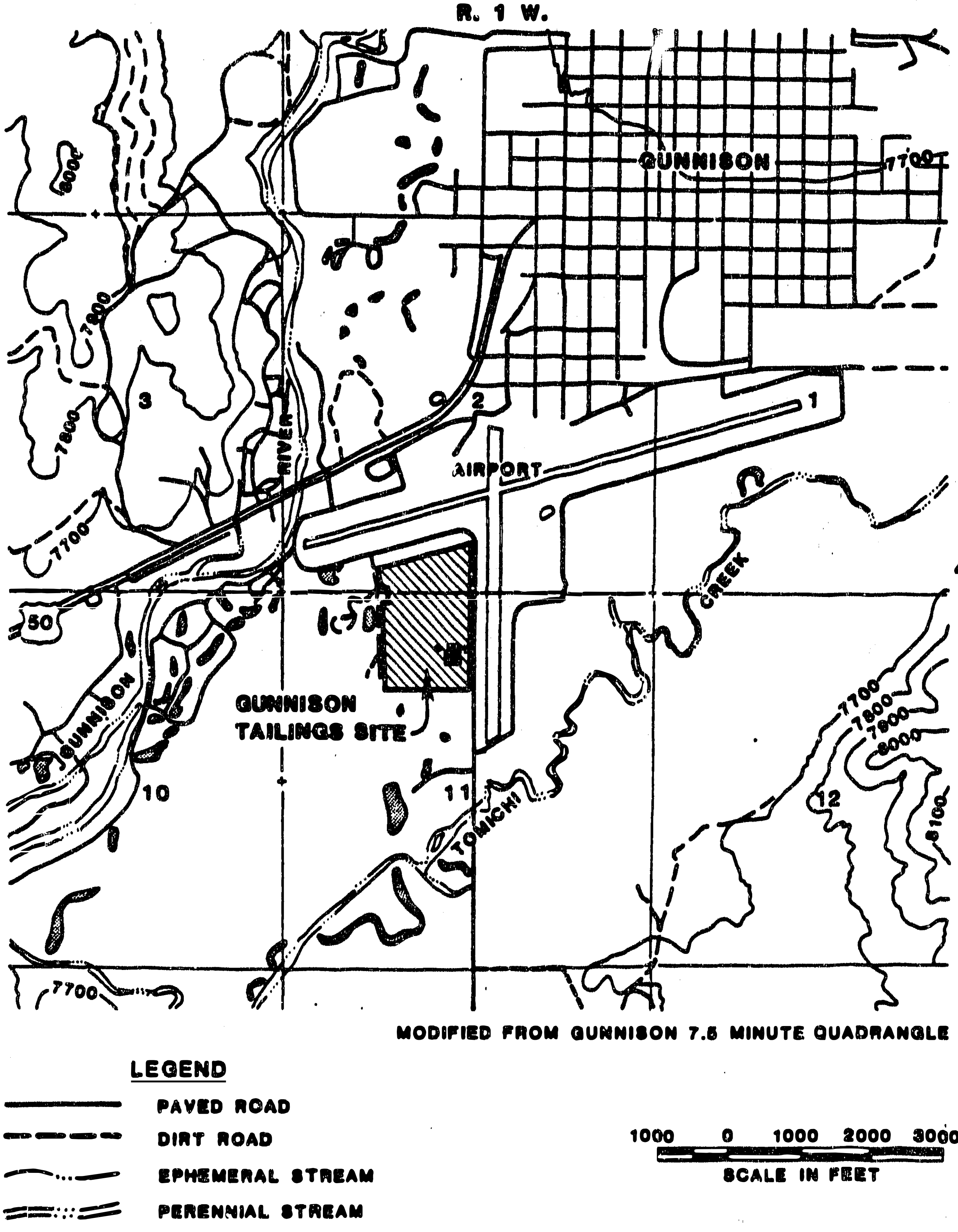



**FIGURE 2.2**
**SITE MAP**
**GUNNISON TAILINGS SITE**

The regional topography consists of a narrow river valley bounded by high mountain peaks which rise more than 5000 feet above the valley. The climate is cool and dry with an average annual precipitation of 11 inches per year. The vegetation in the river valley is predominately cottonwoods, willows, and grasses. The vegetation changes to predominately sagebrush and then to pinon/juniper as the elevation increases along the sides of the surrounding mountains.

The uranium mill was operated for four years from 1958 to 1962. During this period, the mill processed approximately 540,000 tons of uranium ore [using] an acid-leach process. Remaining at the site are two of the original mill buildings, a water tower[,] and the tailings pile. Tailings are the residue of the uranium ore processing operations and are in the form of finely ground rock, much like sand. The rectangular tailings pile measures 1180 feet by 1440 feet and has a maximum thickness of 1[7] feet. The pile contains approximately 492,000 cubic yards of tailings and covers 35 acres. The pile has a 0.5-foot cover of uncontaminated gravel, sand and silt[,] and a sparse cover of vegetation. The total amount of contaminated materials including the tailings, soils beneath and adjacent to the tailings and at 14 vicinity properties (off-site locations) is estimated to be 812,000 cubic yards.

The principal hazard associated with the tailings piles 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. Inhalation of radon and its radioactive decay products can cause lung cancer if the concentrations of radon are high enough and the time of exposure long enough.

Cancers can also occur in other organs as a result of exposure to gamma radiation and from the consumption of contaminated food and water. If the tailings and the associated contaminated materials are not properly stabilized, natural processes such as wind and water erosion or removal of the material by man could spread the contamination and increase the potential public health hazard.

### 2.1.4 Purpose

This environmental assessment is prepared pursuant to the National Environmental Policy Act, which requires Federal agencies to assess the impacts that their actions may have on the environment. This environmental assessment examines the short-term and long-term effects of the DOE proposal to perform remedial action at the Gunnison site. Various alternatives to the DOE proposal are also examined.

DOE will use the information and analyses presented here to determine whether [these] alternative[s] will have a significant impact on the environment. If the impacts are determined to be significant, a more detailed document called an "Environmental Impact Statement" will be prepared. If the impacts are not judged significant, the DOE may issue an official "finding of no significant impact," and implement the preferred alternative. These procedures and documents are defined in regulations issued by the Council on Environmental Quality (CEQ) in Title 40, Code of Federal Regulations, Parts 1500 through 1508.

Chapter 2 describes the alternatives. Chapter 3 discusses the present condition of the environment. Chapter 4 assesses the environmental impacts of **[each of the] [remedial action]** alternative[s]. This document does not contain all of the details of the studies on which it is based. The details are contained in the appendices at the end of this document and in the referenced supporting documents.

In summary, remedial action at the Gunnison site is needed to minimize or eliminate the potential health hazard produced by the radioactive materials in the tailings piles and associated off-site materials. The U.S. Congress has mandated that remedial action be performed, and EPA has issued standards applicable to such actions.

## 2.2 STABILIZATION IN PLACE (SIP) AT THE GUNNISON SITE

The **[stabilization in place]** alternative for the Gunnison site **[includes stabilizing]** the pile above the existing grade on the south side of the present site. All contaminated material around the pile and at the vicinity properties would be relocated to the site. A **[random fill subbase, sandy gravel capillary break, and a clay]** filter layer would be constructed to form a foundation and isolate the tailings above ground water. The tailings and other contaminated material placed on top of the foundation would be covered with silty clay to inhibit radon exhalation and water infiltration, and a rock cover would be placed on top to inhibit erosion and discourage human intrusion.

The design **[for stabilization in place]** was developed to comply with the EPA standards (Appendix A). The following is a summary of the major features of the design. Additional details are contained in Appendix B and the draft Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Gunnison, Colorado (DOE, 1984).

### Design objectives

The purpose of the remedial action is to stabilize and control the uranium mill tailings and associated contaminated material in a manner which complies with EPA standards (Appendix A). Consistent with these standards, and project objectives, the following major design objectives were established:

- o Reduce the average radon flux from the site to 20 pCi/m$^2$sec or 0.5 pCi/l outside the disposal site.

- 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. Appendix B contains details concerning the stability of the design.
- o Prevent inadvertent human intrusion into the stabilized tailings.
- o Minimize burrowing by animals and plant root penetration into the stabilized tailings.
- o Ensure that existing or anticipated beneficial uses of ground and surface water are not adversely affected.
- o Reduce contaminant levels of Ra-226 in areas released for unrestricted use **[and at vicinity properties]** to 5 pCi/g averaged on the first 15 cm of soil below the surface, and 15 pCi/g averaged on 15 cm thick layers of soil more than 15 cm below the surface.
- o **[Undertake]** reasonable effort**[s to]** reduce radiation levels in habitable buildings (including vicinity properties) to 0.02 WL or in any case to 0.03 WL (includes background; gamma will not exceed background by more than 20 microR/hr).
- o Minimize the land area to be utilized by the final disposal area.
- o Protect against releases of contaminants from the site during construction.
- o Minimize areas disturbed during construction and minimize **[human]** exposure to contaminated materials.

Major construction activities

The major construction activities involved with this **[alternative]** are:

Site preparation

- o Grubbing and clearing (as necessary), erection of a temporary security fence, demolition of existing structures, and any necessary upgrading of existing roads.
- o Construction of a waste-water **[retention basin]** to protect against release of contaminants from the site during construction.
- o Construction of drainage control measures to direct all generated waste-water and storm-water runoff to the **[retention basin]** during construction activities.
- o Installation of measures to control erosion from all disturbed areas during remedial action.
- **[o Decontamination (replacement, or compensation) of existing structures on the site.]**

Foundation

o Excavation of contaminated material from a portion of the disposal site.

[o] Placement of uncontaminated fill into the excavated disposal site to [provide a base for the tailings that is above the groundwater level.]

o Placement of a 1-foot-thick [sandy gravel] capillary break [followed by a] 2-foot-thick clay filter layer above the subbase [backfill] materials.

Tailings relocation

o Consolidation of contaminated materials from the windblown and ore storage areas onto the existing tailings site.

o Final excavation and placement of tailings and all contaminated materials from the windblown areas, ore storage area, mill site, vicinity properties, and beneath the existing tailings pile onto the foundation layers.

o Even[ly] distribut[e placement] of the demolition debris [(demolished buildings, etc.)] throughout the lower lifts of the tailings embankment.

Cover placement

o Placement of a 5-foot-thick silty clay cover over the tailings embankment to inhibit water infiltration [and] radon exhalation.

Erosion protection

o Emplacement of rock over the radon cover for erosion protection [and to minimize plant root penetration and burrowing by animals.]

[o Emplacement of large rock along the north and east toe of the embankment.]

Site restoration

o Backfilling, final grading for drainage control, and revegetation, as required, of all areas disturbed during remedial action.

o Construction of an unpaved access road looping the toe of the embankment.

o Installation of permanent fencing to discourage inadvertent human intrusion.

Borrow material (radon cover, rock, [sand, gravel] and fill) would be obtained from the three borrow sites shown in Figure 2.3. Material for

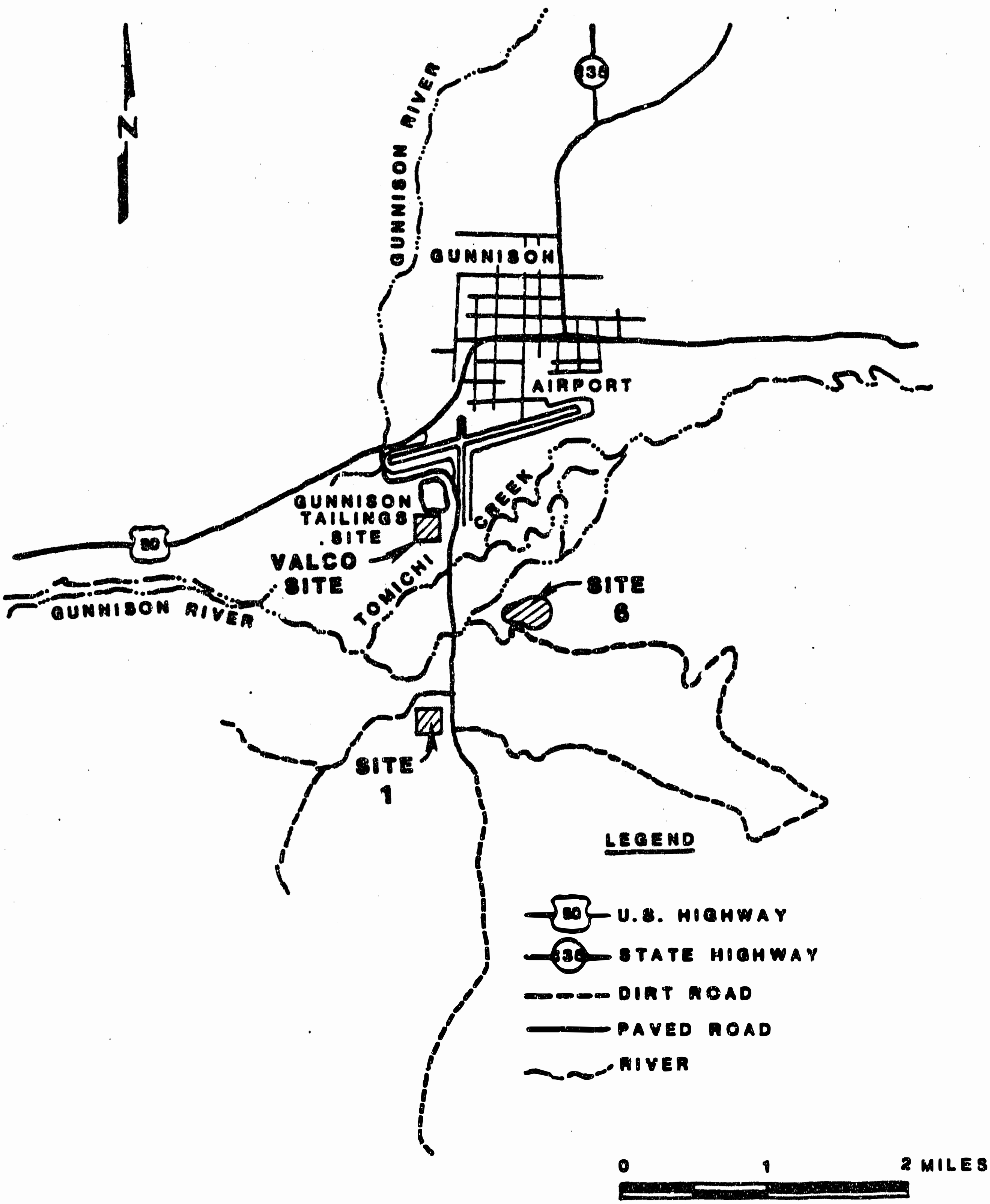



**FIGURE 2.3**
**LOCATION OF BORROW SITES**

the radon cover would be obtained from borrow site 1; rock for erosion protection [and a sandy gravel capillary break] would be obtained from the Valco gravel pit (an existing private sand and gravel operation); and fill material would be obtained from borrow site 6.

Description of final condition

The completed site would be an embankment located on the southern portion of the existing site [(Figure 2.4)].

The top of the embankment would be gently sloped (convex) (2 percent) and would be approximately 45 feet above the surrounding terrain. Sideslopes would have a maximum slope of 5 horizontal to 1 vertical (20 percent) (Figure 2.5).

The [containment structure] would be [convex and] covered with 5 feet of compacted silty clay and then protected by a layer of 2 feet of graded rock on the sideslopes and 1 foot on the topslopes. The graded rock would tie into [a thickened layer of buried rock at the toe of the embankment. An] unpaved access road[, placed on top of the thickened rock layer,] would loop the toe of the embankment inside a 6-foot-high security fence. The area adjacent to the site would be graded to divert surface runoff away from the stabilized embankment.

After decontamination, the remaining areas (northern portion) of the existing site would be filled with uncontaminated fill to a level compatible with the surrounding terrain, recontoured to promote drainage, and revegetated.

Radon control

Control of radon emissions from the stabilized embankment to meet the EPA design standards would be accomplished through a combination of techniques including the following:

- Placing lesser contaminated soils and windblown soils over the tailings.
- Decontamination of a large portion of the present site by excavating and placing contaminated material in the embankment.
- Placing a 5-foot thick compacted silty clay cover over the tailings and contaminated materials.

Long-term stability

To protect against water erosion and slope failure, the embankment [would be covered with a layer of graded rock with] slopes limited to 5 horizontal to 1 vertical (20 percent). The top of the embankment would be gently sloped (2 percent) to promote drainage. Safety factors for slope failure were calculated to be 2.5 (DOE, 1984).

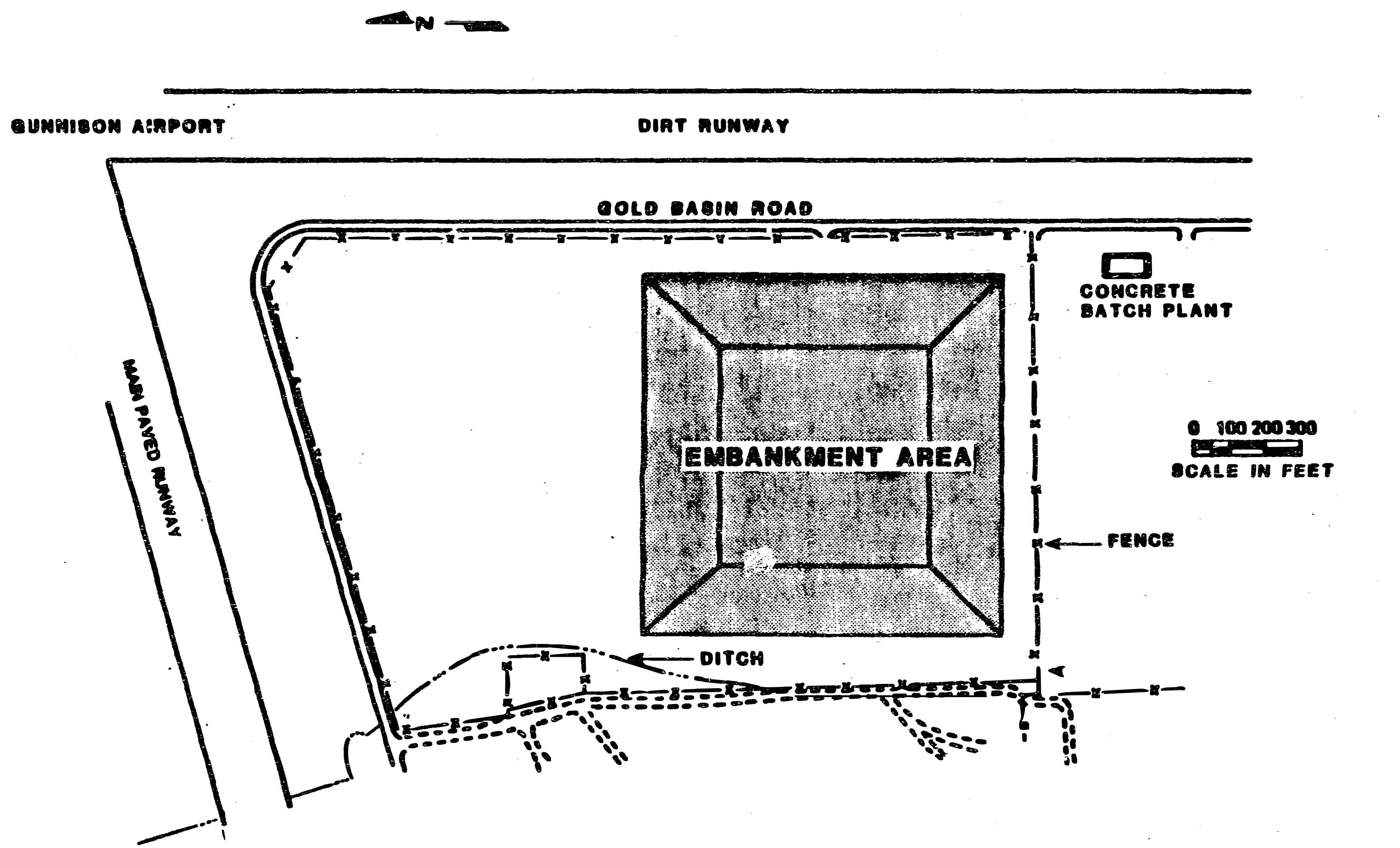
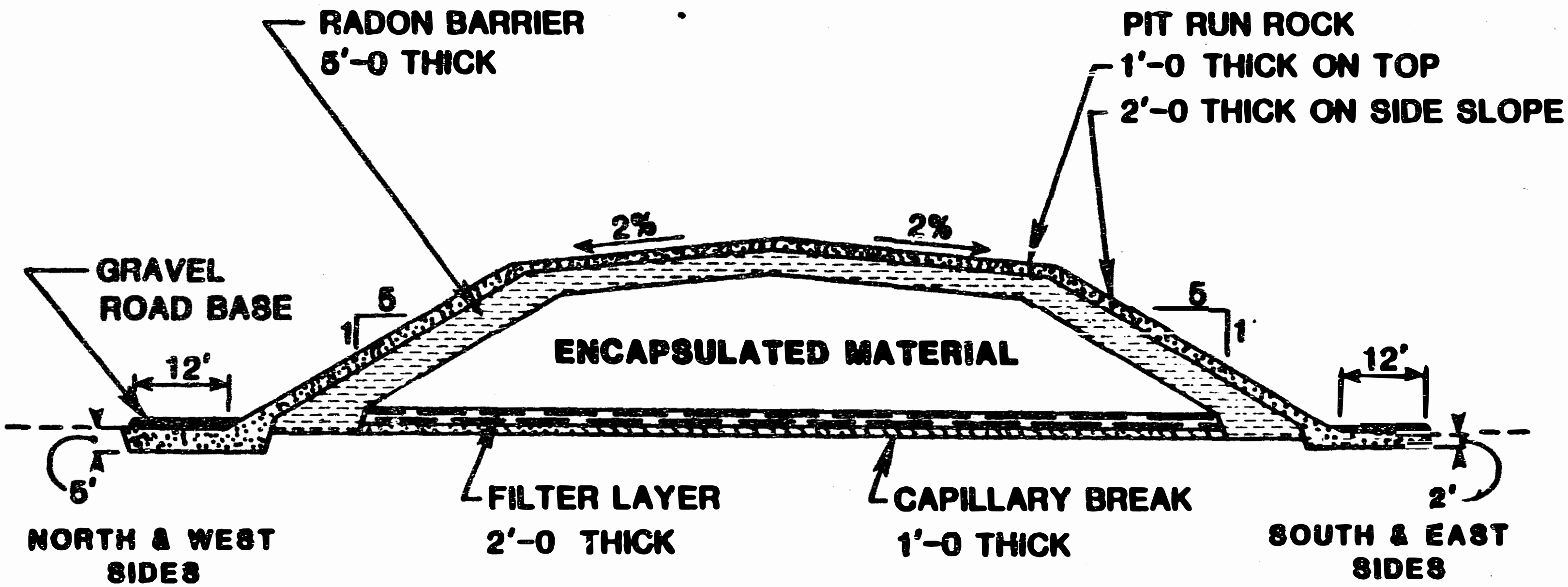



**FIGURE 2.4**
**FINAL CONDITION GUNNISON SITE**




NOTE:
NO HORIZONTAL OR VERTICAL SCALE

**FIGURE 2.5**

**TYPICAL CROSS-SECTION STABILIZATION IN PLACE GUNNISON SITE**

[The remedial action has been designed to ensure that the disposal site would withstand the forces of the Probable Maximum Flood (PMF) resulting from a Probable Maximum Precipitation (PMP), the Maximum Credible Earthquake (MCE) and other erosive forces for 1000 years.

The maximum PMF flow rate was calculated to be 371,000 cfs at the confluence of the Gunnison River and Tomichi Creek; a peak flow rate of 205,000 cfs occurs on the Gunnison River and a peak flow rate of 169,000 cfs occurs on Tomichi Creek. The timing of the PMF flows in the Gunnison River and Tomichi Creek are such that the peak flows do not reach the confluence simultaneously. Thus, the PMF at the confluence is slightly less than the sum of the two tributary PMFs.

The MCE was estimated to be approximately 5.75 on the Richter scale and would generate a ground acceleration of 0.15g.

The erosive forces on the stabilized embankment were based on a one hour PMP rate of eight inches. The PMP rate was then used to calculate the maximum rainfall intensity based on the times of concentrations for flow across the top of the stabilized pile and down the side slopes. The calculated intensities were 43 and 40 inches per hour respectively.

The primary hazard to the long-term integrity of the site are the potential impacts from flooding and stream channel migration. Complete details of the flood analysis with geomorphic considerations are contained in Appendix D. Additional details on other natural hazards to long-term stability are contained in Appendix B.]

Ground-water protection

The alluvial aquifer in the Gunnison River Valley is the major source of potable water in the area. While the wells for the City of Gunnison are to the north and upgradient of the tailings pile, there are at least nine shallow wells downgradient of the pile which are within the plume of contaminated water attributed to the tailings. The uranium concentrations in these wells ranges from 0.009 to 0.068 mg/l ground concentrations and the sulfate concentrations range from 46 to 191 mg/l. Percolation of rainfall and snow melt through the pile plus the partial inundation of the tailings pile during seasonal high ground-water periods carry additional contaminants into the ground water annually. The magnitude and extent of this contamination are discussed in detail in Appendix D.

Two major design features would serve to reduce the ground-water contamination. First, the final embankment cover system would be much less permeable than the present tailings pile and would reduce surface-water infiltration into the tailings. Thus the driving force for leachate production and further percolation of contaminants into the ground water would be greatly [reduced]. Second, the foundation of the embankment would physically separate the contaminated materials from the water table by at least 5 feet. Additionally, the bottom of the tailings embankment would include a [clay] layer that is only slightly more permeable than the cover system [as well as] a [sandy gravel] capillary break between the tailings and the subbase. These features would also inhibit the potential for leaching of soluble contaminants and subsequent migration via either ground-water intrusion or capillary action.

A minor amount of seepage from the embankment would occur as a result of the redistribution of moisture within the tailings. However, the volume of ground-water flow beneath the embankment and the resultant high dilution would minimize the impact of this seepage.

Data collection and modeling of the ground-water contamination at and adjacent to the Gunnison site are not complete. Following completion of these activities, a decision will be made on the need and cost effectiveness of ground-water restoration or other mitigative measures. **[A preliminary analysis of mitigative measures, including aquifer restoration, is presented in Appendix D.2.]**

Personnel, consumption, volumes, and cost estimates and schedules

Estimates of personnel requirements, energy and water consumption, earthmoving volumes, and costs and schedules are contained in Section 2.4. Additional details are contained in Appendix B.

## 2.3 ALTERNATIVES TO [STABILIZATION IN PLACE]

Alternative 1, stabilization in place at the Gunnison site, was discussed in the previous section. Alternatives 2 through 4 are discussed in this section. These alternatives include: no action (Alternative 2), disposal at the East Gold Basin site (Alternative 3), and disposal at the Chance Gulch site (Alternative 4).

The Council on Environmental Quality regulations (40 CFR Parts 1500 through 1508) require that all environmental assessments address the no action alternative. The alternative disposal sites (East Gold Basin and Chance Gulch) were selected through the site selection process discussed in Section 2.6. Figure 2.6 shows the location of the alternative disposal sites.

The design objectives for all of the alternatives, except for the no action alternative, are identical to those objectives selected for stabilization in place. These design objectives are discussed in Section 2.2 and Appendix B.

The engineering designs for the alternate sites are based on existing published data. If one of the alternative sites was to be selected, additional site-specific data would be obtained before final engineering designs are prepared.

All of the alternatives except the no action alternative (Alternative 2) include remedial action at the estimated 14 vicinity properties. Engineering support calculations for remedial action at the vicinity properties are included in Appendix B. These estimates are included in the text of the document only when they make an appreciable contribution to the overall project estimates.

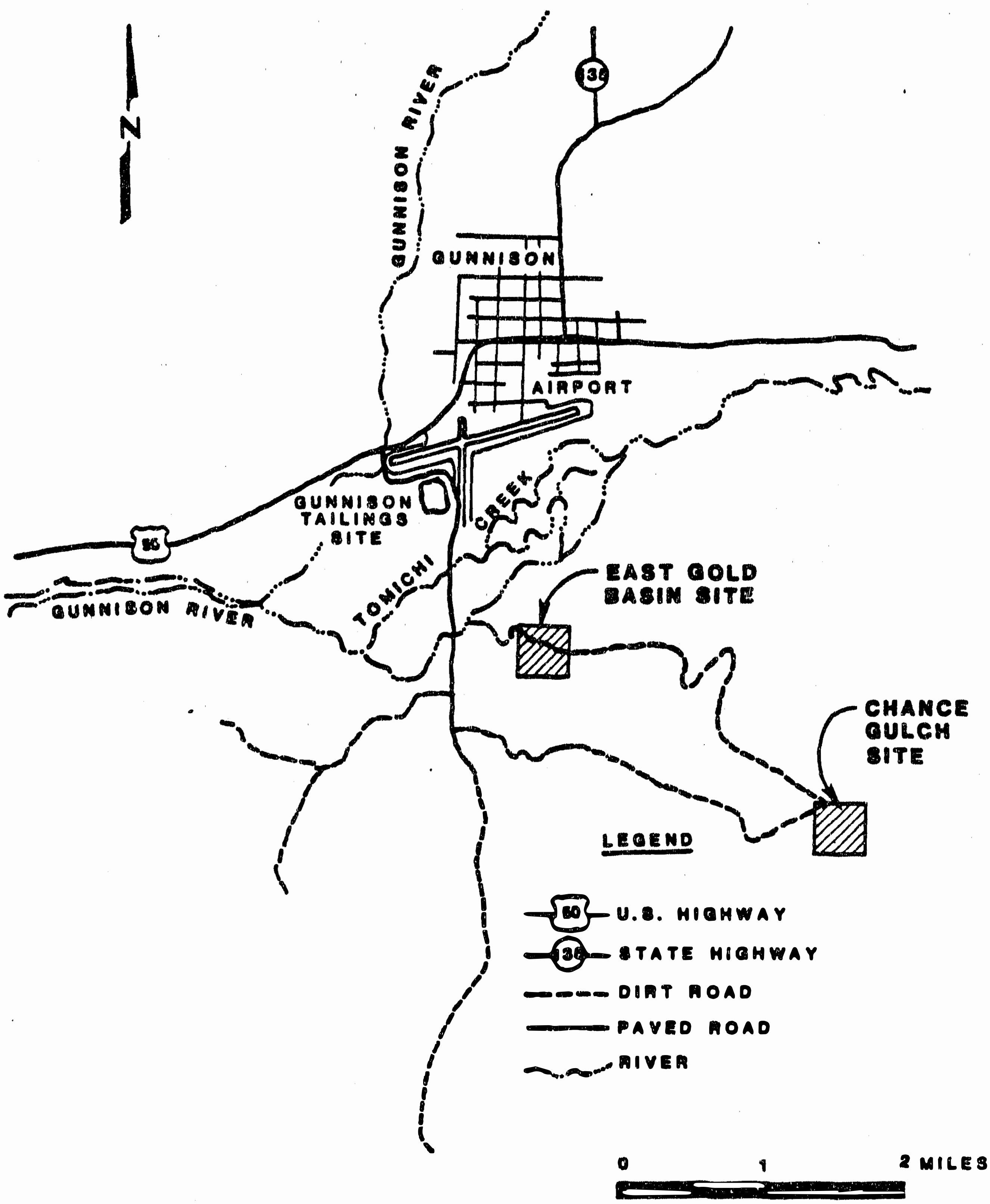



**FIGURE 2.6**
**LOCATIONS OF ALTERNATE DISPOSAL SITES**

2.3.1 No action (Alternative 2)

This alternative consists of taking no steps toward remedial action at the tailings site or the vicinity properties. The tailings pile and vicinity properties would remain in their present condition and would continue to be subject to dispersal 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 UMTRCA (PL95-604) and would not result in DOE's compliance with the EPA standards (40 CFR Part 192).

2.3.2 Disposal at the East Gold Basin site

The East Gold Basin site is located 2 road miles south of the Gunnison site on Federal land administered by the Bureau of Land Management (Figures 2.6 and 2.7). The area surrounding the site [currently] is used for low-density grazing of livestock. A housing development is under construction [about] 2500 feet west of the East Gold Basin site.

Major construction activities

The East Gold Basin alternative consists of moving the tailings and contaminated materials from the Gunnison site and adjacent areas, and consolidating the materials into a gently contoured embankment at the East Gold Basin site.

A disposal area would be constructed partially below grade at this site. The surface materials removed from the area would be stockpiled and used later as a part of the cover system. All soils stockpiled during remedial action would be contoured into a low flat-topped embankment and seeded to protect against wind and water erosion during remedial action.

The contaminated materials would be topped with a 5-foot-thick silty clay cover to control radon exhalation and [to] inhibit water infiltration. The cover would be capped with rock to protect against wind and water erosion. This alternative would involve the following major construction activities.

At the existing site:

Site preparation

- o Grubbing and clearing, erection of a temporary security fence, and upgrading of existing roads.
- o Construction of a waste-water [retention basin] to protect against the release of contaminants from the site during construction.

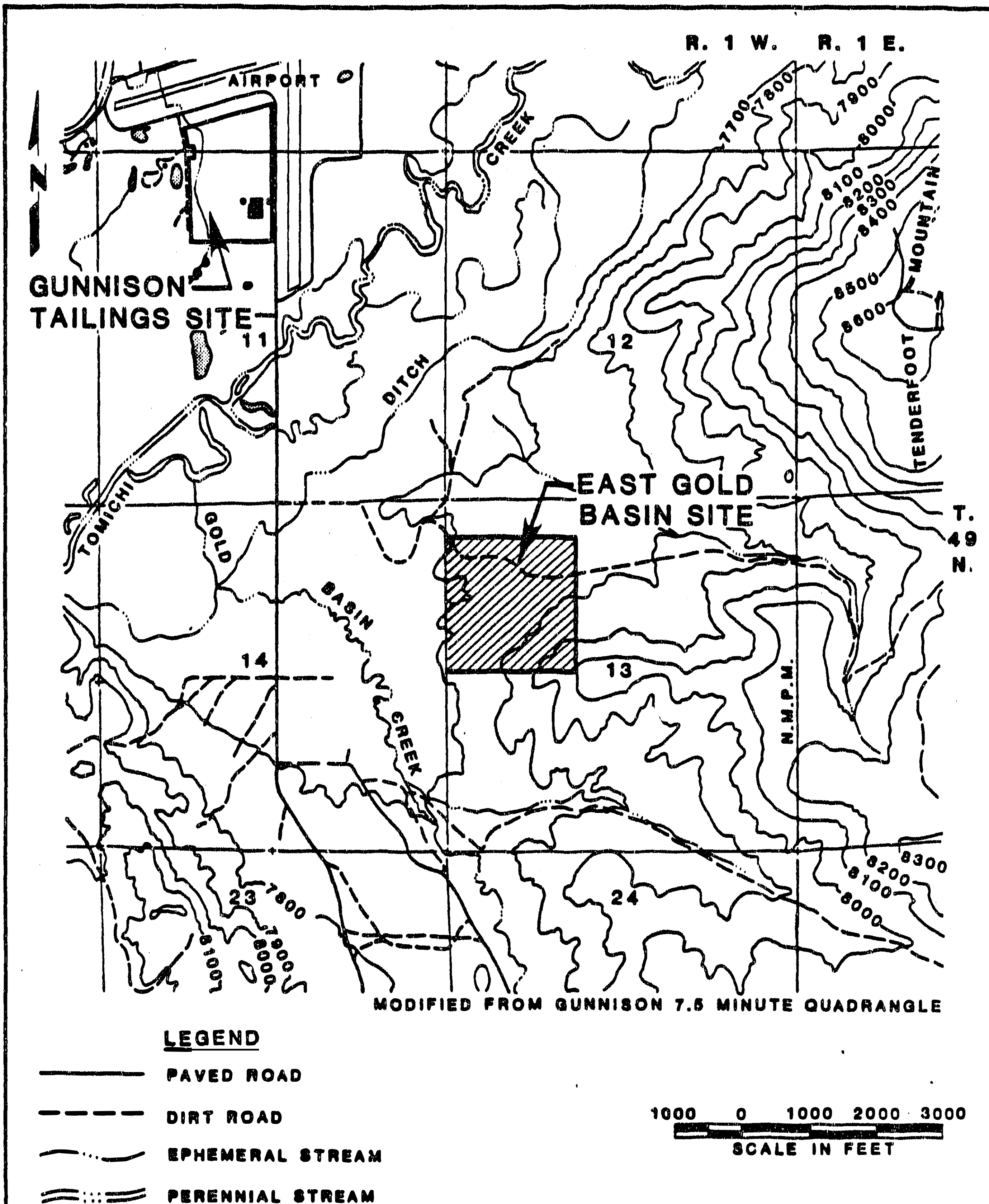



**FIGURE 2.7**
**EAST GOLD BASIN ALTERNATE DISPOSAL SITE**

- o Construction of drainage control measures to direct all generated waste-water and storm-water runoff to [a retention basin] during construction activities.

- o Installation of measures to control erosion and sediment transport from all disturbed areas during construction.

- o Decontamination[, replacement, or compensation of] existing structures on the site.

Tailings relocation

- o Consolidation of contaminated materials from the windblown areas and vicinity properties onto the existing tailings site.

- o Excavation of all tailings and contaminated materials from the existing tailings pile, beneath the tailings pile, windblown areas, mill site, ore storage area, and vicinity properties.

Site restoration

- o Restoration [with uncontaminated fill] of all excavated areas of the existing site to a level compatible with the surrounding terrain and regrading to provide suitable drainage control.

- o Revegetation of all disturbed areas as required.

At the East Gold Basin site:

Site preparation

- o Construction of a 0.8-mile haul road to the new site.

- o Grubbing and clearing, and erection of a temporary security fence.

- o Construction of a waste-water [retention basin] to protect against the release of contaminants from the site during construction.

- o Construction of drainage control measures to direct all generated waste-water and storm-water runoff to the [retention basin] during construction activities.

- o Installation of measures to control erosion and sediment transport from all disturbed areas during construction.

Foundation

- o Excavation below grade at the disposal area and stockpiling of the surface materials.

- o Placement of a 1-foot-thick [sandy gravel] capillary break and a 2-foot-thick clay filter layer.

Tailings relocation

- o Placement and consolidation of the tailings and contaminated materials at the new disposal area into a gently contoured embankment.

Cover placement

- o Placement of a 5-foot-thick silty clay cover over the tailings embankment to inhibit water infiltration [and] radon exhalation.

Erosion protection

- o Emplacement of rock over the radon cover for erosion protection **[and to minimize plant root penetration and burrowing by animals.]**

Site restoration

- o Backfilling, final grading for drainage control, and revegetation, as required, of all areas disturbed during remedial action.

- o Construction of an unpaved access road looping the toe of the embankment.

- o Installation of permanent fencing to discourage inadvertent human intrusion.

Borrow material (radon cover, [rock, sand,] gravel, and fill) would be obtained from the three borrow sites shown in Figure 2.3. Material for the radon cover would be obtained from the material excavated at the East Gold Basin site and from borrow area 1; rock for erosion protection **[and sandy gravel for the capillary break]** would be obtained from the Valco gravel pit (an existing private sand and gravel operation) and fill material would be obtained from borrow [site] 6.

## Description of final condition

The completed site would be an embankment on the southwest quarter of the disposal site and would cover approximately 32 acres.

The below-grade excavation would extend to a depth of 5 feet. The bottom 3 feet would consist of capillary break and filter layer materials. The contaminated material would be placed on the filter layer and would be covered with 5 feet of silty clay (Figure 2.8).

The top of the completed embankment would be gently sloped (2 percent) to promote drainage and would be approximately 45 feet above the surrounding terrain. Side slopes of the embankment would have a maximum slope of 5 horizontal to 1 vertical (20 percent).

The rock erosion barrier would tie into an access road which would loop the toe of the embankment. A security fence with warning signs would enclose the embankment and roadway. Drainage channels adjacent to the embankment would provide drainage and divert surface runoff around and away from the embankment.

After completion of the embankment at the new site and decontamination at the present site, the disturbed areas at each site would be restored with uncontaminated fill to a level compatible with the surrounding terrain, recontoured as necessary for surface drainage, and revegetated as required.

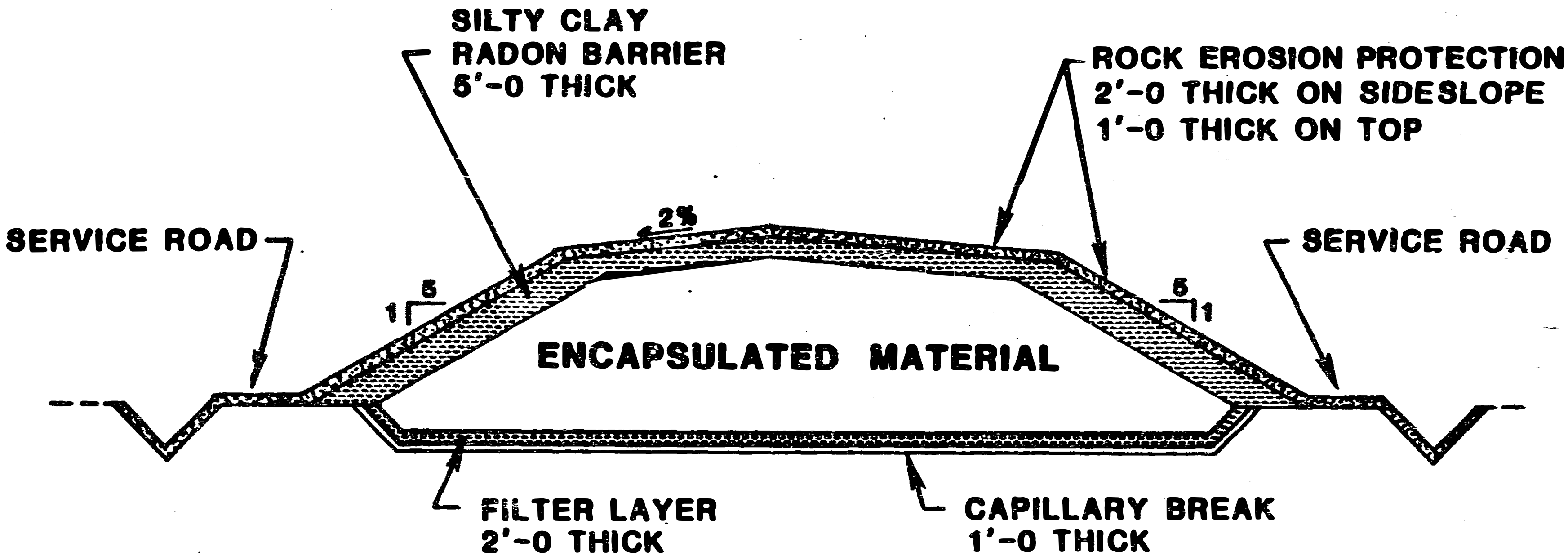
## Radon control

Control of radon emanation from the existing site would be accomplished by relocating all of the tailings and contaminated materials to the East Gold Basin site. Control of radon emissions from the stabilized embankment at the new site would be accomplished through a combination of techniques including the following:

- Placing lesser contaminated soils and windblown soils over the tailings.
- Placing a 5-foot-thick silty clay cover over the tailings and contaminated materials.

## Long-term stability

To protect against water erosion and slope failure, the embankment slopes would be limited to 5 horizontal to 1 vertical (20 percent). The top of the embankment would be gently sloped (2 percent) to promote drainage. Safety factors for slope failure were calculated to be 2.5.




NOTE:
NO HORIZONTAL OR VERTICAL SCALE

FIGURE 2.8 TYPICAL CROSS-SECTION
EAST GOLD BASIN

To protect the stabilized pile from the impact of a highly unlikely Probable Maximum Precipitation (PMP), the embankment would have a layer of rock as part of the cover system. The rock sizes are designed to remain intact during and following a PMP. The rock sizes would be the same as those discussed in Section 2.2.

Due to the height of the embankment, wind velocities at the site, and final embankment contouring, the embankment would be subject to erosion from wind. The same rock layer used to protect against water erosion would protect the embankment against wind erosion.

Since there are no major drainages near this site, flood protection and stream meander are not considerations under this alternative.

Ground-water protection

[There is a potential] that ground water exists in the surface soils at the East Gold Basin site. Stabilizing and covering the radioactive materials would inhibit water infiltration through the embankment thereby limiting downward migration of contaminants. The combination of the capillary break and the relatively impermeable clay filter beneath the embankment would also limit the migration of contaminants into any local aquifer. Therefore, additional protection measures against contaminant transport are not considered necessary for this remedial action alternative. On-site data would be obtained to verify the absence of shallow ground water if this alternative is selected.

Data collection and modeling of the ground-water contamination at and adjacent to the Gunnison site are not complete. Following completion of these activities, a decision will be made on the need and cost effectiveness of ground-water restoration or other mitigative measures.

Personnel, consumption, volumes, and cost estimates and schedules

Estimates of personnel requirements, energy and water consumption, earthmoving volumes, and costs and schedules are contained in Section 2.4. Additional details are contained in Appendix B.

### 2.3.3 Disposal at the Chance Gulch site

The Chance Gulch site is located 6 road miles southeast of the Gunnison site on Federal land administered by the Bureau of Land Management (Figures 2.6 and 2.9). The area surrounding the site is used for low-density grazing of livestock. The nearest residence is approximately 2.5 miles to the west.

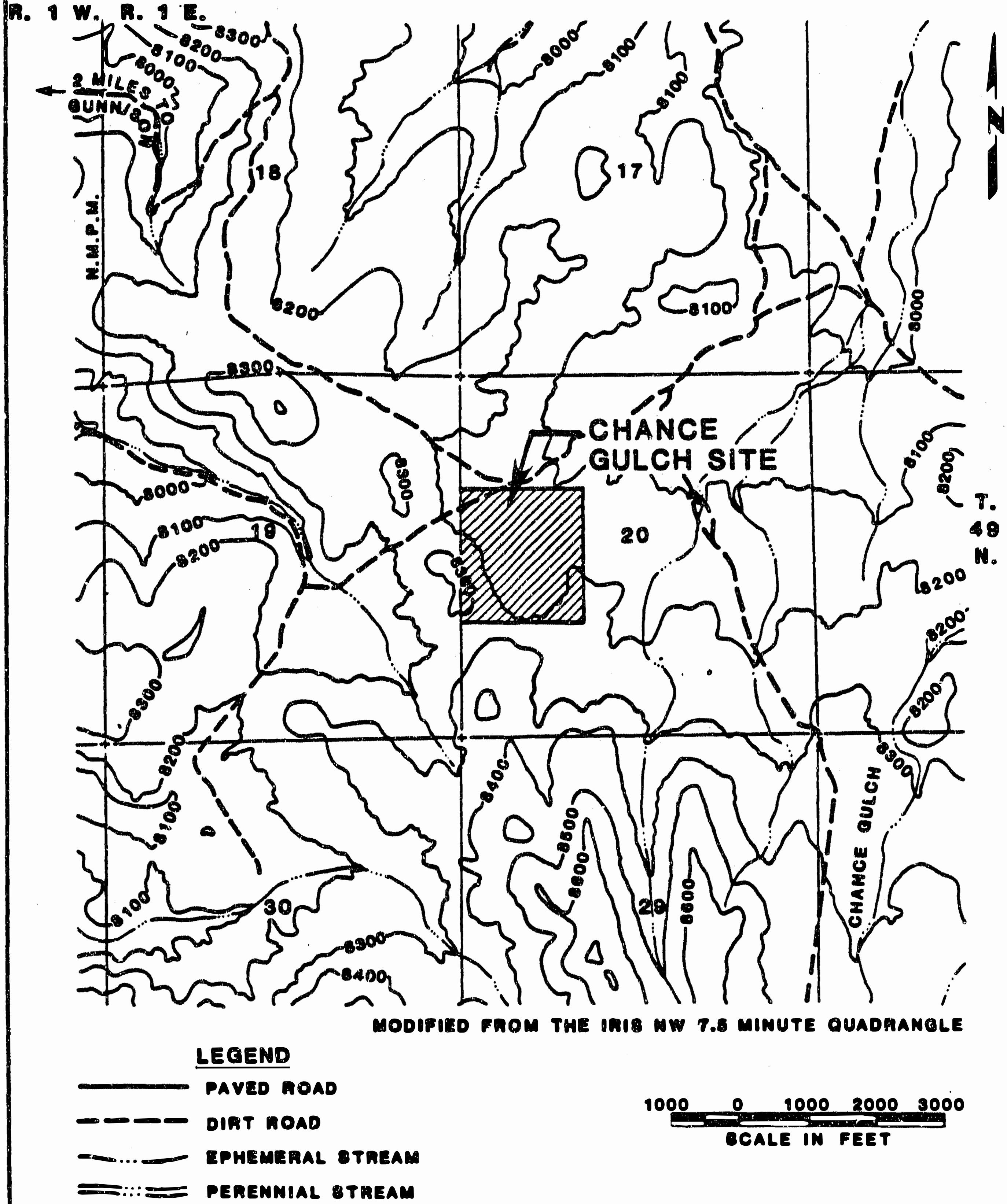



**FIGURE 2.9**
**SITE MAP**
**CHANCE GULCH ALTERNATE DISPOSAL SITE**

## Major construction activities

The Chance Gulch alternative consists of moving the tailings and contaminated materials from the Gunnison site and adjacent areas, and consolidating the materials into a gently contoured embankment at the Chance Gulch site.

The disposal area would be constructed partially below grade at this site. The surface materials removed from the area would be stockpiled and used later as a part of the cover system. All soils stockpiled during remedial action would be contoured into a low flat-topped embankment and seeded to protect against wind and water erosion during remedial action.

The contaminated materials would be topped with a 5-foot-thick silty clay cover to control radon exhalation and inhibit water infiltration. The cover would be capped with rock to protect against wind and water erosion. This alternative would involve the following major construction activities.

At the existing site:

The Chance Gulch alternative would require the same construction activities at the Gunnison site as listed for the East Gold Basin alternative (Section 2.3.2).

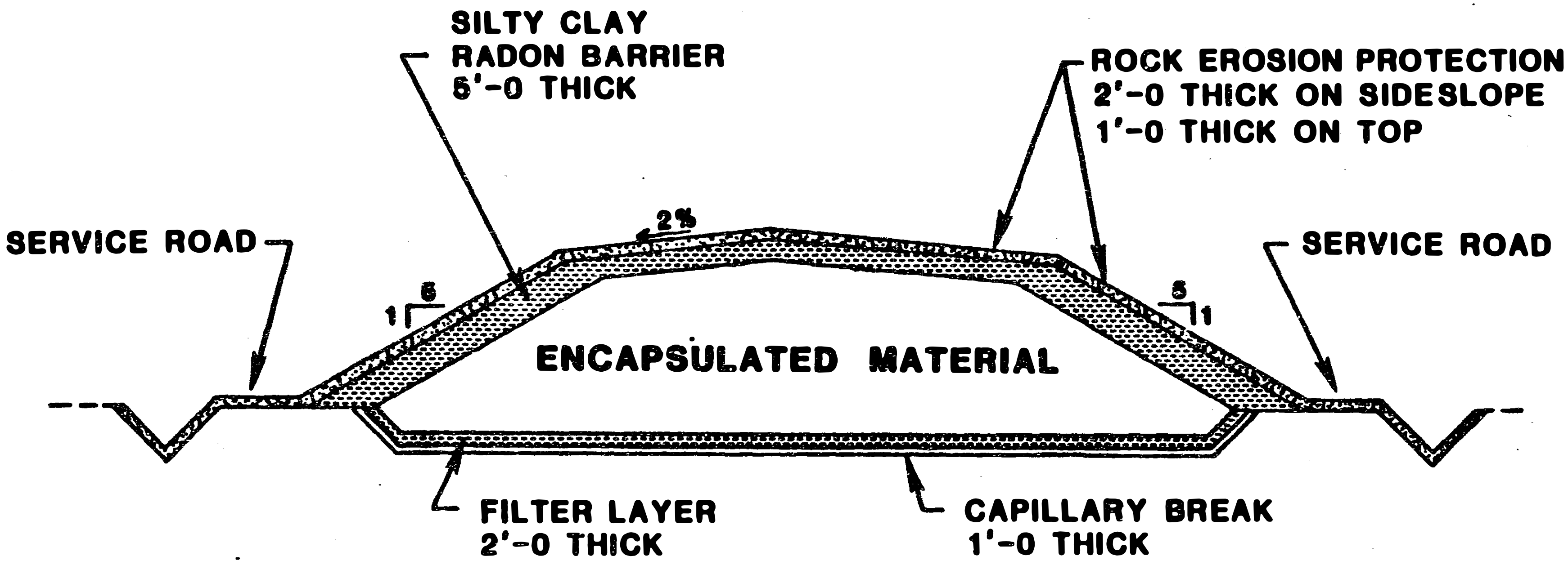
At the Chance Gulch site:

This alternative requires the same construction activities as the East Gold Basin alternative except that 4.4 miles of haul road would be constructed [,] primarily across Federal land administered by the Bureau of Land Management **[which is currently]** used for low-density grazing of livestock.

Borrow material (radon cover, gravel, and fill) would be obtained from the three borrow sites shown in Figure 2.3. Material for the radon cover would be obtained from the material excavated at the Chance Gulch site and from borrow site 1; rock for erosion protection would be obtained from the Valco gravel pit (an existing private sand and gravel operation) and fill material would be obtained from borrow site 6.

## Description of final condition

The completed site would be an embankment on the southwest quarter of the disposal site and would cover approximately 32 acres. The essential features of the final configuration of this alternative are the same as those described for the East Gold Basin alternative (Section 2.3.2) and are shown in Figure 2.10.




NOTE:
NO HORIZONTAL OR VERTICAL SCALE

FIGURE 2.10 TYPICAL CROSS-SECTION
CHANCE GULCH

### Radon control

Control of radon emanation for the Chance Gulch alternative would be accomplished in the same manner as for the East Gold Basin alternative (Section 2.3.2).

### Long-term stability

The Chance Gulch alternative would incorporate the same measures to assure long-term stability as the East Gold Basin alternative (Section 2.3.2).

### Ground-water protection

The Chance Gulch alternative would incorporate the same measures for ground-water protection as the East Gold Basin alternative (Section 2.3.2).

### Personnel, consumption, volumes, and cost estimates and schedules

Estimates of personnel requirements, energy and water consumption, earthmoving volumes, and costs and schedules are contained in Section 2.4. Additional details are contained in Appendix B.

## 2.4 PERSONNEL, CONSUMPTION, VOLUMES, AND COST ESTIMATES AND SCHEDULES

Estimates of personnel requirements, energy and water consumption, major earthmoving volumes, costs, and schedules for all alternatives are contained in Tables 2.2 through 2.5 and Figures 2.11 through 2.13.

## 2.5 REJECTED ALTERNATIVES

### Disposal site selection

The U.S. Department of Energy (DOE) used an extensive process to locate, evaluate[,] and select alternat[e] disposal sites for the Gunnison tailings. The State of Colorado, Federal and local agencies, concerned individuals, and industry representatives were contacted to locate possible disposal sites. Private, state[,] and Federal lands were considered in the alternat[e] disposal site selection process (FBDU, 1977).

Originally, thirteen [potential alternate] disposal sites were considered, and a reconnaissance survey was made of each. Seven of the original sites were subsequently eliminated from further consideration because of disadvantages such as excessive haulage distance, steep terrain, excessive surface drainage, and insufficient borrow material for the stabilization cover. Between 1977 and 1981, three additional sites were identified, and the resulting nine alternat[e] disposal sites were evaluated further (FBDU, 1977, 1981).

Table 2.2 Personnel requirements

| Description of personnel | Stabilization in place | No action | East Gold Basin | Chance Gulch |
|---|---|---|---|---|
| Site preparation | | | | |
| Equipment operators | 6 | 0 | 7 | 8 |
| Truck drivers | 5 | 0 | 7 | 27 |
| Miscellaneous personnel | 17 | 0 | 17 | 17 |
| Supervisor/foremen | 3 | 0 | 3 | 5 |
| Total personnel | 31 | 0 | 34 | 57 |
| Foundation | | | | |
| Equipment operators | 7 | 0 | 6 | 6 |
| Truck drivers | 13 | 0 | 3 | 5 |
| Miscellaneous personnel | 2 | 0 | 2 | 2 |
| Supervisor/foremen | 2 | 0 | 1 | 1 |
| Total personnel | 24 | 0 | 12 | 14 |
| [Windblown] tailings relocation | | | | |
| Equipment operators | 2 | 0 | 2 | 2 |
| Truck drivers | 0 | 0 | 0 | 0 |
| Miscellaneous personnel | 1 | 0 | 1 | 1 |
| Supervisor/foremen | 0 | 0 | 0 | 0 |
| Total personnel | 3 | 0 | 3 | 3 |
| Total tailings relocation | | | | |
| Equipment operators | 8 | 0 | 11 | 9 |
| Truck drivers | 0 | 0 | 29 | 31 |
| Miscellaneous personnel | 2 | 0 | 2 | 2 |
| Supervisor/foremen | 1 | 0 | 4 | 4 |
| Total personnel | 11 | 0 | 46 | 46 |
| Cover placement | | | | |
| Equipment operators | 7 | 0 | 6 | 6 |
| Truck drivers | 13 | 0 | 5 | 9 |
| Miscellaneous personnel | 2 | 0 | 2 | 2 |
| Supervisor/foremen | 2 | 0 | 1 | 2 |
| Total personnel | 24 | 0 | 14 | 19 |

Table 2.2 Personnel requirements (concluded)

| Description of personnel | Stabilization in place | No action | East Gold Basin | Chance Gulch |
|---|---|---|---|---|
| Erosion protection | | | | |
| Equipment operators | 4 | 0 | 4 | 4 |
| Truck drivers | 8 | 0 | 11 | 11 |
| Miscellaneous personnel | 2 | 0 | 1 | 1 |
| Supervisor/foremen | 1 | 0 | 1 | 1 |
| Total personnel | 15 | 0 | 17 | 17 |
| Restoration | | | | |
| Equipment operators | 9 | 0 | 6 | 6 |
| Truck drivers | 17 | 0 | 11 | 8 |
| Miscellaneous personnel | 2 | 0 | 2 | 1 |
| Supervisor/foremen | 3 | 0 | 2 | 1 |
| Total personnel | 31 | 0 | 21 | 16 |
| General supervision | | | | |
| Superintendent | 1 | 0 | 1 | 1 |
| Field staff personnel | 2 | 0 | 2 | 3 |
| Field service personnel | 5 | 0 | 5 | 5 |
| Security personnel | 3 | 0 | 3 | 6 |
| Office personnel | 2 | 0 | 2 | 2 |
| Health physics & monitoring personnel | 5 | 0 | 5 | 5 |
| Total personnel | 18 | 0 | 18 | 22 |
| Maximum at any one time | 102 | 0 | 111 | 108 |
| Average over duration of construction activities | 65 | 0 | 78 | 74 |

Table 2.3 Energy and water consumption

| | Stabilization in place | No action | East Gold Basin | Chance Gulch |
|---|---|---|---|---|
| Fuel (gallons) | 803,000 | 0 | 1,434,000 | 1,894,000 |
| Electricity (Kwh) | 216,000 | 0 | 293,000 | 621,000 |
| Water (gallons) | 21,280,000 | 0 | 22,240,000 | 26,790,000 |

Table 2.4 Summary of major earthwork volumes

| Activity item | [Estimated] in-place volume (cubic yards) Stabilization in place | No action | East Gold Basin | Chance Gulch |
|---|---|---|---|---|
| **Site preparation** | | | | |
| o New haul road | | | | |
| 1. Base course | 0 | 0 | 11,000 | 61,000 |
| 2. Gravel | 0 | 0 | 4,700 | 26,000 |
| **Tailings relocation** | | | | |
| o Partial movement | 67,000 | 0 | 35,000 | 35,000 |
| o Total movement | 812,000 | 0 | 812,000 | 812,000 |
| **Foundation** | | | | |
| o Backfill | 94,000 | 0 | 0 | 0 |
| o Excavation & stockpile | 0 | 0 | 220,000 | 220,000 |
| o Capillary break | 38,000 | 0 | 38,000 | 38,000 |
| o Filter layer | 75,000 | 0 | 75,000 | 75,000 |
| Radon cover | 209,000 | 0 | 209,000 | 209,000 |
| Erosion protection | 81,000 | 0 | 81,000 | 81,000 |
| Site restoration | 237,000 | 0 | 352,000 | 352,000 |

Table 2.5 Summary of construction costs - Gunnison remedial action alternatives

| | Cost ($000) | | | |
|---|---|---|---|---|
| Activity item | Stabilization in place | No action | East Gold Basin | Chance Gulch |
| Site preparation | 1,080 | 0 | 1,430 | 2,260 |
| Foundation | 1,140 | 0 | 1,080 | 1,130 |
| Tailings relocation | 1,440 | 0 | 2,200 | 3,040 |
| Radon cover | 890 | 0 | 570 | 680 |
| Erosion protection | 700 | 0 | 720 | 820 |
| Decontamination | 60 | 0 | 120 | 120 |
| Site restoration | 1,120 | 0 | 1,630 | 1,630 |
| Security | 80 | 0 | 70 | 70 |
| Supervisory & field services | 2,340 | 0 | 3,680 | 4,850 |
| Construction total | 8,850 | 0 | 11,500 | 14,600 |
| Vicinity properties | 1,033 | 0 | 1,033 | 1,033 |
| Total | 9,883 | 0 | 12,533 | 15,633 |

These estimates do not include the costs of:

o property acquisition[.]

o engineering design[.]

o construction management except for field supervision[.]

o overall project management[.]

o long-term maintenance and surveillance[.]

FIGURE 2.11 CONSTRUCTION SCHEDULE: STABILIZATION IN PLACE

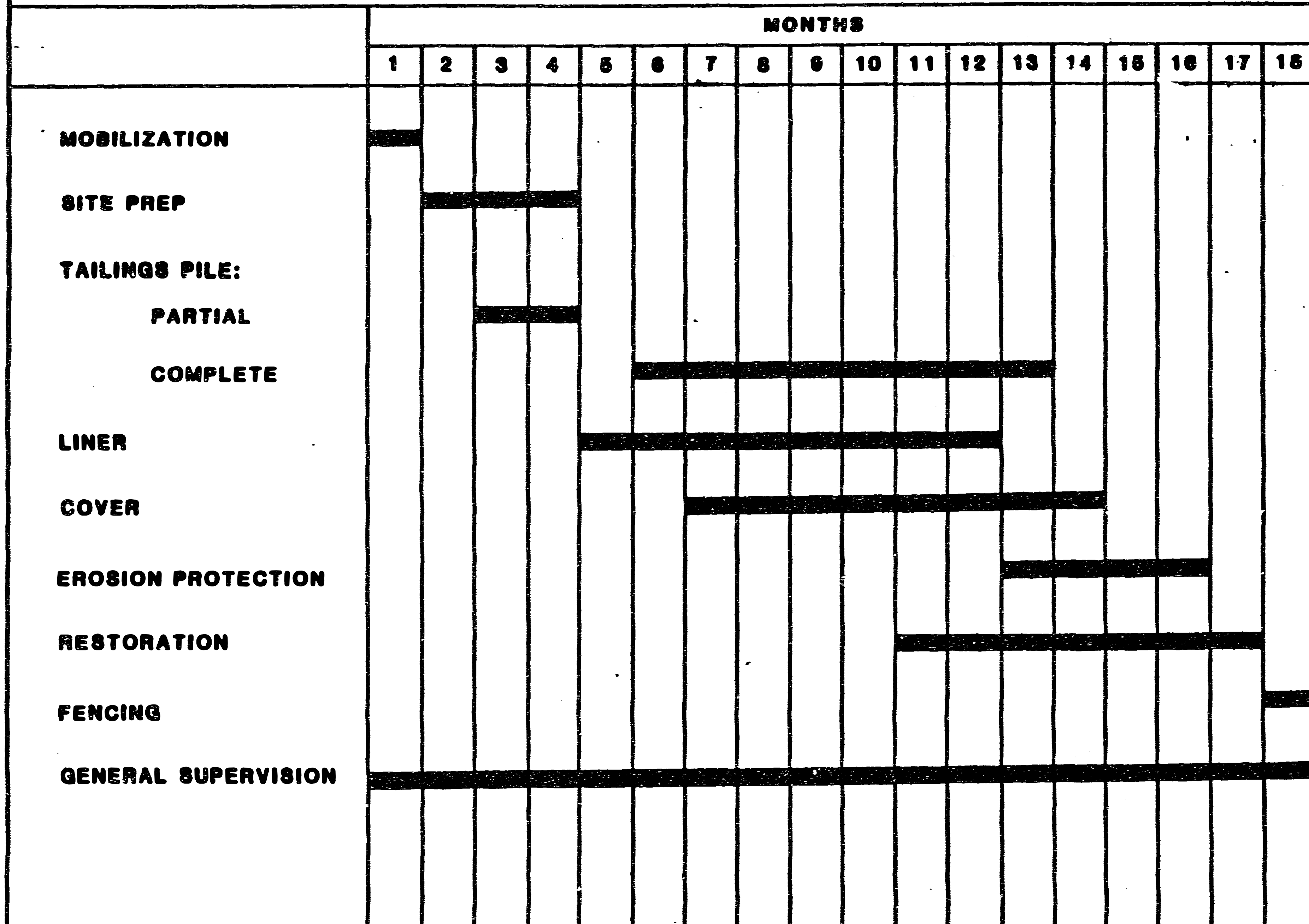
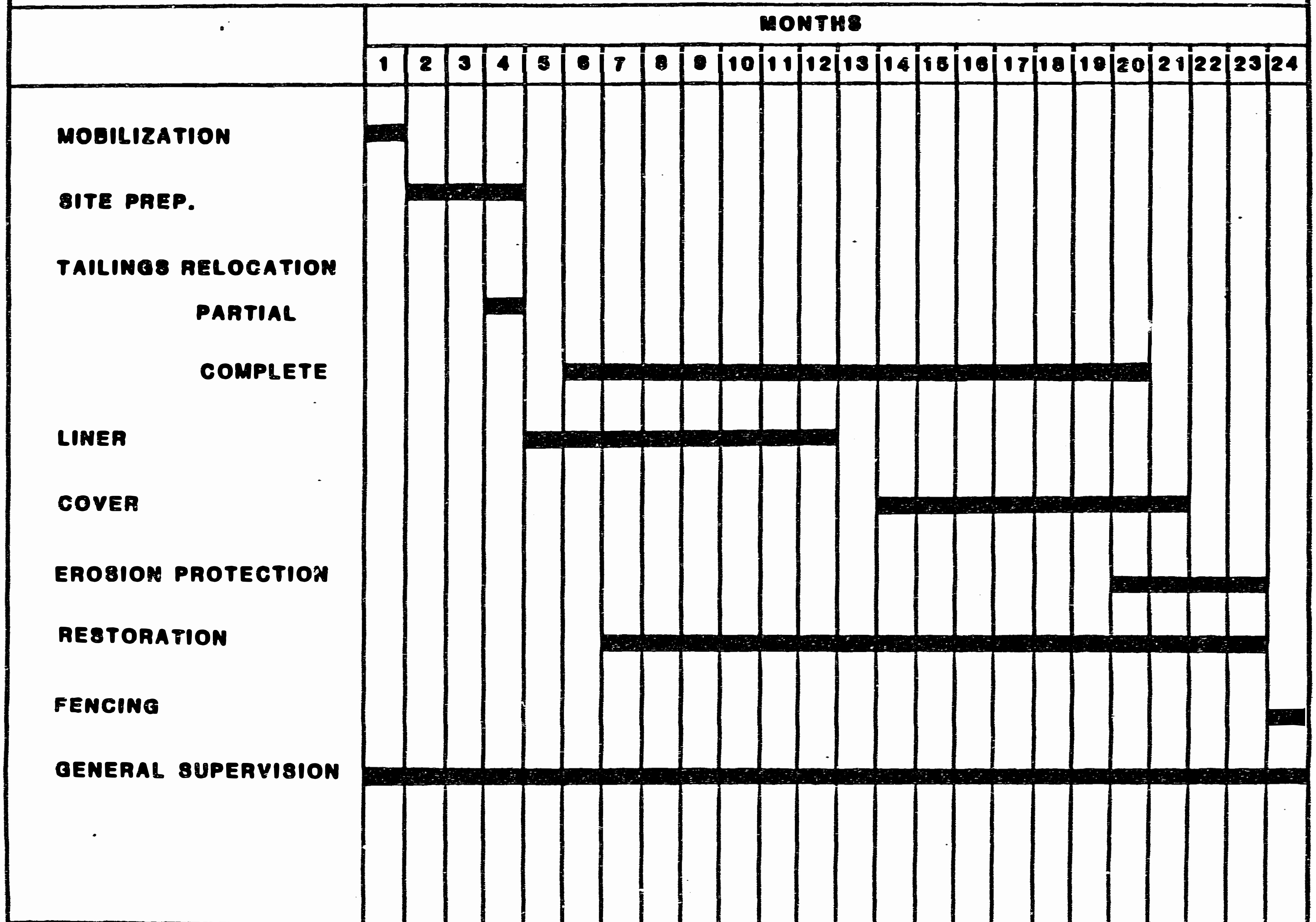
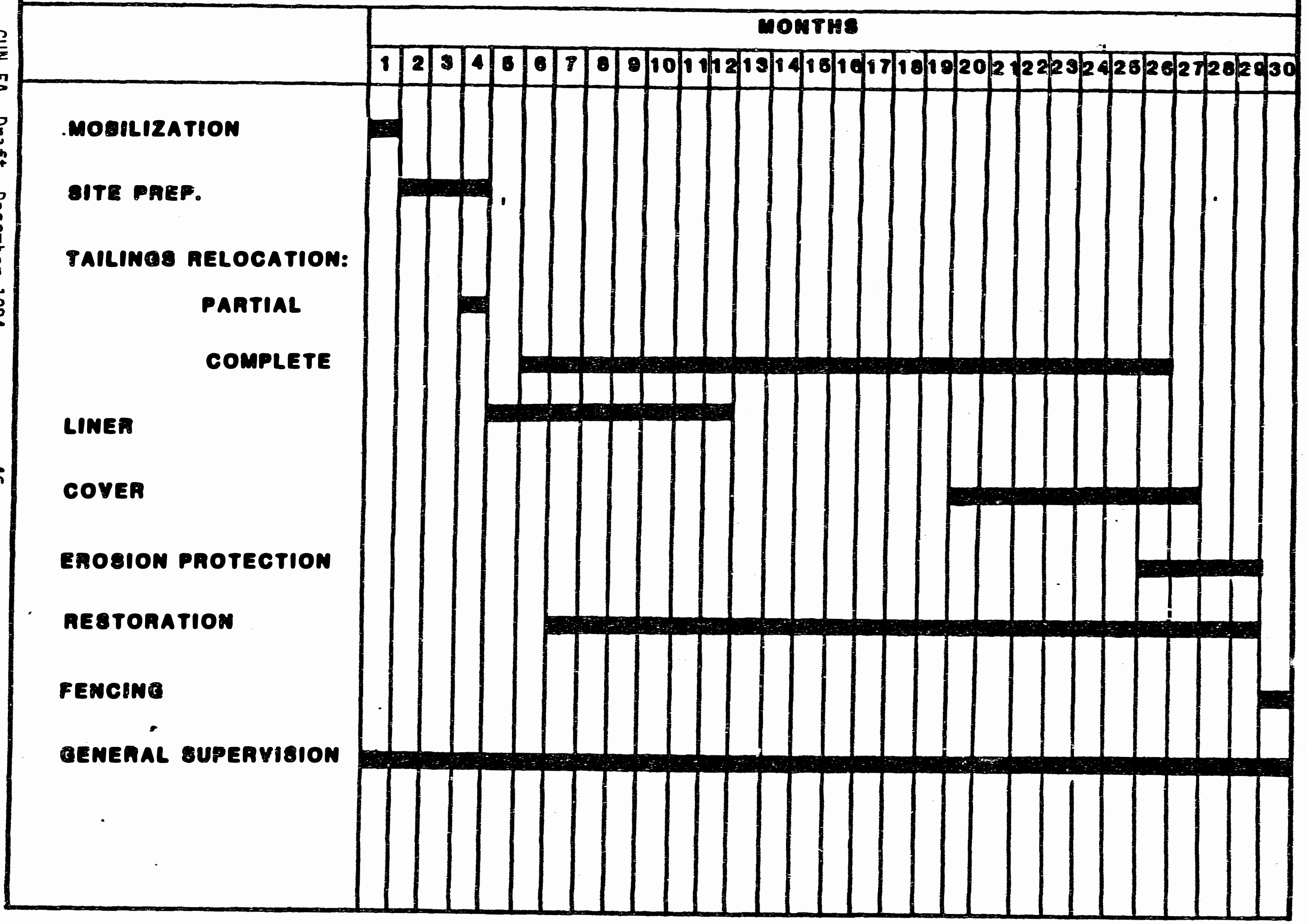


**FIGURE 2.12 CONSTRUCTION SCHEDULE: EAST GOLD BASIN**




Note: This schedule incorporates a three month period during winter when severe weather conditions would prevent remedial action activities from occurring.

**FIGURE 2.13 CONSTRUCTION SCHEDULE: CHANCE GULCH**



[The nine candidate alternate disposal sites were evaluated on the basis of the existing hydrologic (ground-water and surface-water characteristics), geologic, meteorologic, ecologic and economic conditions. Ground-water analysis investigated the potential for confined aquifers, subsurface drainage and water contamination. Surface water characteristics examined included drainage basin configuration, surface drainage, water erosion, flooding, and natural storage basin features. Geologic evaluation addressed stability and soil characteristics such as the presence of slides or faults and types of unconsolidated and bedrock materials. The meteorological evaluation examined National Weather Service data for wind and precipitation.] The ecologic evaluation assessed land use potential, animal habitats, proximity to land use potential, animal habitats, proximity to population centers, and aesthetics. Economic considerations included estimates of impacts to support facilities such as highways, distance from the Gunnison site, and the extent of site preparation and long-term maintenance (FBDU, 1981).

Following the evaluation of all sites, the alternat[e] disposal sites addressed in this document (East Gold Basin and Chance Gulch) were selected (DOE, 1983).

In addition to evaluating alternat[e] disposal sites, DOE evaluated two alternative methods for disposal of the Gunnison tailings; returning the tailings to the original mine sources, and reprocessing the tailings.

Returning the tailings to the original mine sources

Returning the tailings to the mines from which the ore was obtained was determined to be not feasible. The ores processed at the Gunnison site came from mines in the Cochetopa Pass area to the southeast of Gunnison. These mines are farther from the site than any of the disposal sites, and many of these mines have collapsed and are not available for disposal of the tailings (FBDU, 1981). This alternative disposal method was not considered further.

Reprocessing the tailings

The feasibility of reprocessing the tailings to recover residual uranium, vanadium and molybdenum was evaluated. A drilling and sampling program was conducted to determine the total recoverable amounts of these metals in the tailings and underlying material. Laboratory testing was then performed to determine the optimum reprocessing method[:] conventional plant processing (milling) or heap leaching. Finally, the economics of the optimum reprocessing method were evaluated (DOE, 1982).

The evaluation concluded that recovery of vanadium from the tailings is neither technically nor economically feasible. The vanadium content of the tailings is quite low[,] as was the recovery of vanadium in the laboratory tests. The recovery of uranium and molybdenum is technically but not economically feasible. Recovery costs (capital plus operating costs) for the uranium and molybdenum were estimated at $228 per pound while the total market value for both products was only $34 per pound. Market values for uranium and molybdenum would have to increase to $324 and $120 per pound respectively for reprocessing to "break even" (DOE, 1982).

Reprocessing of the tailings would not reduce the radium content of the tailings. Since radioactive decay of the radium is the source of radon gas, there would be no reduction of the hazard from radon and radon daughters; hence, the reprocessed tailings would require remedial action to meet EPA standards. Reprocessing was therefore eliminated from further consideration.

Borrow sites

Initially, nine sites were identified as potential sources of borrow material for the Gunnison remedial action. Preliminary investigations eliminated three of these sites from further consideration because of unsuitable conditions such as insufficient quantities of materials, distance from the tailings and alternative disposal sites, and proximity to residential development. Detailed studies and evaluation of the remaining six sites lead to the selection of the Valco gravel pit and [borrow] sites 1 and 6 (Figure 2.3) as borrow sources (SHB, 1983).

The existing Valco gravel pit was selected as the source of rock[, sand, and gravel]. Silty clay and general fill material would be obtained from sites 1 and 6. All of these sites have been used as a source of borrow material in the past. Borrow materials for the alternat[e] disposal sites (East Gold Basin and Chance Gulch) would be obtained from the area to be disturbed at the alternate site and these same three borrow sites. The surface of borrow site 1 is owned by the county of Gunnison and the minerals are owned by the Federal government and administered by the Bureau of Land Management. Both the surface and minerals at borrow site 6 are privately owned.

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SHB (Sergent, Hauskins, and Beckwith), 1983. Memorandum dated December 27, 1983[,] from Ralph E. Weeks to Wayne A. Ericson, P.E., regarding Supplemental Discussion of Borrow Source Investigation, Gunnison Site, UMTRA Project, SHB Job No. E-83-1093A.

# 3.0 AFFECTED ENVIRONMENT

## 3.1 BRIEF DESCRIPTION OF THE AFFECTED AREA

The Gunnison tailings site and the alternat[e] disposal sites are located near the city of Gunnison in Gunnison County, Colorado. Figure 3.1 shows the location of each site and the major demographic features of the area. The major urban center in the area is the city of Gunnison with **[an estimated 1982]** population of **[6,031]**. Most of this population is concentrated within the city limits **[which are]** just northeast of the tailings site.

The area has a cold desert climate with an average annual precipitation of 11 inches. The predominant winds are from the north, and the strongest winds are from the southwest to west-northwest quadrants.

The tailings site is located in the Gunnison River valley. Vegetation ranges from juniper, pinon pine, and sagebrush high on the valley sides to cottonwoods, willows, and native grasses in the valley bottom near the river. The alternate disposal sites are located in mountain rangeland where vegetation consists of low shrubs with a thin mixture of grasses and forbs.

The tailings site is located on the drainage divide between the Gunnison River and Tomichi Creek (Figure 3.2). The tailings pile is bounded on the north and east by the Gunnison County Airport. South of the tailings are the original mill buildings[,] and an operating gravel pit[,] and a concrete batch plant. The land immediately west of the tailings is currently used for commercial and agricultural purposes.

The East Gold Basin alternate disposal site is located 2 road miles southeast of the tailings site (Figure 3.3), in a gently sloping, bowl-shaped area at the head of a small drainage basin. The land is administered by the Bureau of Land Management (BLM) and used for low-density grazing. The site is approximately 2,500 feet from a residential subdivision.

The Chance Gulch alternate disposal site is approximately 6 road miles southeast of the tailings site (Figure 3.4), in a large, gently sloping bowl at the head of the Chance Gulch drainage basin. The land is administered by the BLM and used for low-density grazing. The site is approximately 2.5 miles from the nearest residence.

Implementation of **[stabilization in place]** or removal of the tailings to either of the alternate disposal sites would require that fill, gravel, **[sand,]** and rock be obtained from borrow sites. Three sites have been chosen as sources of the necessary borrow materials (Figure 3.5). **[They are the Valco site, site 1, and site 6.]**

## 3.2 DESCRIPTION OF THE EXISTING TAILINGS PILE

The mill at the Gunnison site was constructed to produce uranium for sale to the Atomic Energy Commission. Gunnison Mining Company operated the mill from February 1958 until December 1961, and Kermac Nuclear Fuels

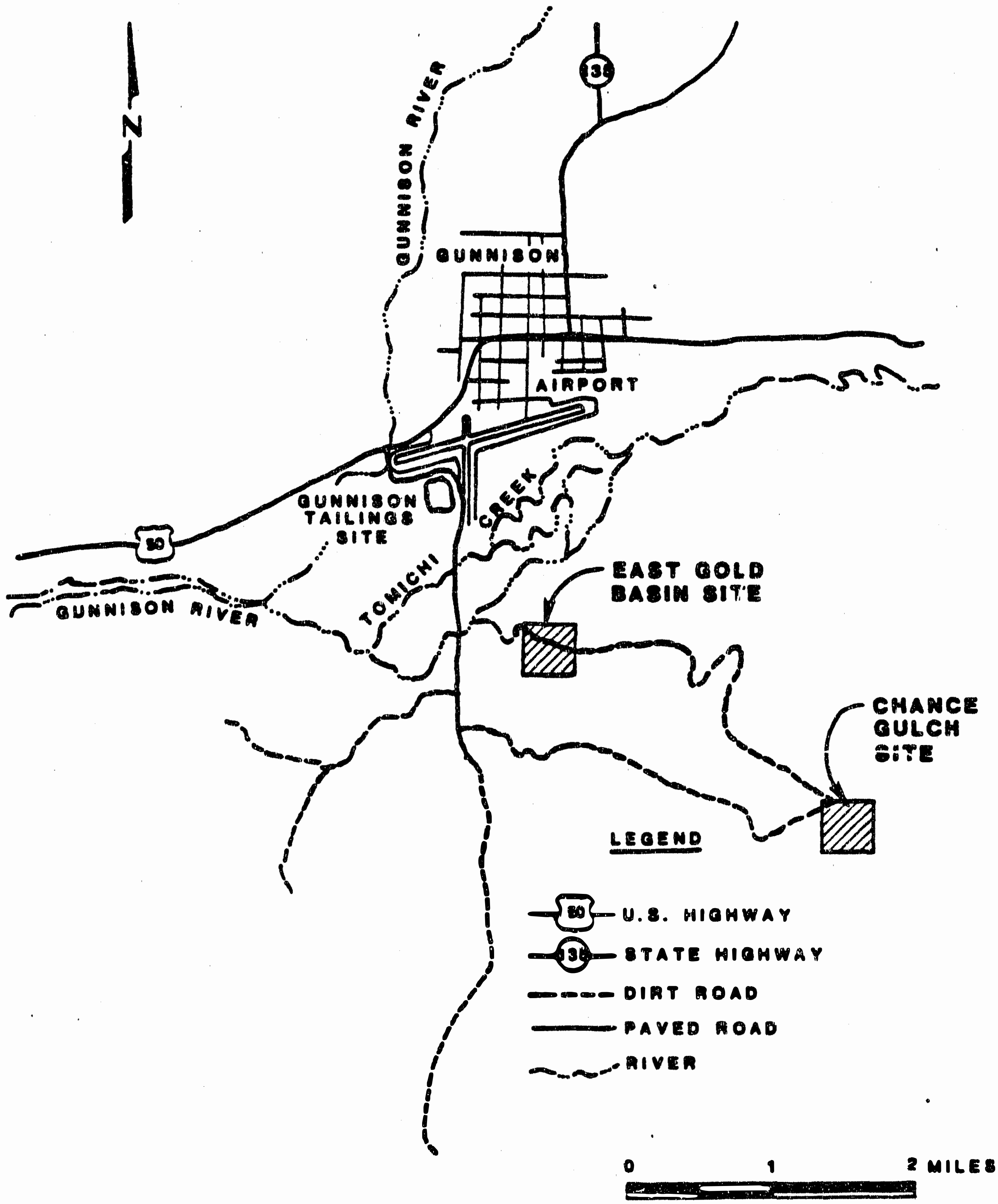
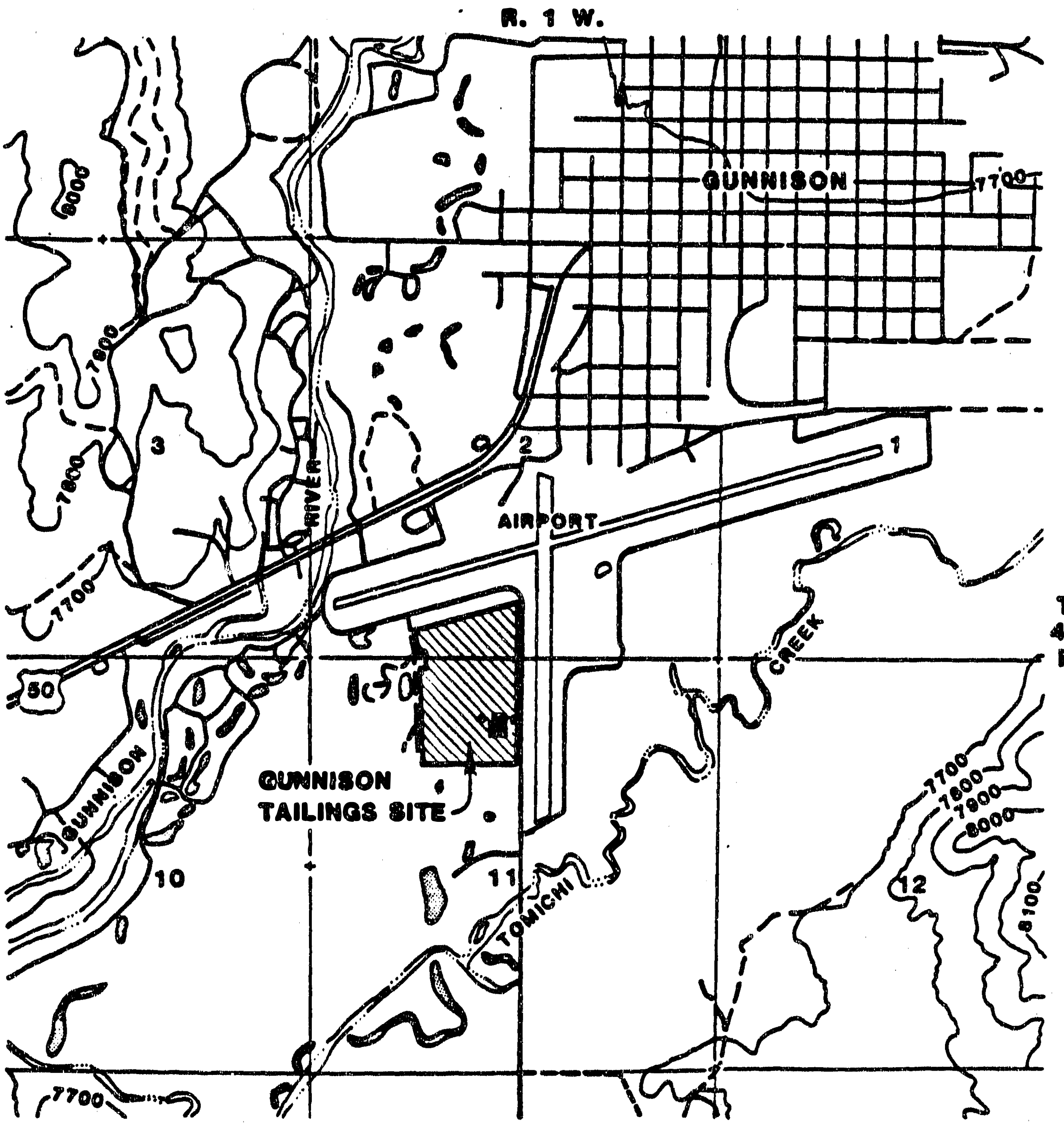



**FIGURE 3.1**
**LOCATIONS OF ALTERNATE DISPOSAL SITES**




**LEGEND**

PAVED ROAD

DIRT ROAD

EPHEMERAL STREAM

PERENNIAL STREAM

1000 0 1000 2000 3000

SCALE IN FEET

**FIGURE 3.2**
**SITE MAP**
**GUNNISON TAILINGS SITE**

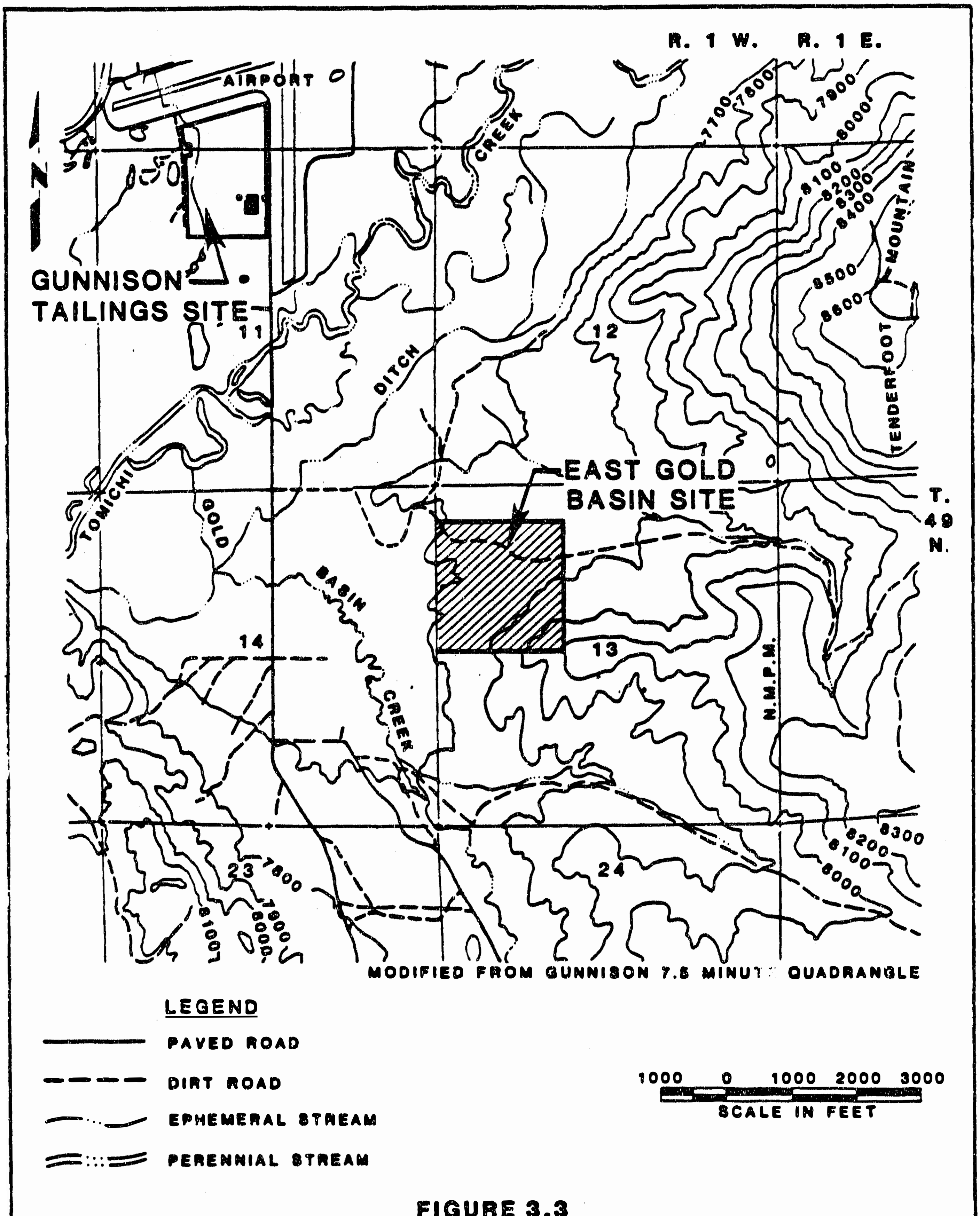



**FIGURE 3.3**
**EAST GOLD BASIN ALTERNATE DISPOSAL SITE**

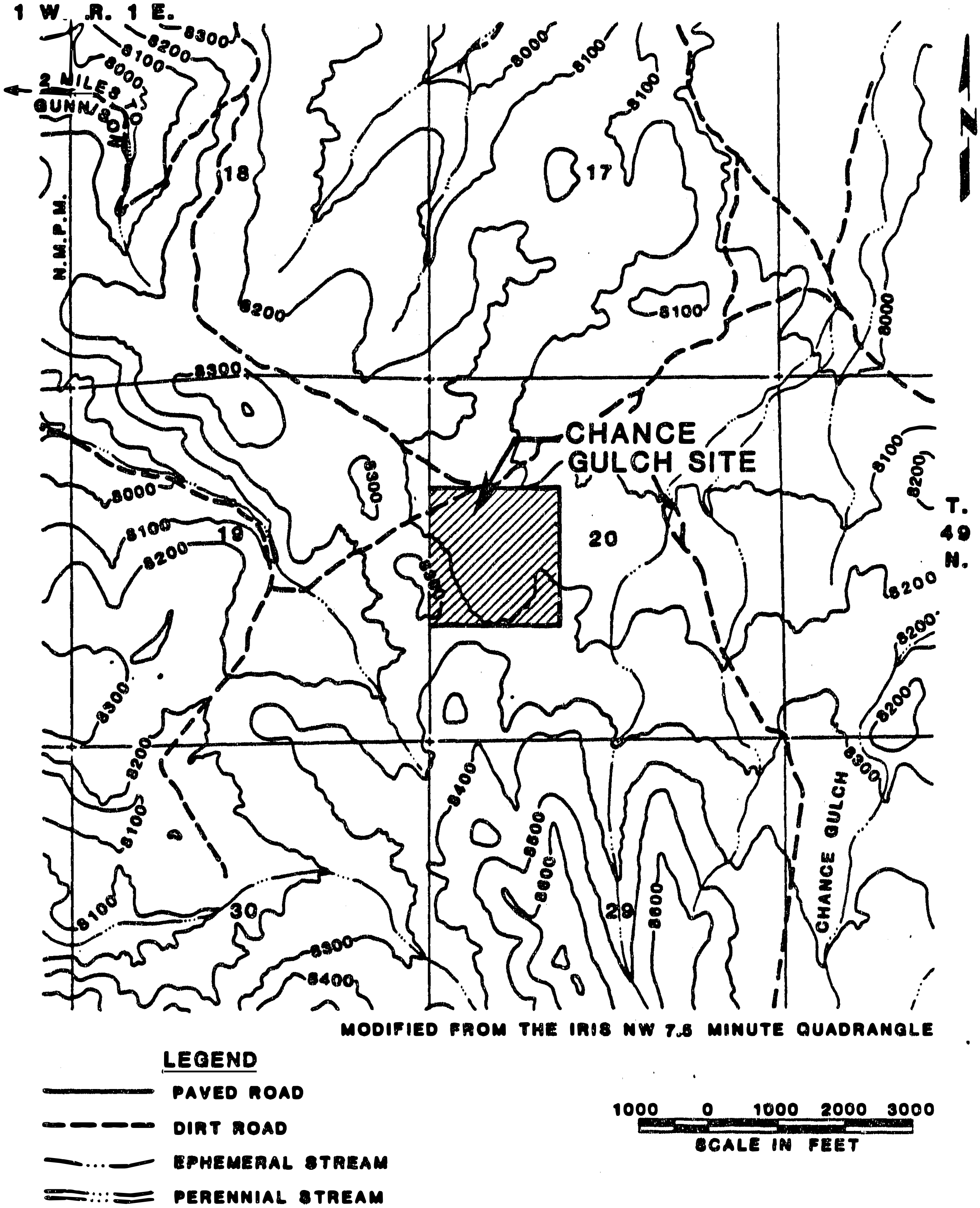



**FIGURE 3.4**
**CHANCE GULCH ALTERNATE DISPOSAL SITE**

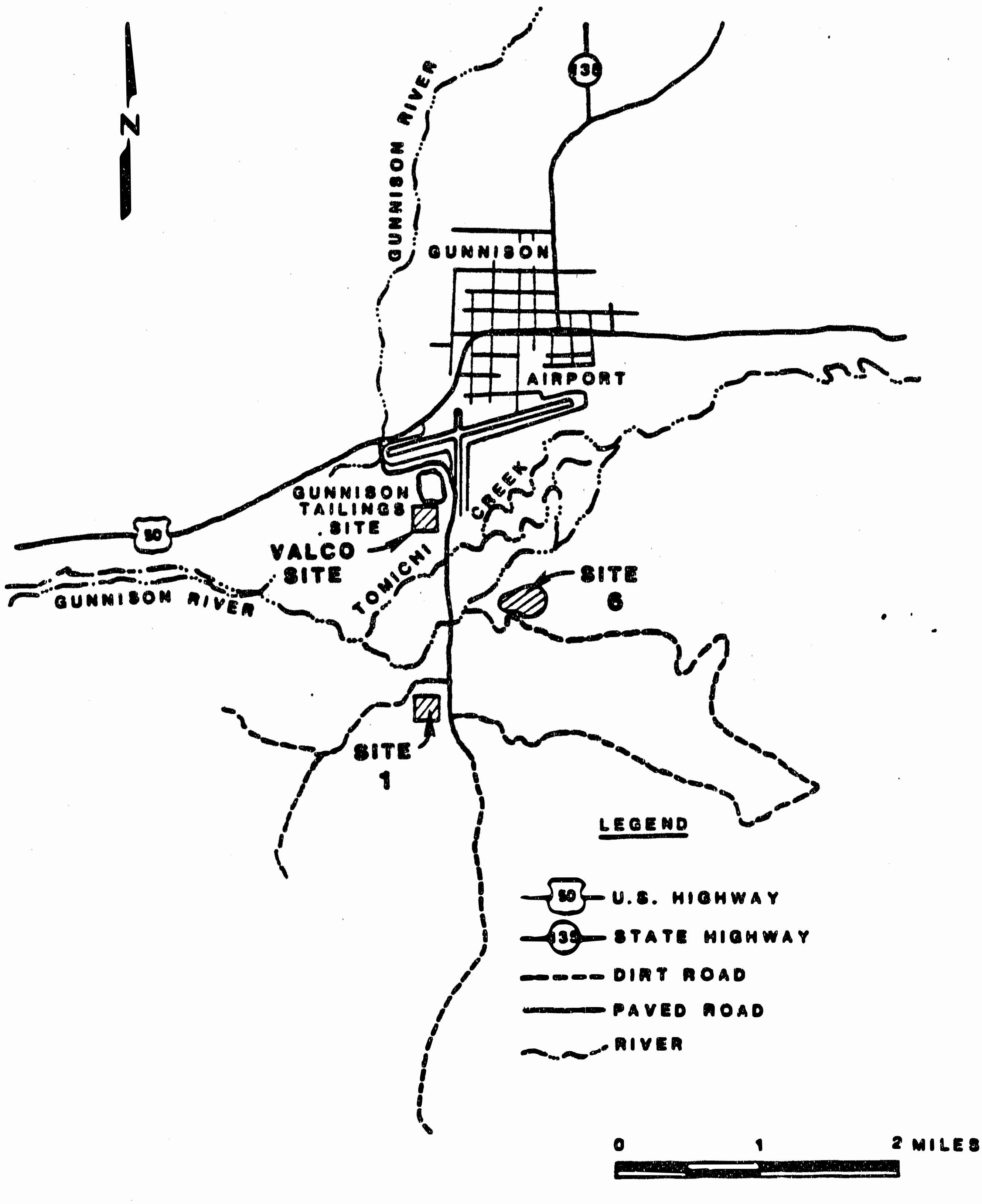



**FIGURE 3.5**
**LOCATION OF BORROW SITES**

Corporation operated the mill from December 1961 until its closure in April 1962. Ore was trucked to the mill from mines in the Cochetopa Pass area about 25 miles southeast of Gunnison (FBD, 1981).

The mill had a capacity of 200 tons of ore per day. The ore was ground and then leached with sulfuric acid and sodium chlorate. After leaching, the uranium-rich solutions and waste solids were separated by a four-stage, countercurrent classifier and thickener circuit. The uranium solutions were then treated by solvent extraction to concentrate and recover the uranium, and the solids were sent to the tailings pile (FBD, 1981). During its 4 years of operation, the mill processed about 540,000 tons of ore at an average grade of 0.15 percent $U_3O_8$ to produce 800 tons of uranium concentrate (yellow cake) (FBD, 1983b).

The tailings at the Gunnison site are in a rectangular-shaped pile that covers about 35 acres (Figure 3.6). The pile averages about 9 feet in thickness and contains approximately 492,000 cubic yards of tailings. The moisture content of the tailings averages about 12 percent, and the bulk density ranges from about 85 to 115 pounds per cubic foot (DOE, 1982).

The tailings pile has been contoured, covered with [0.5 foot] of material from a nearby gravel pit, and vegetated with a mixture of grasses. The vegetative cover was watered for several summers, and the vegetation is now sustained by natural precipitation. The top of the pile has a sparse cover of vegetation but is experiencing some sheet and rill erosion and minor gullying. The steeper side slopes are not as well covered with vegetation and have experienced a large amount of gullying. Stabilization of eroding areas was performed during a follow-up action in the summer of 1982.

Sixteen acres of land surface adjacent to the tailings pile have been contaminated by wind dispersion of the tailings. The 21 acres occupied by the mill buildings and former ore storage area are also contaminated. The total volume of contaminated material, including the tailings and underlying material and vicinity properties, is estimated to be about 812,000 cubic yards.

Of the original mill structures, only the metal mill building, an office building, and a steel water tower remain. The mill building is used for storage. The office building is leased to small businesses, and a mobile home next to the office building houses a caretaker. The water tower is no longer used. The entire designated site is enclosed by a five-strand, barbed wire fence posted with radiation warning signs. The fence is not intact at the northeast corner of the site.

## 3.3 WEATHER

The existing meteorology (temperature, precipitation, wind speeds, and direction) for the Gunnison area is described below.

The annual average rainfall between 1941 and 1970 was 11 inches with no one season of the year exhibiting a major portion of the precipitation

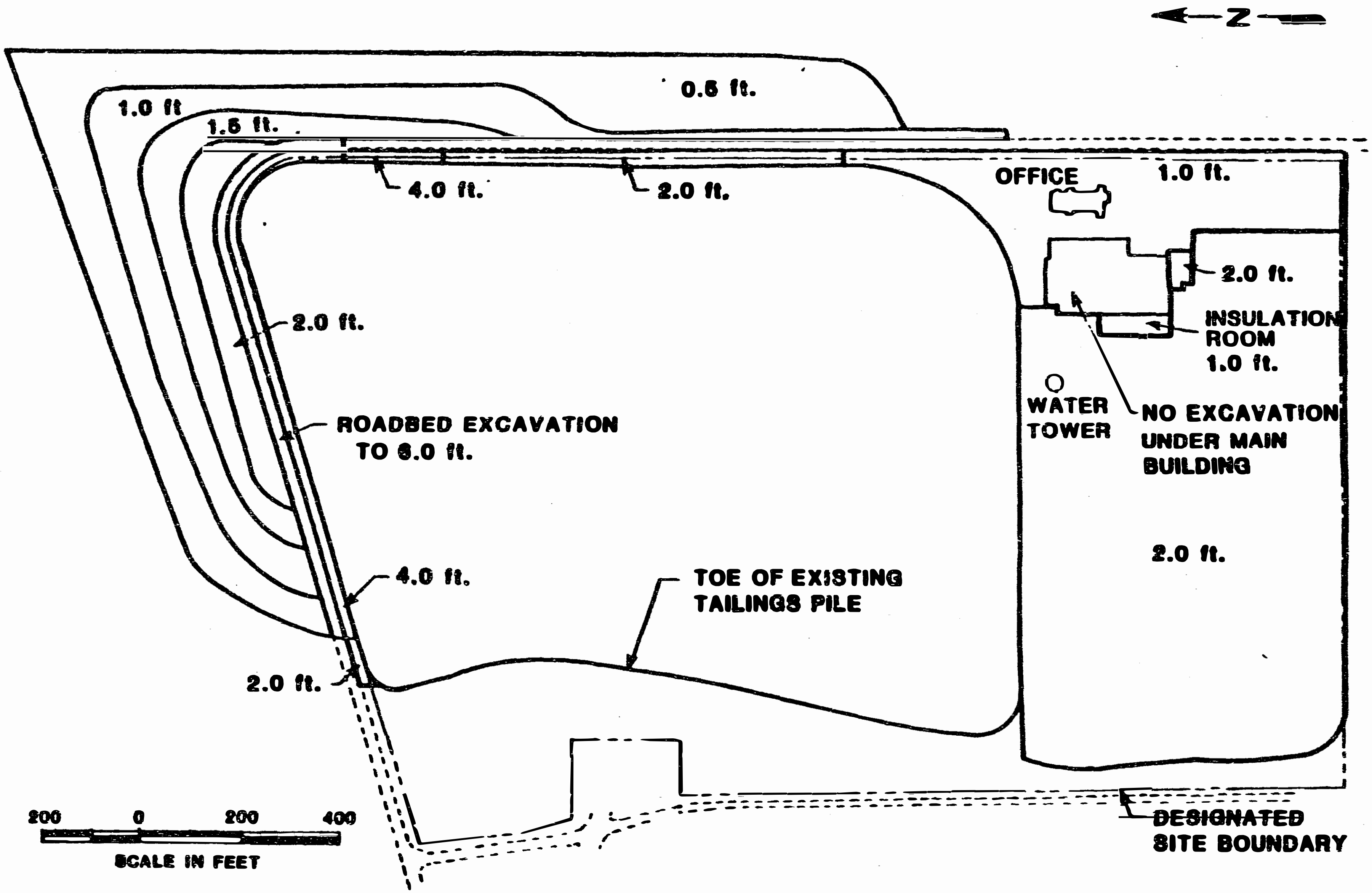



**FIGURE 3.6**
**PRESENT CONFIGURATION OF THE GUNNISON SITE**

(Appendix C). Snowfall was measured at Gunnison by the National Oceanic and Atmospheric Administration over a 23-year period from 1951 to 1973. The annual average snowfall during this period was 58 inches[,] with the major portion (88 percent) occurring in the period from November to March.

The project area is located at an elevation of approximately 7,700 feet. Winds in the upper Gunnison River basin are influenced by the local topography (e.g., mountains and valleys). However, the development of strong wind patterns typical of mountain-valley settings is somewhat lessened due to the relatively small size of the airshed. Wind measurements at the Gunnison County Airport (Appendix C) indicate that the annual wind flow is predominantly from the north, occurring 15 to 18 percent of the time with average wind speeds of 6 to 7 miles per hour (Isbill, 1980).

In addition to wind speed and direction, another indicator of the likely degree of [air] pollutant dispersion is the atmospheric stability class. The stability class is an indication of turbulence of the atmosphere and includes the wind speed as estimated at a height of 10 meters, the degree of solar radiation or, if during the nighttime, the cloud cover. There are six stability classes (A to F) with Class A being the most unstable and Class F the most stable. The most frequent stability class[es] for Gunnison are Classes D and E, which occur 33 and 23 percent of the time, respectively (AMAX, 1981).

Temperature, precipitation, and prevailing wind flows for the East Gold Basin and Chance Gulch alternat[e] disposal sites are [generally considered] to be similar to the conditions described above for the Gunnison tailings site, since the alternat[e] sites are located at approximately the same altitudes and situated in similar topographical settings. However, it is likely that some local variation[s] in wind flow patterns exist at each of the sites. The Chance Gulch site is located within the Tomichi Creek airshed which has an east-west orientation. It is expected that the Tomichi Creek topography serves to channel winds in an east and west direction. This contrasts with winds in Gunnison which are predominantly southwesterly [(]up-valley[)] during the day and northerly [(]down-valley)] at night. It is expected that winds at the East Gold Basin site closely approximate the wind regime in Gunnison since both are in north-south valleys.

## 3.4 AIR QUALITY

Of the air pollutants of regulatory concern (nitrogen dioxide, sulfur dioxide, carbon monoxide, TSP, ozone[,] and lead), only TSP levels are monitored in Gunnison. The annual geometric mean TSP level in 1980 was 63 micrograms per cubic meter (microg/m$^3$) which exceeded the Federal annual secondary standard of 60 microg/m$^3$. The Federal and state 24-hour TSP secondary standard of 150 microg/m$^3$ is not to be exceeded more than once per year. The second highest 24-hour level measured in Gunnison in 1980 was 98 microg/m$^3$, which is below the applicable standard. It is expected that ambient levels of criteria air pollutants other than TSP are well below applicable standards in the Gunnison area, particularly since few industrial sources exist.

Although no air[-]quality data exist for the East Gold Basin and Chance Gulch sites, it is likely that the air pollutant levels would be somewhat lower than levels at the current tailings site due to **[lower levels]** of man-made emission sources **[in the surrounding area.]**

## 3.5 SURFACE AND SUBSURFACE FEATURES

The Gunnison site lies west of the Continental Divide within the Southern Rocky Mountain physiographic province. The regional stratigraphy is characterized by sedimentary units which have been uplifted and intruded by molten and hardened base material. The topography was greatly influenced by glaciation during the Quaternary period, and is characterized by steep slopes, cirques, lakes, U-shaped valleys, and glacial moraines and outwash deposits. Major topographic features in the project area are the Gunnison River and Tomichi Creek which trend east to west, and the surrounding hills which rise to 1000 feet above the valley floor.

### Gunnison site

The existing tailings site is located on the floodplain alluvium of the Gunnison River and Tomichi Creek. The area was carved into deep valleys during the Pleistocene epoch and the valleys were subsequently filled to their present level with alluvium. The thickness of the alluvium underlying the tailings pile is estimated to be at least 200 feet, with local variations attributed to a buried paleo-valley or a Cenozoic Age fault (Cimarron Fault), or both. Boreholes drilled in the area have produced well logs to a depth of 150 feet without encountering bedrock. Cuttings logged during the drilling indicate a coarse textured alluvium, with particle sizes dominated by sands, gravels, and cobbles (FBD, 1983b).

The alluvial materials were deposited on Jurassic and Cretaceous Age sandstones and conglomerates. The bedrock geology consists of Precambrian igneous and metamorphic rocks overlain unconformably by a relatively thin sequence of sedimentary rocks. These strata include the Morrison Formation, the Dakota Sandstone, and the Mancos Shale (Figure 3.7). Overlying the sedimentary units and forming the surrounding hills are extrusive volcanic rocks of Tertiary Age, including the San Juan Tuff (FBD, 1983b).

Soils present beneath the tailings are cobbly sand[y] loam (Fola series) and loam (Irim series). Figure 3.8 contains a map of tailings area soils. The Fola cobbly sandy loam is a deep, well-drained soil formed on alluvial fans and terraces of mixed origin. The Irim loam is found on floodplains adjacent to the Gunnison River and its tributaries. The Irim loam has a fluctuating water table, with seasonal overflow and deposition of silt, sand, and gravel not uncommon. Both soils have little or no slope. Runoff is slow, and the erosion hazard is slight to none (SCS, 1975).

The Gunnison [site] is located in [S]eismic [R]isk [Z]one 1. Zone 1 areas have a low seismic risk in which the maximum predicted earthquake would result in only minor damage. During the period 1882 to 1982, the largest earthquake in the region occurred in 1901 at Buena Vista,

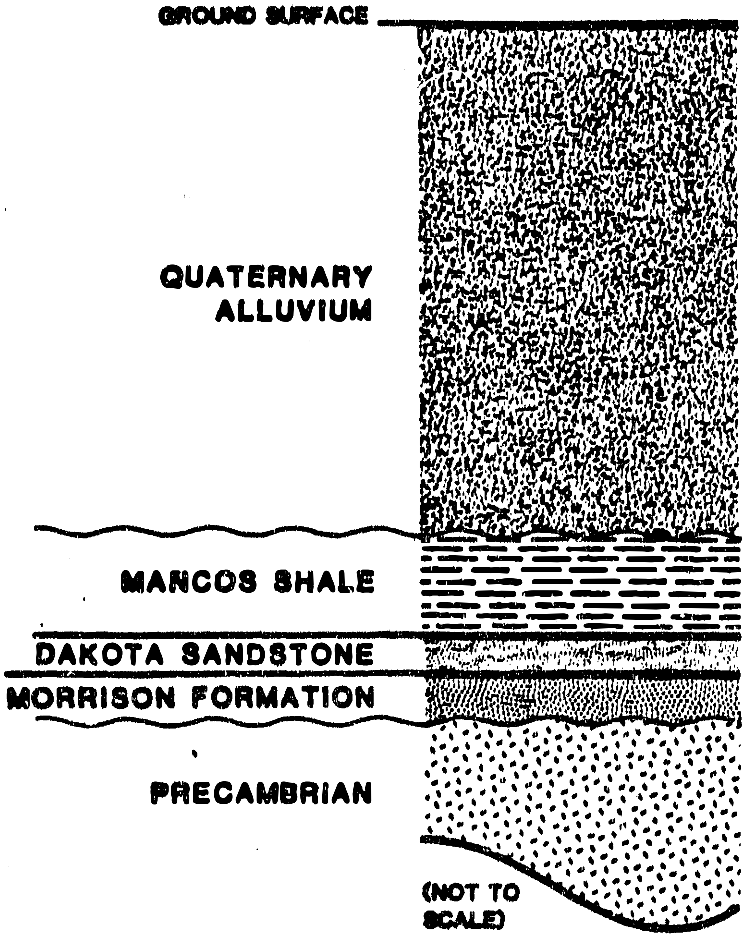



**FIGURE 3.7**

**GENERALIZED STRATIGRAPHIC COLUMN OF GUNNISON SITE AND VICINITY**

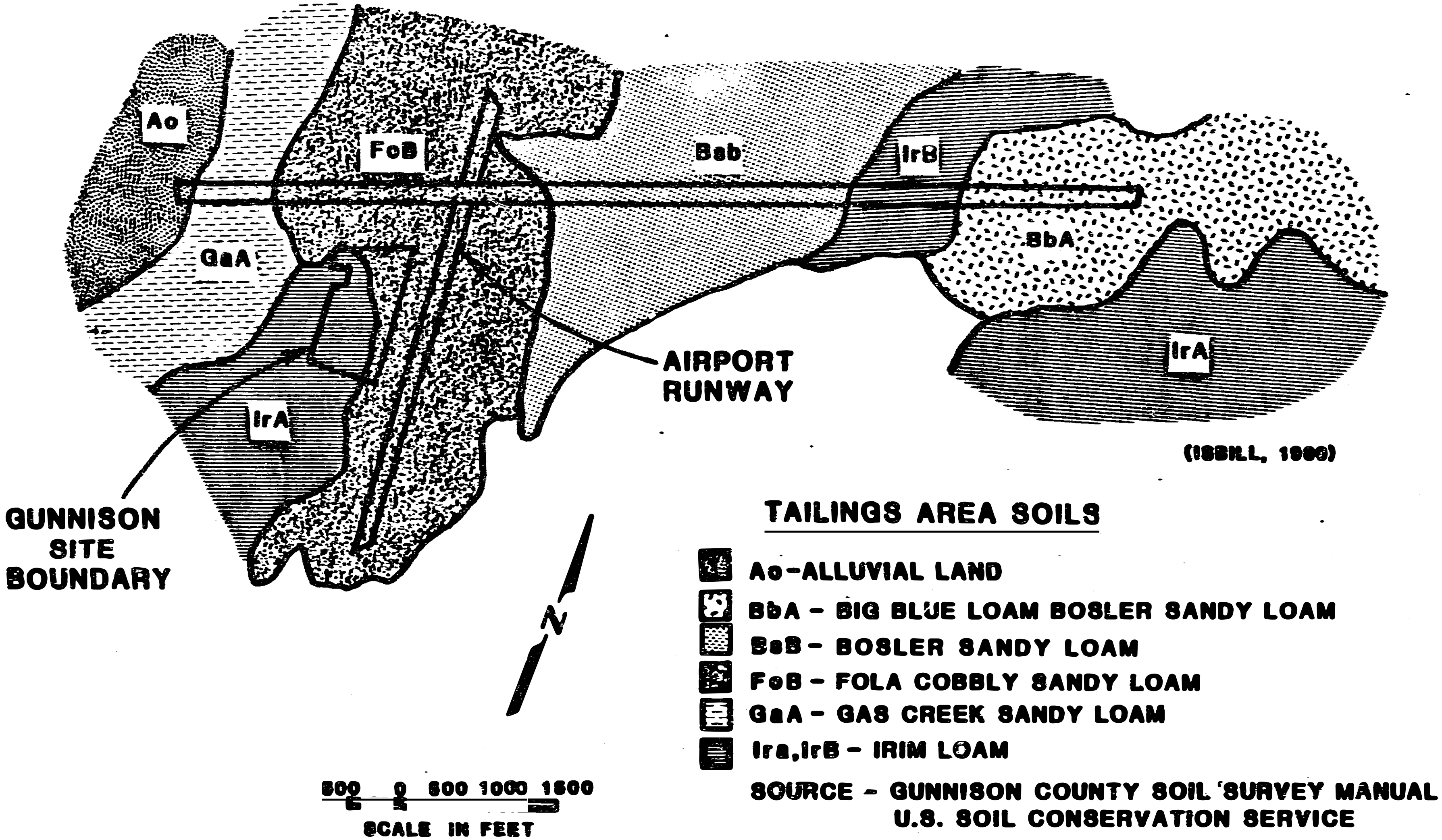



**FIGURE 3.8**

**SURFICIAL SOILS – GUNNISON, COLORADO AREA**

Colorado, 75 miles east of Gunnison (NOAA, undated). This earthquake was rated as a VII on the Modified Mercalli scale. The seismicity of the Gunnison River valley is believed to be controlled by the Cimarron Fault (DOE, 1983). This and several other large faults in the area have been mapped. The faults are inactive and are generally associated with the Laramide Orogeny which formed the Rocky Mountains 60 to 70 million years ago. Based on the current knowledge of the regional structural geology, the probable maximum horizontal acceleration at the epicenter of an earthquake would be expected to be five percent of the force of gravity (0.05 g) or less. This corresponds to a VII on the Modified Mercalli scale and magnitude 5.5 on the Richter scale. There is a 90 percent probability that an earthquake of this intensity would not be exceeded in 50 years. The Maximum Credible Earthquake was estimated to be 5.75 (Richter) and would generate a ground acceleration of 0.15g (SHB, 1983b).

Known mineral deposits in Gunnison County include coal, manganese, iron, silver, lead, gold, zinc, barite, nickel, copper, uranium, marble, and molybdenum (AMAX, 1981). In the vicinity of the tailings pile, however, only sand and gravel resources are present. An active sand and gravel operation is located adjacent to the south side of the tailings site. The deposits are generally saturated to within a few feet of the natural ground surface and are used extensively in the local area as a source of domestic and industrial water. The tailings pile covers similar sand and gravel deposits, and restricts access to them, but these deposits are widespread throughout the Gunnison valley.

## East Gold Basin site

The East Gold Basin disposal site is underlain by hundreds of feet of steeply dipping, Precambrian schists and gneisses. The 40-acre site, at an elevation of 7,800 feet, is at the head of a drainage basin in a bowl-shaped area that faces west and slopes gently at about a 10-percent grade.

Soils formed to a depth of 5 feet are channery loams (gravelly clay loam) of the Parlin-Hopkins series. This upland soil [is] formed from locally-transported material composed of loam with 30 percent long, flat stone fragments weathered from rhyolite and tuff.

The area is seismically stable, with little risk of an earthquake of large magnitude. An inactive Tertiary age fault has been identified 0.5 miles to the west. However, there is no evidence of faulting or significant seismic occurrences within the past 20,000 years (USGS, 1976). **[East Gold Basin is in Seismic Risk Zone 1.]**

There are no known commercially marketable resources at the East Gold Basin site. There are no mining claims on file for the East Gold Basin site.

## Chance Gulch site

The Chance Gulch disposal site is located in a large, open bowl that slopes gently to the north-northeast at about a 5 percent grade. The site is at an elevation of 8,150 feet. The floor of the basin and the south wall [are] composed of Precambrian metasedimentary rock. The three other sides of the basin are composed of a series of bedded gravels, volcanic flows, agglomerates, and tuff beds of Tertiary age. A notable feature of the unconsolidated deposits is the lack of gullying or channels resulting from the flowing water on the nearby flat surfaces or slopes underlain by the gravel.

The Parlin-Hopkins channery loam soil complex underlies the site and has developed moderately deep soils with accumulated thicknesses of over 5 feet. The area is not subject to flooding or landslides.

The Chance Gulch site is seismically stable. An ancient fault zone of Tertiary age exists about 2.5 miles to the northwest. Earthquakes of large magnitude and high intensity are not likely to occur and have not occurred in the area in recent times (20,000 years) (USGS, 1976). **[Chance Gulch is also in Seismic Risk Zone 1.]**

There are no mining claims on file for the Chance Gulch alternate disposal site.

Borrow sites

Three borrow sites are proposed as sources of materials for the remedial action [(Figure 3.5). At] borrow site 1[,] located 1.5 miles south of the existing tailings site[, d]eposits consist of silty clay with some gravel[. **Large riprap required for stabilization in place may be quarried from this site.** T]he moisture content is estimated at 13 percent. [At] the commercial sand and gravel operation owned by Valco, Inc., located immediately south of the existing tailings site, deposits consist of mixed alluvium overlain by loam; moisture content varies seasonally. Borrow site 6 is located 2 road miles southeast of the tailings site. Deposits consist of clayey sand and silty sand; the moisture content is undetermined.

## 3.6 WATER

Section 3.6.1 describes surface-water occurrence, flow patterns, quality, and use for the Gunnison site, the alternat[e] disposal sites[,] and [the proposed] borrow sites. Section 3.6.2 describes ground-water occurrence, quality, and use for each of the sites. Additional details are contained in Appendix D.

### 3.6.1 Surface water

[All of] the [disposal] sites lie within the Gunnison River/Tomichi Creek drainage basin near the confluence of the two sub-basins (Figure 3.9). The Gunnison River has a drainage basin of 1,012 square miles above its confluence with Tomichi Creek and has an average flow of about 700 cfs. The maximum recorded flow for the period of record is 11,400 cfs in 1918 (Appendix D). Tomichi Creek has a drainage basin of 1,061 square miles above its confluence with the Gunnison River and has an average annual flow of about 160 cfs. A maximum flow of 1900 cfs was recorded in 1957

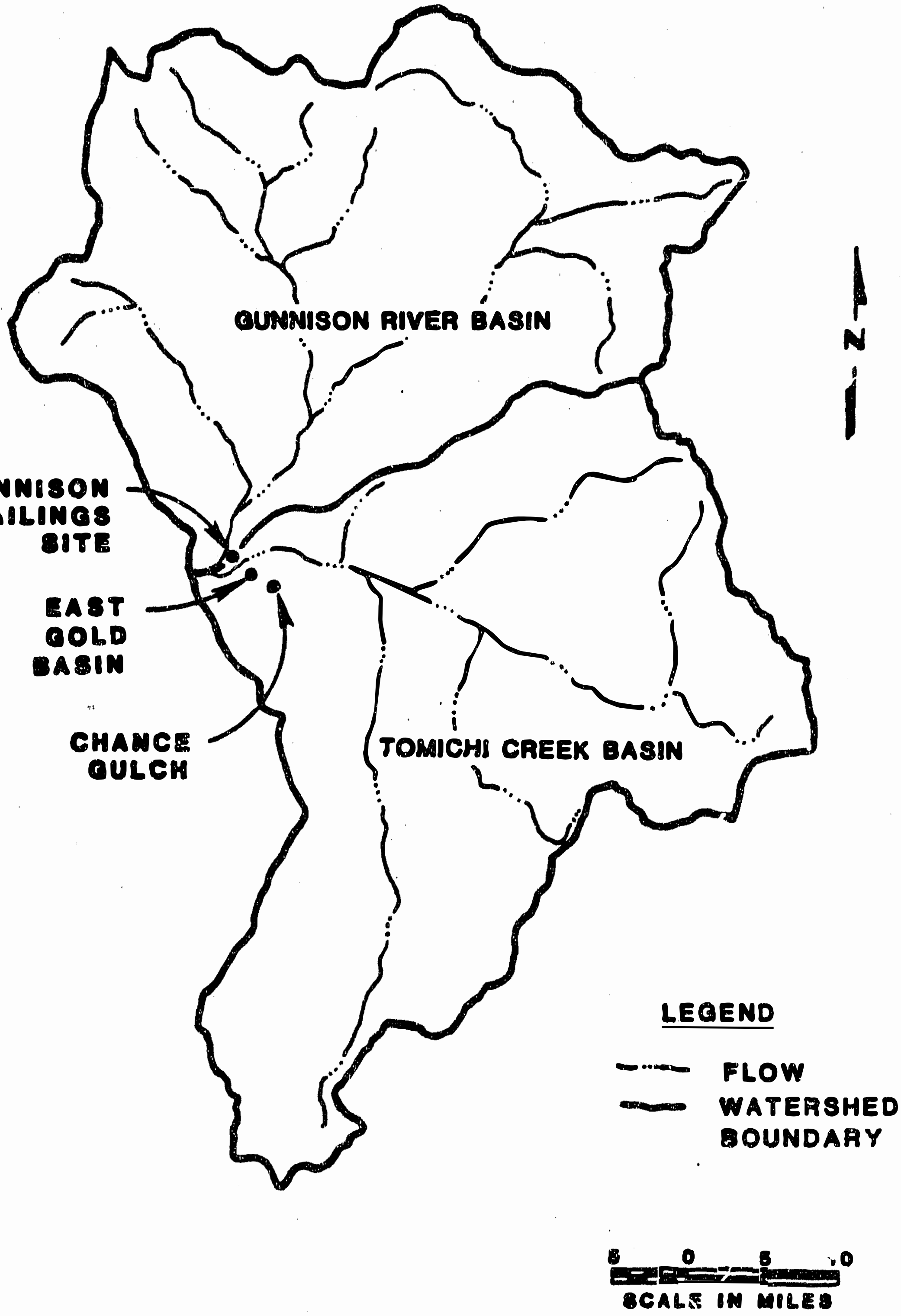



**FIGURE 3.9 GUNNISON RIVER BASIN MAP**

(Appendix D). **[Analysis indicates that the maximum PMF flowrate on the Gunnison River is 205,000 cfs and on Tomichi Creek the maximum PMF flowrate is 169,000 cfs.]**

Convective type thunderstorms occur extensively over the Gunnison River basin during the summer months. The aerial extent of such storms is generally limited and does not cause peak flows in the basin. Snowmelt generally occurs during the April-June season, a period during which precipitation is low at most weather stations. However, occasional general storms can occur during this period of time. Precipitation during these general storm periods will be of an orographic type, with higher elevations receiving the heaviest precipitation. Storms of a tropical origin occasionally cause very heavy precipitation. However, these types of storms are restricted to the fall period and have not caused peak flows in the basin. An inspection of the records indicate that maximum flows occur in the Gunnison River basin during the spring snowmelt period and are occasionally augmented by rainstorms (ECI, 1976).

Gunnison site

The Gunnison site lies in the Gunnison River basin, 0.4 mile east of the Gunnison River, 0.4 mile northwest of Tomichi Creek and 1.5 miles above the confluence of the two. Drainage across the site is to the south and east, towards Tomichi Creek. The site is bounded on the west by small storm drainage ditches and on the south and west by an irrigation ditch.

The water uses established for the Gunnison River and Tomichi Creek by the Colorado Water Quality Commission include recreation, fishery operation, and irrigation. The Gunnison River is classified for use as a Class 2 recreation water (other than whole body contact), a cold water fishery, and water supply and agriculture diversion both above and below the mill site. Tomichi Creek is classified for use as a Class 2 recreation water, a cold water fishery and for agriculture diversions from its source to its confluence with the Gunnison River.

At the present time, there is no evidence to indicate that surface water quality in the Gunnison River and Tomichi Creek have been affected by contaminants from the tailings. Appendix D contains additional details.

**[Flooding is a primary hazard to the long-term integrity of this site. If the PMF were to occur, over 80 percent of the Gunnison River flow would overflow the bank towards Tomichi Creek and would surround the embankment. Because of the morphology, this increases the probability that the Gunnison River main channel could shift laterally towards the embankment. If this were to occur, the flow could impact on the pile with velocities and scour depths that would either seriously damage the cover system or undercut the embankment causing it to fail.]**

## East Gold Basin site

The East Gold Basin site is located on the western slope of Tenderfoot Mountain at the head of a small hollow. The site drains to Gold Basin Creek which is more than 1000 feet to the west and approximately 40 feet lower than the lowest portion of the site. Tomichi Creek is 3000 feet to the north and over 60 feet lower than the site. Neither of these streams would have an impact upon the site. A small area of approximately 25 acres drains toward the site. This area is well vegetated and contributes little overland flow toward the site.

No surface-water quality data are available for Gold Basin Creek or other intermittent streams in the area. Also, no data are available for any uses of these intermittent streams.

## Chance Gulch site

The Chance Gulch site is located on a gentle slope near a ridge which separates the Chance Gulch drainage basin from Gold Basin Creek, located more than 2 miles west of the site on the opposite side of the drainage divide. The closest major drainages are 2,000 feet east and west of the site. The drainage to the west is beyond the ridge and the one to the east is approximately 40 feet lower than the site. An area of approximately 50 acres drains towards the site. This area is well vegetated and contributes little overland flow toward the site.

Two springs occur immediately north of [the site] and at a elevations lower than the site. These springs appear to be fed by snowmelt and thus flow only in the spring and early summer.

No surface-water quality data are available for the intermittent streams in the area. However, the two springs were sampled once by the USGS in 1976 and found to have potable water quality (Giles, 1980). No data are available on the use of these drainages other than the minor drainage contribution they make to the Tomichi Creek Basin.

## Borrow sites

Borrow sites have been identified immediately south of the Gunnison site (Valco borrow site), about 1.5 miles south of the Gunnison site (borrow site 1) and just north of the East Gold Basin site (borrow site 6).

The Valco site has two main pits adjacent to Tomichi Creek. The bottoms of these pits are below the streambed elevation of Tomichi Creek and intercept the ground water. The current levels of water in these pits are primarily the result of ground-water discharge. As each pit is worked, water is pumped into the adjacent pit for discharge into Tomichi Creek. Elevated levels of uranium and $SO_4^{2-}$ have been detected in samples taken from these pits (Appendix D).

Borrow sites 1 and 6 are the in vicinity of the intermittent streams around the East Gold Basin site. Surface water occurs only during rainfall and snowmelt. No major drainages occur on these sites. No data on historical flows or water quality are available.

### 3.6.2 Ground water

#### Gunnison site

[The largest user of ground water in the area is the City of Gunnison. Gunnison's municipal supply consists entirely of ground water withdrawn from nine wells completed in the alluvial deposits along the Gunnison River. These wells range in depth from 34 feet to 108 feet and all are upgradient of the tailings pile (Water Resources Consultants, Inc., 1981). The city well nearest the pile is approximately 1300 feet north-northeast of the pile's northeast corner.

During the period 1967 through 1980 the city pumped an average of 1257 acre feet per year (af/yr). Annual pumpage increased from 996 af/yr in 1967 to 1623 af/yr in 1983. The greatest withdrawal occurs in June, the least in December (Water Resources Consultants, Inc., 1981).

The city does not supply water outside of the city limits and most people rely on shallow domestic wells completed in alluvium along the Gunnison River and its tributaries. There are approximately 80 private domestic wells south and west of the pile between Tomichi Creek and the Gunnison River. The tailings pile is actively producing contaminants which affect the quality of water produced by these wells. Details of the effect of the pile on the quality of water produced by these wells is discussed in Section D.2.3.4.

The mill site rests upon an aquifer which is formed by the confluence of two aquifers: the alluvial deposits along the Gunnison River, and the alluvial deposits along Tomichi Creek (Figure 3.10). The aquifer is composed of poorly sorted boulder to clay-sized particles (CSU, 1983), and is at least 100 feet thick near the site (FBD, 1983b). Water levels fluctuate from near ground surface to about 10 feet below ground surface. Peak levels occur in the summer and the bottom of the pile may become saturated at this time (CSU, 1983).

It is assumed that most of the water flowing beneath the site originates as mountain front recharge along the Gunnison and Tomichi aquifers. During periods of high stream flow, portions of the aquifer adjacent to the Gunnison River and Tomichi Creek receive some water directly from the streams. Other sources of recharge may be leakage from canals and the sewage treatment plant north of the pile and, percolation of precipitation. The aquifer probably discharges to the Gunnison River and Tomichi Creek. This will be determined after data from the additional monitor wells are analyzed.

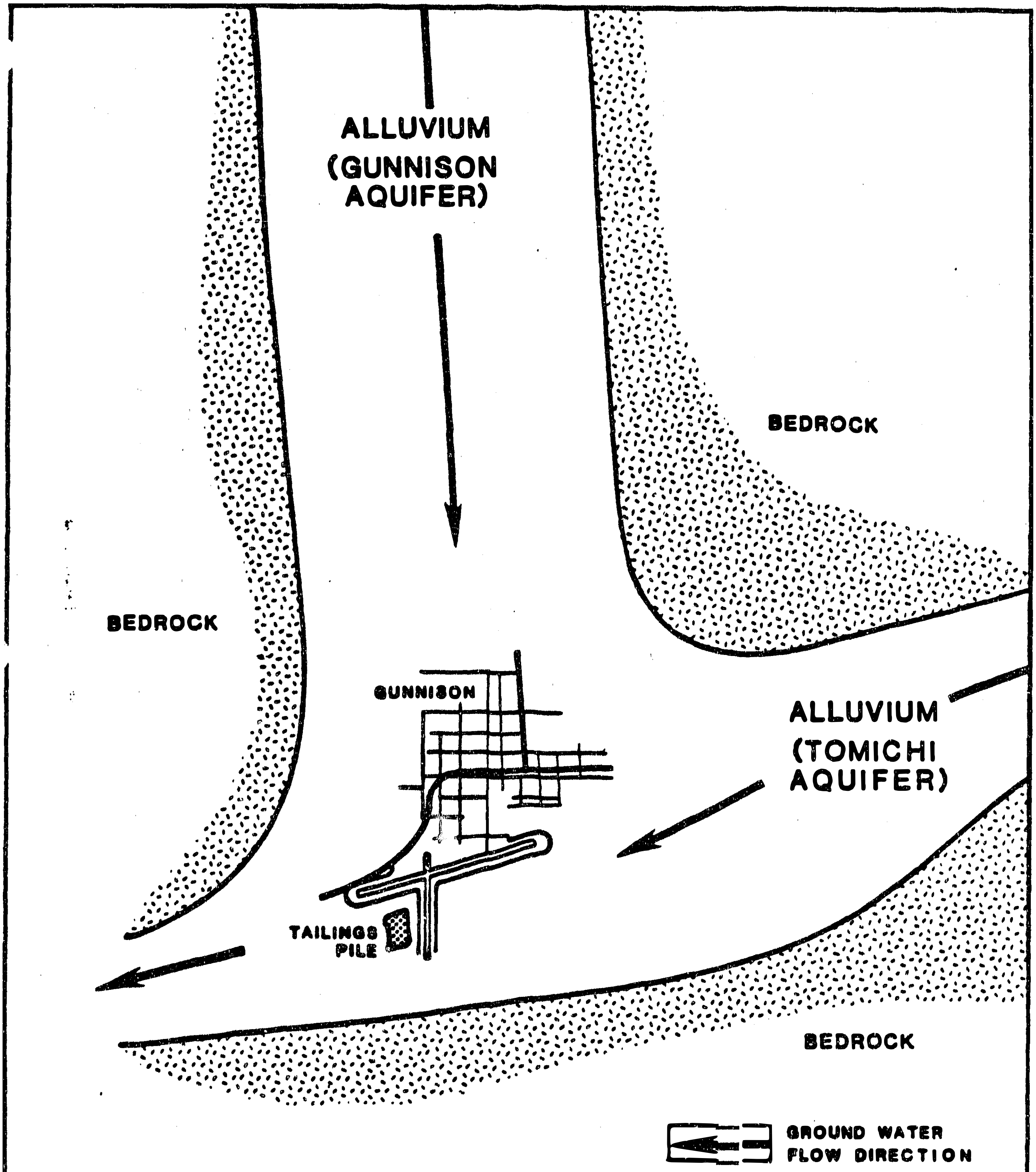



**FIGURE 3.10**
**SCHEMATIC REPRESENTATION OF PRINCIPLE AQUIFERS NEAR GUNNISON**

The general flow direction beneath the site is to the south-southwest (Figure 3.11). However, anisotropies caused by buried stream channels may divert some flow from the general direction (FBD, 1983b; SHB, 1983a). Flow velocities range from 180 feet/year to 3100 feet/year (DOE, 1984).

The quality of the ground water, unaffected by the tailings pile is summarized in Table 3.1. The water is generally potable; however, there are exceptions. First, high concentrations of iron (Fe) are found in many parts of the aquifer. Second, hydrogen sulfide ($H_2S$) is found in a reducing zone along the Gunnison River. The Fe and $H_2S$ occur naturally. Finally, high concentrations of nitrate ($NO_3^-$) are found near the pile. As discussed in Appendix D, the tailings pile is not the source of this contamination.

The pile is composed of interbedded sand and slime tailings and is covered with about 6 inches of sandy clay and gravel. On the average, the pile is about 50 percent saturated with tailings pore solution (CSU, 1983). The tailings pore solution contains high concentrations of uranium (U), sulfate ($SO_4$), Fe, and heavy metals (Table 3.2). These contaminants may be transported from the pile by two mechanisms. First, precipitation may percolate through the top of the pile. As precipitation moves downward through the tailings, it will carry contaminants into the underlying ground water. Second, ground water may move up into the base of the pile during periods of high water. The ground water in contact with the tailings will become contaminated.

One or both the transport mechanisms is operating at Gunnison and the pile is contaminating the ground water. A plume containing concentrations of U and $SO_4$, well above background levels extends about 8000 feet from the southern boundary of the pile (Figures 3.12 and 3.13). The plume is discharging to Tomichi Creek and the Gunnison River.]

East Gold Basin site

The bedrock beneath the East Gold Basin site consists of fractured Precambrian schist and gneiss. This bedrock underlies approximately 5 feet of loam (FBD, 1983b). No data are available regarding the ground water flow regime or quality at this site. However, due to the absence of springs and other surface water in the immediate vicinity of the site and the topographically elevated position of the site, the occurrence of shallow ground water is unlikely.

Chance Gulch

The bedrock beneath the Chance Gulch site is volcanic tuff which underlies loam soils and Quaternary alluvium. Two springs occur at the interface of the bedrock and unconsolidated materials immediately north and downslope of the Chance Gulch site (CDM, 1981).

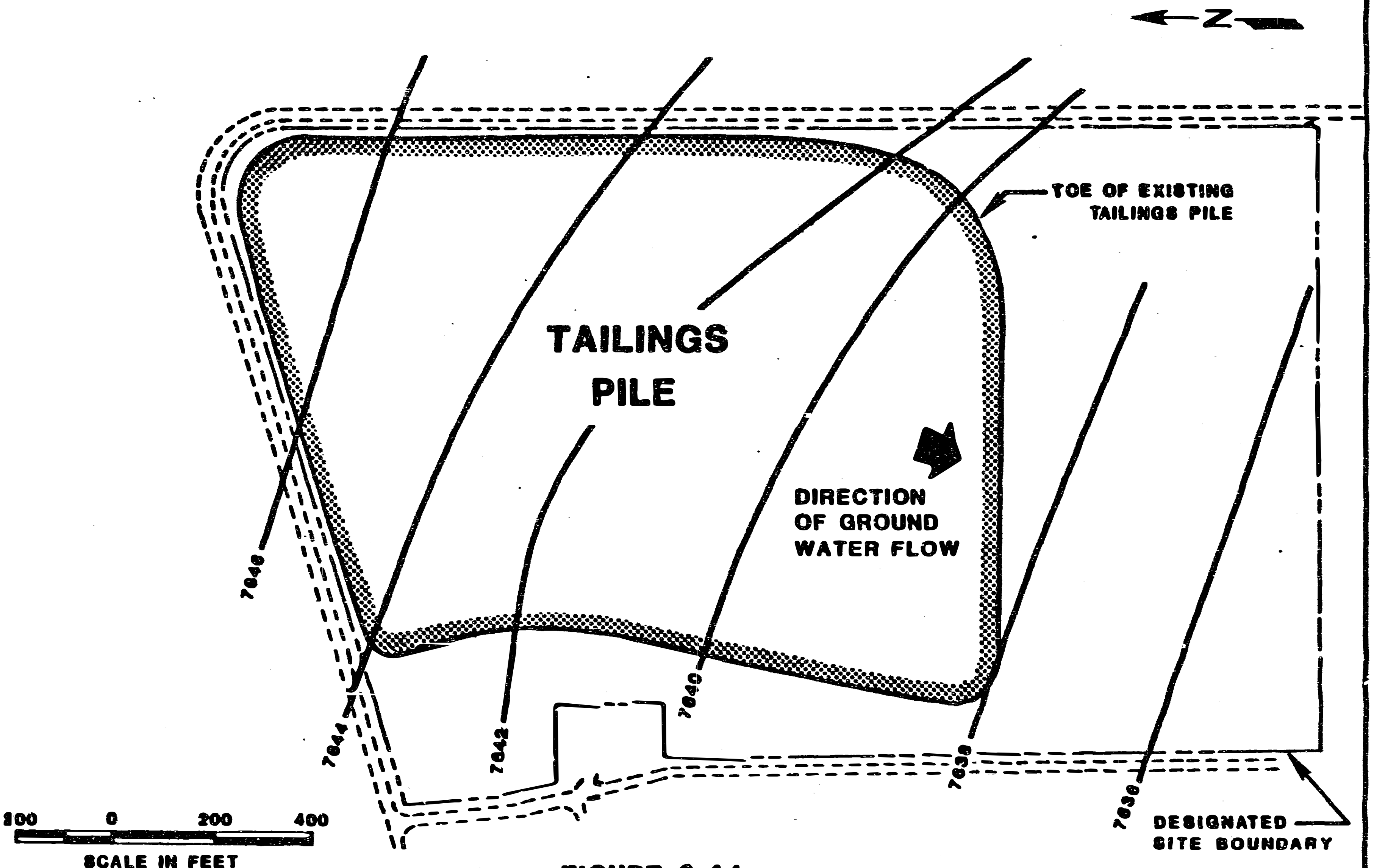



FIGURE 3.11
GROUND WATER ELEVATIONS (FASL)
9-83 DATA: 35 MEASUREMENTS

Table 3.1 Ground-water quality in the Gunnison area

| Constituent | Concentration (mg/l)[a] | Standard (mg/l)[b] |
|---|---|---|
| $SO_4$ | 44.0 | 250 (RCL) |
| Fe | 3.3 | 0.3 |
| $H_2S$ | --- | 0.05 (MPC) |
| $NO_3$ | 115 .0 | 45.0[c] |
| As | Not detected | 0.05[c] |
| Ba | 0.28 | 1.0[c] |
| Cd | Not detected | 0.01[c] |
| Cr | Not detected | 0.05[c] |
| Mo | 0.003 | 0.05 |
| Pb | 0.012 | 0.05[c] |
| Se | Not detected | 0.01[c] |
| U | 0.008 | --- |

NOTES:
RCL = Recommended concentration limit.
MPC = Maximum permissible concentration.

[a]Highest concentration found in any of 19 samples representing background conditions.

[b]EPA, 1979. Recommended concentration limits are based on aesthetic considerations. Maximum permissible concentrations are based on health considerations.

[c]Colorado Department of Health, 1981. Colorado has no drinking water standards for the other constituents listed.

Table 3.2 Constituents found in water extracts of tailings

| Constituent | Concentration (mg/l)[a] |
|---|---|
| [$SO_4$ | 221,000 |
| Fe | 110,000 |
| As | 00.1 |
| Ba | 0.3 |
| Cd | 0.85 |
| Cr | 0.01 |
| Mo | 0.01 |
| Pb | 2.2 |
| Se | 0.08 |
| U | 50 |

[a]Sample from North West suction sampler depth equals 4 feet.]

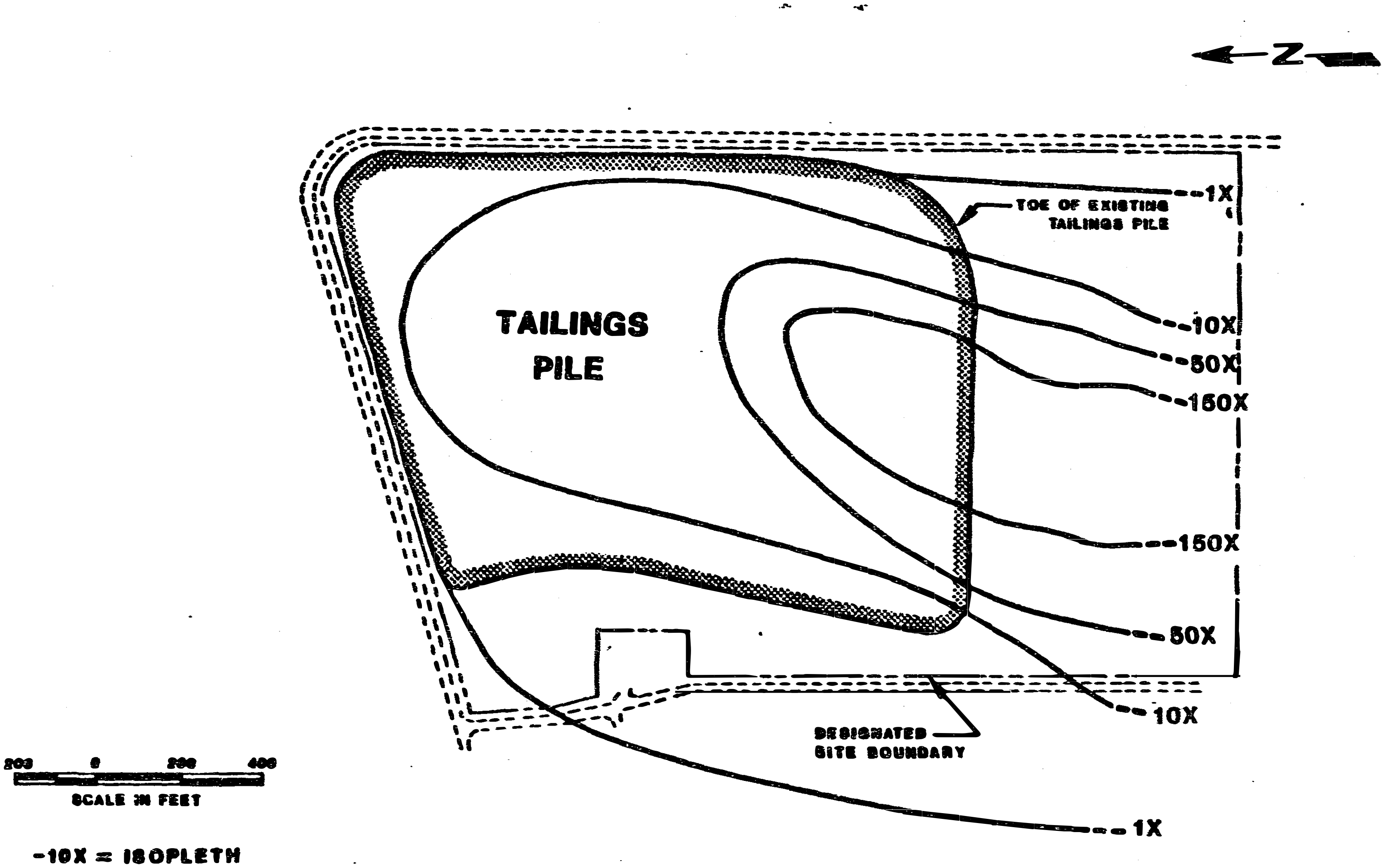



**FIGURE 3.12**
**URANIUM PLUME NEAR PILE**
**U AS MULTIPLE OF HIGHEST BACKGROUND CONCENTRATION (0.008 mg/l)**
**DATA: 63 SAMPLES FROM 48 WELLS**

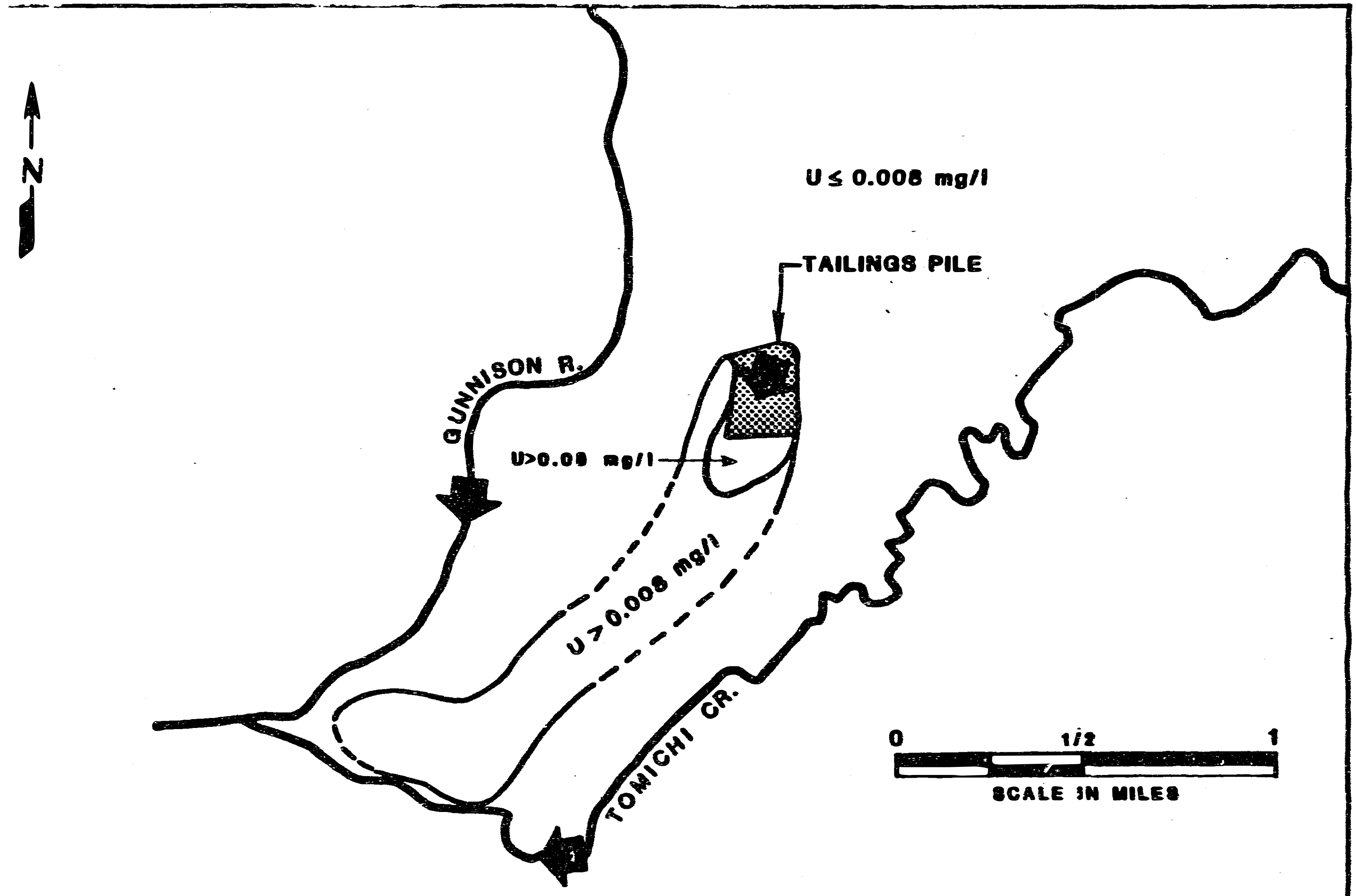



**FIGURE 3.13**
**URANIUM PLUME, APPROXIMATE AREA WHERE URANIUM CONCENTRATIONS ARE GREATER THAN HIGHEST BACKGROUND CONCENTRATION (0.008 mg/l)**

The two springs were sampled in Chance Gulch. The pH of one of the springs was 9.1, which exceeds the EPA drinking water standard for pH.

## 3.7 ECOSYSTEM[S]

### 3.7.1 Ecosystems

Regional

The vegetation at the Gunnison site and the alternate disposal sites is characteristic of the upper sagebrush zone that occurs throughout western Colorado. The Gunnison River basin typically contains big sagebrush shrubland, or black sagebrush shrubland with pasture and hay fields along the Gunnison River and Tomichi Creek (BLM, 1980; CDM, 1981).

Appendix E contains listings of the plant and animal species that occur or have been observed in the vicinity of the Gunnison and alternat[e] disposal sites.

Gunnison site

The Gunnison site has been extensively disturbed by the milling operations and many of the plant species are of the primary succession type which invade disturbed areas. There are also some plant species which were introduced during previous attempts to stabilize the tailings pile, and still other plant species that are native to the area and are found in undisturbed locations. Along the irrigation ditches adjacent to the site are aspen and cottonwood trees (FBD, 1983b).

Mammals that occur in the vicinity of the site include the prairie dog, skunk, cottontail rabbit, jackrabbit, red fox, coyote, and small mammals such as the long-tailed mole and chipmunk. Deer and elk graze in the hay fields of the Gunnison River valley during the winter. No deer or elk have been observed near the Gunnison site in recent years due to development and agricultural use (Isbill, 1980).

The area between the Gunnison River and Tomichi Creek is a relatively rich riparian habitat. Gunnison County is located along the central alignment of the Rocky Mountain Flyway, and migrating waterfowl use the Gunnison River and Tomichi Creek during the fall and spring. There are a number of bird species which breed in the sagebrush shrubland and those areas that border the range of shrublands (CDM, 1981).

[O]nly a few reptile species inhabit the sagebrush community within Gunnison County. These include the short horned lizard, sagebrush lizard, and the fence lizard. The garter snake is likely to occur in irrigation ditches adjacent to the site. These ditches could also provide breeding habitats for various amphibians found in the area.

### East Gold Basin site

This area is used primarily for livestock grazing. The major range types are dry mountain loam and mountain swale. The area is sagebrush shrubland with characteristic plant associations. Big sagebrush is the dominant species (BLM, 1980).

Mammals typical of the sagebrush steppe that occur on or near this site would be the jackrabbit, cottontail rabbit, deer mouse, chipmunk, long-tailed weasel, coyote, and skunk. The mule deer and elk are winter inhabitants of the area and graze in the sagebrush. Several bird species are found in the sagebrush shrubland. Some species breed exclusively in the sagebrush while others breed in the sparse understory or upon bare ground within the sagebrush community (CDM, 1981). Reptile species diversity is low, and the absence of standing water precludes amphibians from inhabiting this site.

### Chance Gulch site

This area is used primarily for livestock grazing. The major range types are dry mountain loam and mountain swale (BLM, 1980). This area is dominated by big sagebrush shrubland with associations of rabbitbrush and snakeweed (CDM, 1981).

The terrestrial fauna are typical of the sagebrush steppe ecosystem.

### Game species

The game species which could inhabit the alternative disposal sites include elk, mule deer, jackrabbit, cottontail, mourning dove, and sage grouse. The crucial winter range for elk and mule deer is north of State Highway 50 (BLM, 1980; CDM, 1981) and to a limited extent, the hay fields just south of Highway 50 (CDM, 1981). The crucial range is a little over three miles from any of the alternate disposal sites. The sagebrush shrubland of the East Gold Basin and Chance Gulch sites are used lightly by big game during the winter months (CDM, 1981).

Sage grouse is the most sensitive of the game species found in this area. This bird species breeds exclusively in the sagebrush shrubland and resides throughout the year in the Gunnison River valley. Nesting usually occurs within a three-kilometer area of a lek [(courtship assembly grounds)] and there are known sage grouse leks within the area around the Chance Gulch and Gold Basin sites. This area is thought to have the highest concentration of leks in the Gunnison River valley (CDM, 1981).

## 3.7.2 Threatened and endangered species

No known threatened or endangered wildlife species inhabit the Gunnison or alternate disposal sites. There are a number of species that could possibly use this type of habitat (Table 3.3)

Table 3.3 Federal [and Colorado] threatened and endangered species with potential habitat [at] migration patterns through the Gunnison area

| Wildlife list[a] | Scientific name | Common name |
|---|---|---|
| [C, F | Falco peregrinus anatom | Peregrine falcon |
| C | Grus canadensis fabiba | Greater sandhill crane |
| C,] F | Haliaectus leucocephalus | Bald eagle |
| [C, F | Canis lupus | Grey wolf |
| C | Gulo gulo | Wolverine |
| C | Lutra canadensis | River otter |
| C | Lynx canadensis | Lynx |
| C, F | Mustela nigripes | Black-footed ferret |
| C, F | Ursus arctos | Grizzly bear] |

| Plant list[a] | Scientific name | Common name |
|---|---|---|
| F | * Astragalus microcymbus | Skiff milkvetch |
| [C | * Arabis gunnisoniaria | Rockcress] |

NOTES:

[a]List

F = Federal (U.S. Fish & Wildlife "Federal Endangered Species Act" of 1973) (USFWS, 1973).

[C = Colorado (Colorado Department of Natural Resources "Non-game and Endangered Species Conservation Act" of 1973) (CDNR, 1973).]

at various times of the year, but the current range of most of these species does not include the Gunnison area.

Of the species listed in the table, the following are more likely to [utilize] one of the sites. The Whooping crane and the Greater sandhill crane would be expected to be found resting and feeding along Tomichi Creek during the spring and fall migrations. The Peregrine falcon could potentially visit the area during its migration and has reportedly been seen north and northwest of Gunnison (CDM, 1981; Isbill, 1980). The Bald eagle is an occasional winter migrant, but does not nest in the area (Isbill, 1980).

[The Shiff milkvetch] proposed [for listing as a] threatened [or] endangered plant species that may occur [in] the vicinity of the Gunnison and alternate disposal sites. The Skiff milkvetch is listed in category 2 and is "currently under review" (USFWS, 1980). This species occurs less than three miles southwest of the alternate disposal sites (Peterson, et al., 1981) in an area which has habitat similar to those at the disposal sites.

## 3.8 RADIATION

Appendix H and Section 4.1 contain a discussion of radiation, radiation measurements, and health effects calculations. The existing radiation levels at the Gunnison site and alternate disposal sites are discussed below.

### 3.8.1 Background radiation

Radioactive elements occur naturally throughout the air, water, soil, and rock of the earth. The concentration of these elements varies greatly throughout the United States. The concentrations in the Gunnison area are generally higher than the average for the United States because of local mineralization and the relatively high elevation (approximately 7,700 feet).

Background radioactivity levels typical of the Gunnison region and not influenced by the Gunnison tailings pile have been established (ORNL, 1980). The average background concentration in soil is 1.5 $\pm$ 0.6 pCi/g for [radium]-226 [(Ra-226)] and 1.1 $\pm$ 0.3 pCi/g for [thorium]-232 [(Th-232)].

The average background gamma radiation exposure rate from both terrestrial and cosmic sources, measured at 3 feet above the ground, is 14 microR/hr with a range of 7 to 22 microR/hr (ORNL, 1980). Cosmic rays (radiation from the sun and other sources external to the earth) contribute approximately 7.7 microR/hr (55 percent) to the 14 microR/hr background gamma exposure rate at the Gunnison site (EG&G, 1981).

The average outdoor background radon concentration in the Gunnison area is 1.0 pCi/l based on measurements at 5 locations around the City of Gunnison. The range of radon concentrations for these 24-hour samples was 0.9 to 1.1 pCi/l (FBD, 1981). [Radionuclide concentrations in airborne dust are not available.]

### 3.8.2 Radiation levels

#### Gunnison [tailings] site

The average radium content of the tailings is 314 pCi/g; however, the tailings are not homogeneous. Radium concentrations vary from 90 to 1400 pCi/g. [The uranium concentration measured in the tailings is 0.0057 percent $U_3O_8$ (MSRD, 1982).]

On-pile gamma radiation measurements ranged from 34 to 280 microR/hr (FBD, 1983b) for the existing pile with about [0.5 foot] of cover. Using Schiager's (1974) estimate of 2.5 (microR/hr)/ (pCi/g), the bare pile gamma exposure rate would be 785 microR/hr based on the average Ra-226 concentration of 314 pCi/g. [The gamma exposure rate decreases to near-background levels within 1000 feet in all directions from the tailings pile (Bendix, 1984).]

Radon flux from the existing pile has been measured (FBD, 1981) and ranges from 70 to 250 $pCi/m^2sec$, with an area[-]averaged flux of 150 $pCi/m^2sec$. The radon flux source term was calculated using the RAECO Model (NRC, 1984), assuming that no cover exists. The calculation resulted in an annual average radon flux of 260 $pCi/m^2sec$ from the bare tailings based upon [the] average Ra-226 concentration of 314 pCi/g.

The soil beneath the tailings pile exceeds the EPA standard of 15 pCi/g of Ra-226 to an average depth of [approximately] 4 feet. The Ra-226 concentration in this material ranges from 15 pCi/g to 500 pCi/g.

Tailings have been dispersed by wind and water erosion and have contaminated soils adjacent to the tailings pile (Figure 3.14). The Ra-226 concentration of these contaminated soils ranges from 5 to 800 pCi/g.

Additional contaminated areas are the former ore storage and mill site areas. These areas have concentrations ranging from 5 pCi/g to 300 pCi/g of Ra-226.

The ground water beneath the tailings pile is also contaminated. Section 3.6 [and Appendix D] contain details on the extent of ground-water contamination.

#### East Gold Basin and Chance Gulch sites

No data exist on background radiation levels at either the East Gold Basin or the Chance Gulch alternat[e] disposal sites. Both sites are believed to have radiation levels consistent with regional levels as determined by ORNL (1980). These are 14 microR/hr for gamma exposure [rate] at 3 feet above the ground surface, 1.5 ± 0.6 pCi/g Ra-226, and 1.1 ± 0.3 pCi/g Th-232.

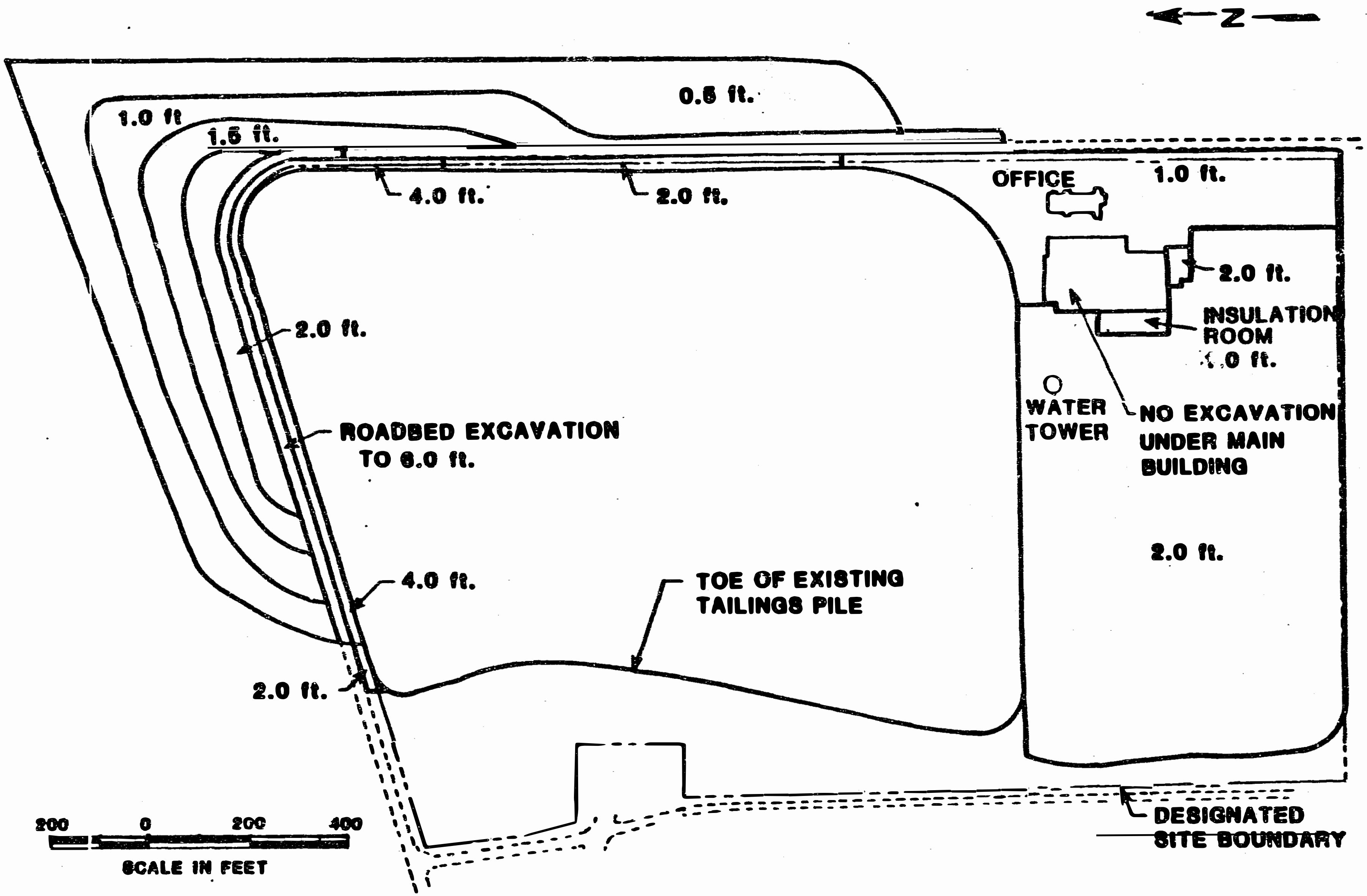



**FIGURE 3.14**
**LIMITS OF CONTAMINATION GUNNISON SITE**

## 3.9 LAND USE

The existing tailings site is located just outside of the city of Gunnison, adjacent to the community's developed areas. Land use on the existing tailings site is limited to use of some of the buildings by local businesses. The mill buildings are used as offices and as a storage area for boats, trailers, and boxed materials. The land use in the vicinity of the Gunnison site is shown in Figure 3.15.

A KOA campground is within several hundred feet of the west boundary of the tailings site, separated from the site by a drainage ditch and fence. Gold Basin Road is adjacent to the site on the east and north. The Gunnison airport, which is owned and operated by Gunnison County and is partially within Gunnison's city limits, is across Gold Basin Road to both the north and east. The airport's main runway is located within 200 feet of the tailing site's northern boundary; a seldom-used, dirt emergency runway is located parallel to Gold Basin Road within 150 feet of the tailings site eastern boundary. The Valco gravel pit and concrete batch plant **[are]** located immediately south of the tailings site.

The city of Gunnison is located north and east of the tailings site. The land immediately north of the airport is in light industrial use, but includes junkyards and trucking operations. The land west of the tailings is primarily agricultural, although there are trailer camps, motels, residences, and a number of other urban uses as well (FBD, 1981).

The land use in the tailings site vicinity is shifting from agricultural to more urban uses (light industry and residences). The area further east of the airport's dirt emergency runway is zoned for industrial use. A map of the city's urban service area, contained in the city's 1980 Master Plan, shows the site and the adjacent areas to the south of the site in industrial use, and areas to the west and east in residential use (City of Gunnison, 1980).

Substantial residential development activity is occurring in unincorporated County areas along Gold Basin Road beginning nearly 1 mile south of the tailings site and extending further south (Figure 3.16). The County has no zoning map or formal land use plan, but considers development proposals on a case-by-case basis. There are three approved housing subdivisions, Gold Basin Meadows (39 building sites), Hartman Rocks (12 sites) on the west side of Gold Basin Road, and the Panoview Park subdivision (49 units) **[on the east side of Gold Basin Road]** slightly further south of the Gold Basin and Hartman Rocks subdivisions. As of March, 1984, there were 30 developed units in this area, with additional development activity (roads and utilities installation) underway. Also, a second phase of the Gold Basin Meadows subdivision (48 lots) has been proposed, but not yet approved, to the north of the already-approved Gold Basin Meadows subdivision. Additional potential development areas extend to the east of the proposed Gold Basin Meadows development (Williams, 1984).

There is a County-owned borrow site on the east side of Gold Basin Road just south of the Hartman Rocks development **[(borrow site 1)]**. This borrow site is proposed for use for the remedial action. The minerals at this site are owned by the Federal government and administered

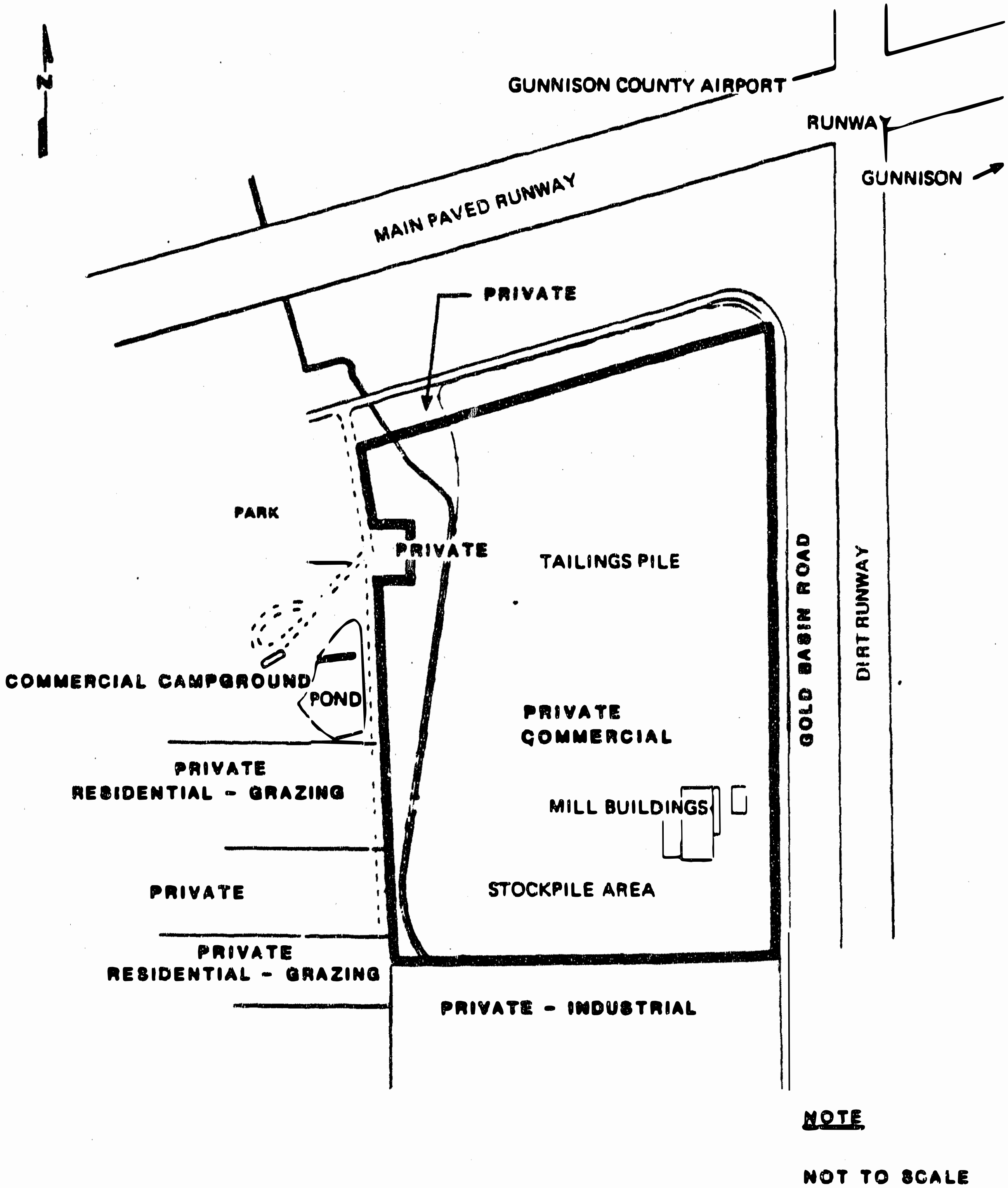



FIGURE 3.15 LAND USE IN THE VICINITY OF THE GUNNISON SITE

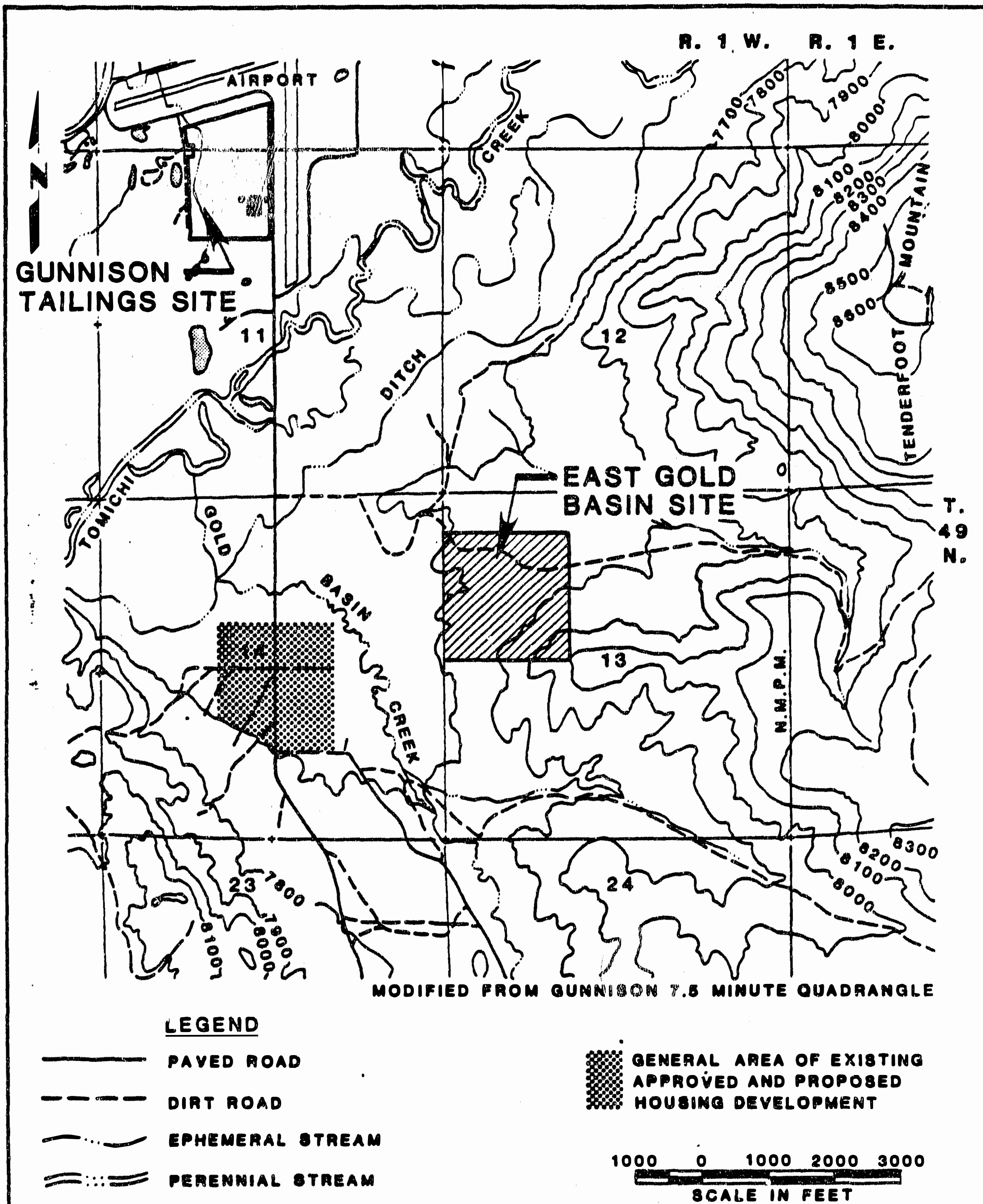



**FIGURE 3.16 LOCATION OF EXPANDING HOUSING DEVELOPMENT NEAR EAST GOLD BASIN SITE**

by [the] BLM. A 50-acre site about 2 road miles southeast of the existing tailings site would also be used as a borrow site (borrow site 6). This site is privately owned and is used for low-density grazing. Some borrow activity has occurred along the northern fringe of this area.

The East Gold Basin alternat[e] disposal site is located approximately 2,500 feet east of the Gold Basin Meadows subdivision. The site is Federal land managed by the BLM and currently used for low-density grazing (FBD, 1983a). The East Gold Basin site is within one-quarter mile of the hiking trail that leads to the Western State College "W" icon. This trail is particularly well travelled in the autumn, at the college's homecoming time. At its closest point, the disposal site is approximately 2,500 feet from the nearest existing residence (in the Panoview subdivision).

The Chance Gulch alternat[e] disposal site is located on Federal land administered by the BLM approximately 6 road miles southeast of the Gunnison site. The site is 2.5 miles from the subdivisions being developed near Gold Basin Road and is used for low-density grazing (FBD, 1983a). The new County landfill site, to be opened in 1984 or 1985, is approximately 4 miles to the east of the Chance Gulch site (Bailey, 1984).

## 3.10 AMBIENT SOUND LEVELS

Sound levels were measured in 1982 at a number of locations near the tailings pile. Sound levels recorded at and near the tailings pile were 45 and 58 decibels (dBA), measured on the A-scale (of the several noise scales, scale A is the one which most closely approximates the human ear). Among the highest noise levels recorded were those measured near Highway 50 in the city of Gunnison, ranging from 70 to 72 dBA. Measurements were not taken at the East Gold Basin or Chance Gulch sites; however, it can be expected that noise levels would be somewhat lower than the lowest measured [at the tailings site] (45 to 50 dBA) since the [alternate disposal] sites are removed from population centers and transportation routes. According to the National Academy of Science's scheme for relating sound levels to population densities, sound levels at the East Gold Basin and Chance Gulch sites would be equivalent to an $L_{dn}$ (day-night sound level) of 40 dB which corresponds to a partially-developed rural area (NAS, 1977). ($L_{dn}$ is a noise-rating scheme which assigns a 10-decibel penalty to the nighttime period to account for the heightened noise perception during that time.)

## 3.11 SCENIC, HISTORIC, AND CULTURAL RESOURCES

### 3.11.1 Scenic resources

The scenic resources of the Gunnison site are characterized by a combination of industrial, suburban, and pastoral views with distant views of surrounding mountains. Noticeable features in the vicinity include the Gunnison airport, the Valco gravel pit and concrete batch plant, irrigated pasture lands, residential areas, and ranches with clusters of cottonwood trees. The orange and white water tower on the site is a man-made landmark visible from a wide area of the Gunnison valley.

In terms of the BLM Visual Resource Management (VRM) system (BLM, 1978), the Gunnison and Valco borrow sites are situated in an area assigned to Class II (Figure 3.17) (BLM, 1980). BLM management activities in Class II areas are directed toward [the objective] that any changes in the basic elements (form, line, color, texture) should not be evident in the characteristic landscape. A contrast may be seen but should not attract attention.

Borrow sites 1 and 6 in the remedial action are located in VRM Class II and Class III areas (Figure 3.17). BLM management activities in Class III areas are directed at allowing contrast in the basic visual elements that may be evident and [may] begin to attract attention in the characteristic landscape. However, the changes should remain subordinate to the existing landscape. Both borrow sites have been subject to previous borrow activities that have altered the natural landscape.

Scenic resources at the East Gold Basin alternat[e] disposal site consist primarily of foreground and middle ground views of grass and sagebrush covered hills and occasional homes with some distant mountain vistas. BLM considers visual resources in this area to be part of VRM Class III (Figure 3.17).

The Chance Gulch alternat[e] disposal site is characterized by foreground and middle ground views of grass and sagebrush covered hills and limited distant mountain vistas. This area is part of the BLM VRM Class IV which has the least constraints for land use of the four VRM classes in the Gunnison River basin. Class IV areas are managed to allow "contrasts that may attract attention and be a dominant feature of the landscape in terms of scale; however, a change should repeat the basic elements (form, line, color texture) inherent in the characteristic landscape (BLM, 1980). Of the two alternat[e] disposal sites, the Chance Gulch area is the least sensitive from the visual resource standpoint.

### 3.11.2 Historical resources

History in the Gunnison River basin reflects many activities including mineral prospecting and extraction, cattle ranching and recreational development. Ute Indians traditionally used the area for summer hunting through most of the nineteenth century. Spanish contact with the Indians may have occurred in the early 1800's primarily as a result of expeditions from Mexico. Trappers and fur traders utilized the area as early as 1815. Later, several United States Government expeditions traveled through the basin, including one group led by Captain John W. Gunnison for whom the area is named (AMAX, 1981).

Beginning in the 1860's, gold prospectors entered the basin, encroaching on Indian territory which had been established by treaty. In 1871, the Gunnison cow camp was established near the confluence of the Gunnison River and Tomichi Creek as a food supply camp for the Ute Indians. A few years later, the Ute Reservation was relocated to the Montrose area ending the Indian presence in the Gunnison basin (AMAX, 1981).

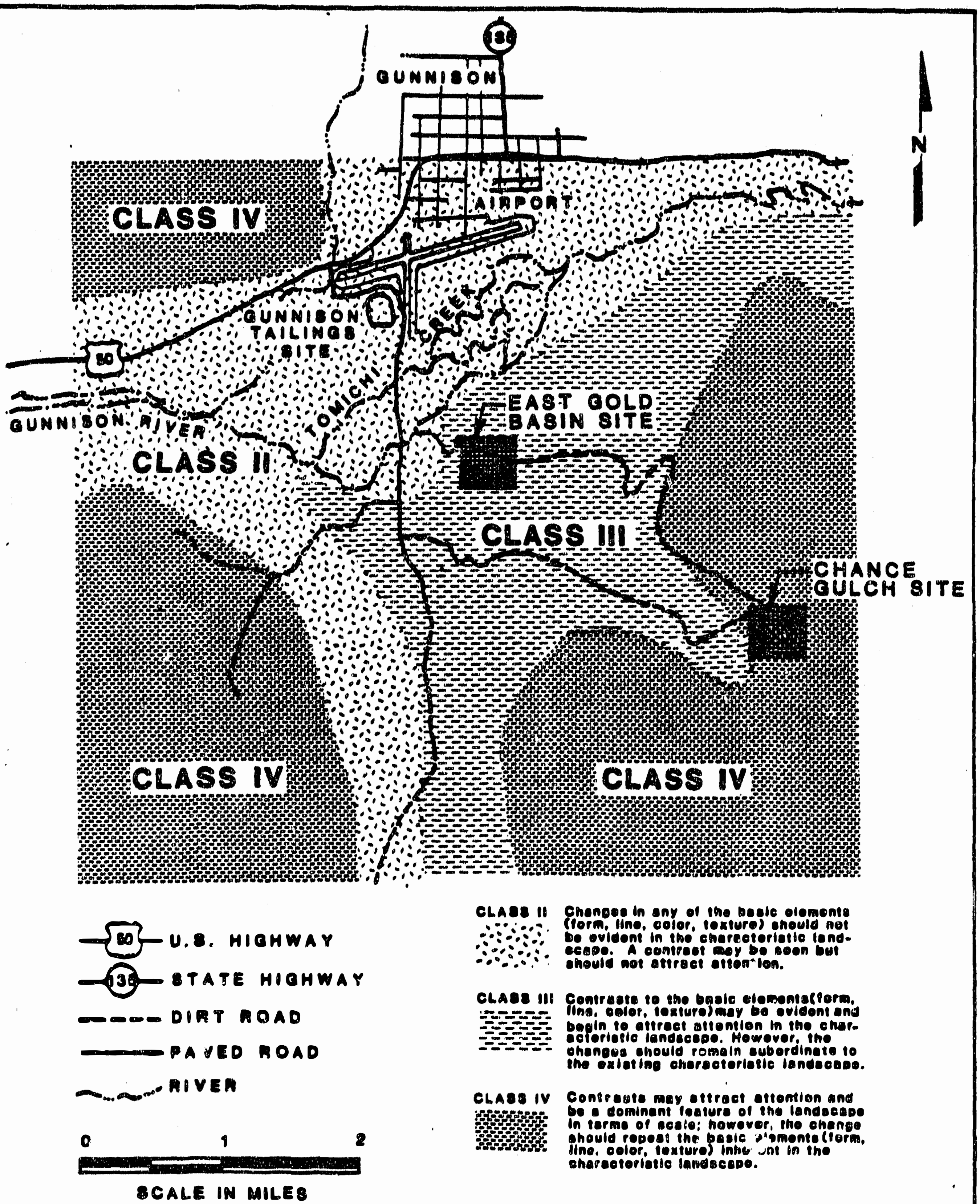



**FIGURE 3.17 VISUAL RESOURCE MANAGEMENT CLASSES**

Alonzo Hartman was one of the operators of the Gunnison cow camp and later homesteaded the land calling it the Dos Rios Ranch. Hartman became one of the most prominent cattlemen of Colorado. The Dos Rios Ranch House and Hartman Castle are historic buildings (Site No. 5GN01517A) that were built by Hartman in the late 1800's and are eligible for nomination to the National Register of Historic Places. The ranch buildings are located several hundred feet from the southwest corner of the the Gunnison tailings site (Sullenberger and Baker, 1981).

In the 1870's, cattle ranching became established and led to widespread settlement of the area. The city of Gunnison was incorporated in 1879 and became the hub for economic trade in the Gunnison River basin and surrounding areas. Mining of coal, precious metals, and uranium led to several population surges over the years. Ranching, education (Western State College), and recreation (mainly skiing) have added stability to the community.

Uranium processing at the Gunnison site began in 1958 when the mill was constructed by Gunnison Mining Company. After approximately four years of processing uranium ore from the Cochetopa Pass area, the mill ceased operation.

An inventory of historic buildings in Gunnison and the surrounding area was completed (Sullenberger and Baker, 1981). The list of vicinity properties to be included in the remedial actions will be cross-checked with the list of historic properties to determine if any historic structures would be affected. As presently defined[,] none of the remedial action alternative[s] would affect historic buildings.

### 3.11.3 Cultural resources

The Gunnison tailings site, borrow alternat[e] sites, and alternat[e] disposal sites are located in the Gunnison River basin[,] which is believed to have been seasonally inhabited as early as 11,000 years ago. Known as the Uncompahgre Complex of the Desert Archaic Tradition, the culture of aboriginal peoples consisted of seasonal exploitation of plant, animal, and mineral resources by small groups of nomadic hunter-gatherers. In contrast to the pueblo buildings of the Mesa Verde Anasazi culture, archaeological sites of the Uncompahgre Complex consist mainly of lithic scatters of stone tools and tool fragments. Studies and analyses of artifacts indicate that activities in the region included plant and animal food processing, tool manufacture, and at least seasonal habitation (USFS, 1981; AMAX, 1981).

The latest of prehistoric occupations of the Gunnison River basin involved the Ute Indians, who were present when the first Anglo-American trappers visited the area in the early nineteenth century. Ute culture was similar to prior occupations, dominated by subsistence off the land and trade with other groups (Reed and Scott, 1979).

A BLM Class I archaeological inventory (file search) at the Colorado Historical Society revealed many archaeological sites within a few miles of the tailings site (A. Townsend, 1983). BLM Class III surveys (on-site surveys) of the tailings, borrow alternative, and alternate disposal sites have not been conducted by DOE, although several surveys have been conducted on adjacent lands. Land at the tailings site have been disturbed by prior mineral processing activities and ditch construction[,] leaving little potential for archaeological resources to remain undisturbed.

BLM Class III surveys for the residential subdivisions near the East Gold Basin alternative disposal site indicate an archaeological site density of approximately 6.8 sites per square mile (WCRM, 1980). There is no other information on cultural resources at the East Gold Basin site.

The Chance Gulch alternat[e] disposal site is located on the edge of a highly sensitive archaeological area that was identified during field surveys conducted for the Mount Emmons Project EIS. In the Mount Emmons Project study area, bordering on the Chance Gulch site, 78 archaeological sites were discovered with an average site density of 28.57 per square mile. One of the archaeological sites (5GN00829A), located less than 1/2-mile from the Chance Gulch alternative site, is a prehistoric campsite that is eligible for nomination to the National Register of Historic Places (AMAX, 1981).

The significance of the Chance Gulch area is summarized by the following statement by the State Historic Preservation Officer:

> "Chance Gulch is probably more accurately defined as a large archaeological district. Sites identified here establish prehistoric occupation of the area dating from approximately 500 B.C. The entire area could be useful for constructing a resource exploitation model for the western slope. The area contains extraction and manufacturing sites as well as maintenance camps. Needless to say, this is a highly sensitive area archaeologically..." (USFS, 1981).

The Valco borrow site and borrow site 1 have been disturbed by borrow activities; therefore, it is doubtful that any archaeological resources are present at these sites. BLM Class III surveys were conducted for the residential subdivisions southwest of borrow site 6. These surveys indicated an archaeological site density of approximately 6.8 sites per square mile (WCRM, 1980). The presence of archaeological sites at borrow site 6 should be similar to this density[,] although the northern edge [of the] borrow site has been disturbed by previous borrow activities.

## 3.12 SOCIOECONOMIC CHARACTERISTICS

The following is a brief description of the socioeconomic characteristics of the Gunnison area. This material summarizes more detailed data provided in Appendix G.

As of the end of 1982, Gunnison and Gunnison County had estimated populations of 6,031 and 11,321, respectively. Total county population is forecasted to increase to 12,284 by 1985, and 13,987 by 1990. The total housing stock of the City was roughly 2,000 units as of the end of 1981. Roughly half of these units were occupied by renters, with a vacancy rate in 1980 of 5.5 percent. The 1980 County housing stock included 4,500 year-round units, with roughly 48 percent rentals and a rental vacancy rate of approximately 13.9 percent.

The economy of the Gunnison area is dependent on four major industries: recreation and tourism (by far the largest), education (reflecting the presence of Western State College in Gunnison), cattle ranching, and mining. The county labor force exceeds 6,300 people with unemployment rates in the last several years somewhat below the statewide average. The retail trade, services, and government sectors are the largest employees in the county.

The city of Gunnison has a fairly diverse revenue base, with sales and use taxes and various fees for service being particularly important revenue sources. Gunnison County's General Fund is heavily dependent on property tax revenues and intergovernmental transfers.

The city sewer system, which has a 1.3 million gallons per day (mgd) capacity, is currently overloaded roughly six months out of the year; a major problem is infiltration of ground water into the sewer lines. The city expects to receive a Federal grant in 1984 to allow construction of a 4.2 mgd capacity treatment plant, which, it is hoped, will be operational by 1986 or 1987.

Gunnison is served by U.S. 50, a major, all-weather highway interconnecting with I-70 at Grand Junction (180 miles to the west) and I-25 in Colorado Springs (180 miles to the east). State Highway 135 provides road access from Gunnison north to the Crested Butte area. Average daily traffic (ADT) on U.S. 50 in 1981 was 10,000 at its intersection with State Highway 135. The ADT for Highway 135 immediately north of Gunnison was 7,500 in 1981 (FBD, 1983b). No traffic count data are available for Gold Basin Road, which is adjacent to the tailings site. Access to the East Gold Basin site is across 0.8 miles of an unimproved dirt road[,] which intersects Gold Basin Road approximately 1 mile south of the Gunnison site. This unimproved road crosses private and Federal land.

Access to the Chance Gulch site is across the same unimproved dirt road which provides access to the East Gold Basin site. The Chance Gulch site is 4.4 miles to the east of the East Gold Basin site on this unimproved dirt road.

The Gunnison County Airport is located in the city of Gunnison immediately north of the tailings site. The airport is regularly serviced by two airlines that provide service to western slope communities and to Denver. The airport is a terminal stop for skiers using the Crested Butte area and an enroute stop for other air carrier traffic (Isbill, 1980). The airport runway is 7,200 feet in length and is certified for [daytime use by] jet aircraft.

There are 35 certified, full-time peace officers in Gunnison County, 12 of whom are employed by the Gunnison City Police Department. The city of Gunnison and the County Fire Protection District provide fire protection services to the area, with all equipment housed in one facility. Manpower consists of a full-time fire marshal, a part-time fire chief, and 35 volunteers. There are six public schools in the county, with five of these located in the city of Gunnison. Total capacity of the schools is approximately 2,050; total enrollment as of February, 1984, was 1,377 [(Anderson, 1984)].

The city of Gunnison obtains potable water from nine shallow wells, with the water chlorinated at the well head. The city and county have water rights to surface flows from the Gunnison River, which is expected to be used in the next 15 to 20 years to accommodate growth in the area [Early, 1984].

## 3.13 PUBLIC [PARTICIPATION]

Since the enactment of UMTRCA, the DOE has held numerous meetings in Gunnison to ascertain public interests and opinions regarding remedial action at the Gunnison site. These meetings have been held with city and county officials, various agencies, and individual citizens during the preplanning stages and throughout DOE's site characterization efforts. Several public meetings have been held with widespread notification of the event, and interested citizens were encouraged to express their concerns and receive answers to their questions regarding plans for the Gunnison site.

In 1982, a Gunnison task force, made up of private citizens and local officials, was formed to serve as a major communication link between DOE and the community. The DOE has met many times with this group to provide information on and obtain input about DOE's efforts. From time to time, the DOE has also issued press releases regarding activities taking place at the Gunnison site.

The types of concerns and comments expressed during these meetings and consultations include the following:

1. Where are the locations of properties off of the designated site which contain elevated radon levels, to what are those high levels due, and what will be done to take care of such properties?

2. How will variations in meteorological conditions influence the ground water in the area?

3. Ground[-]water sampling should be conducted for a full year to gather data reflecting seasonal fluctuations in ground[-]water flow.

4. What correcting parameters will be utilized to compensate for variations in local precipitation with regard to precipitation throughout the entire watershed area?

5. What effects, if any, will remedial action have on the airport, and what special measure[s] will be taken during remedial action?

6. Will the buildings on the site be demolished or will decontamination be considered?

7. What will be the impact of the remedial action alternatives on cultural resources and endangered plants and animals in the area?

8. What will be the impacts of flooding on the integrity of the tailings pile?

These concerns have been addressed in the EA.

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# 4.0 ENVIRONMENTAL IMPACTS

The environmental impacts of each of the alternatives are discussed in this chapter. All of the alternatives except the no action alternative include remedial action at the estimated 14 vicinity properties; however, only those impacts of remedial action at the vicinity properties which make an appreciable contribution to the impacts of the overall remedial action are included in this chapter.

## 4.1 RADIATION

### 4.1.1 Exposure pathways

There are five principal radiological pathways by which individuals could be exposed during the remedial action (Figure 4.1). These are: (1) inhalation of radon daughters; (2) direct exposure to gamma radiation emitted; (3) inhalation and ingestion of airborne radioactive particulates; (4) ingestion of ground and surface water contaminated with radioactive materials; and (5) ingestion of contaminated foods produced in areas contaminated by tailings. For the calculation of health effects, only those pathways which would result in the largest radiological doses were considered **[in detail]**: inhalation of radon daughters and direct exposure to gamma radiation. **[Brief calculations are provided in Appendix H which estimate radiation exposures and health effects to remedial action workers from the air particulate pathway and to the general population from the ground water ingestion pathway.]** Following definition of the extent of ground water contamination beneath and adjacent to the Gunnison site, the **[significance of]** health impacts from consumption of this water will be estimated **[in more detail. Exposures via the airborne radioactive particulate pathway and ingestion of contaminated foods produced in the area would be much smaller (an order of magnitude or more) than the doses from radon daughter inhalation and exposure to direct gamma radiation.]**

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

Gamma radiation is also emitted by many members of the uranium-238 decay series. Gamma radiation behaves independently of atmospheric conditions and travels in a straight line until it impacts with matter. Gamma radiation emitted from the tailings delivers an external exposure to the whole body. Gamma radiation levels emitted from the tailings become negligible beyond 0.3 miles from the perimeter of the tailings due to the interaction of the gamma rays with matter in the air.

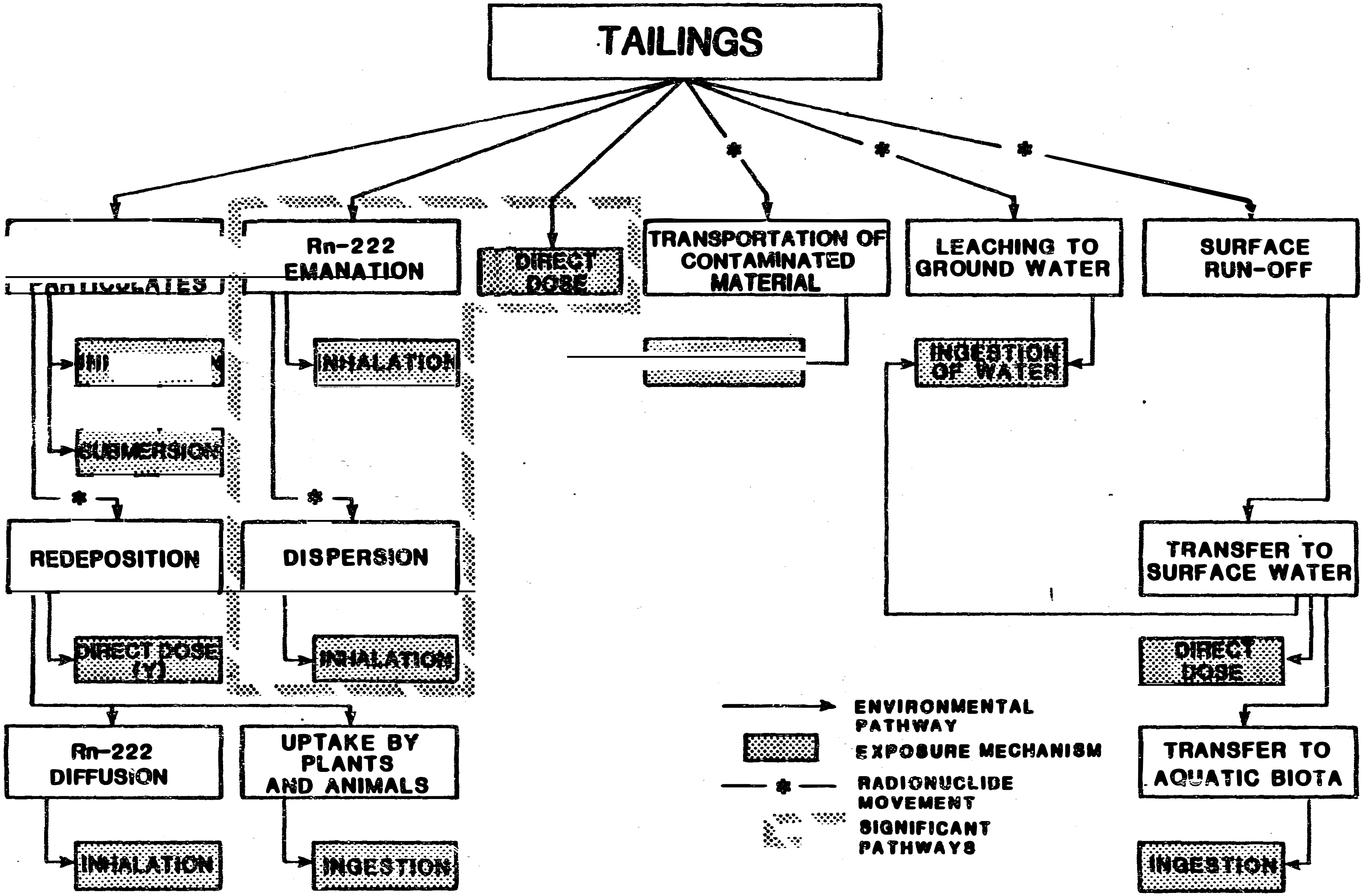


**FIGURE 4.1**

**POTENTIAL RADIATION EXPOSURE PATHWAYS**

**TO THE GENERAL PUBLIC AND REMEDIAL ACTION WORKERS**

The general public and nearby workers are presently being exposed to radon daughters and direct gamma radiation from the unstabilized tailings. Radon is diffusing into the atmosphere where it is being dispersed by winds over a large area (i.e., inhalation pathway). Gamma radiation is being emitted and [exposes] any person living or working within 0.3 miles of the tailings (i.e., direct gamma exposure pathway).

Following remedial action, there would be no exposure to direct gamma radiation since each alternative includes the construction of a five-foot-thick silty clay cover which gamma radiation could not penetrate. However, there would continue to be a small public exposure to radon and radon daughters following remedial action because the cover for each alternative would substantially reduce but not eliminate the release of radon. This results in a small lung dose to the nearby population with the health effects proportional to the size of the population. The tailings cover for each alternative would have a very low permeability and thereby slow the rate of radon diffusion through the cover. Most of the radon would decay into its solid daughter products before it could diffuse through the cover and enter the atmosphere. The rate of radon emanation would be no greater than the allowable levels contained in the EPA standards (Appendix A).

**[Exposure to gamma radiation may cause genetic health effects in addition to somatic health effects (e.g., cancer). 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 health effect calculations in Appendix H and summarized here reflect only the somatic risk.]** The following sections discuss the excess [somatic] health impacts that would result during and after the implementation of each alternative and the health impacts of construction-related accidents that might occur.

### 4.1.2 Health impacts

During remedial action

The estimates of excess health effects (i.e., cancer) in this section are based on the procedures discussed in Appendix H. These procedures are based on realistic but conservative assumptions to estimate the level of excess health effects. Table 4.1 lists the estimated excess health effects that would occur for each alternative during remedial action.

During implementation of each of the alternatives except the no action alternative, the exposure to the general population from th[e radiological] pathways would increase as the tailings are disturbed on [the] site and as the tailings are transported to an alternat[e] site. Remedial action workers would also be exposed to these pathways during remedial action.

Table 4.1 Excess health effects during remedial action[a]

| Alternative[b] | General population radon daughter health effects | General population gamma health effects | General population transportation gamma health effects | Remedial action worker radon daughter health effects | Remedial action worker gamma health effects | Total excess health effects |
|---|---|---|---|---|---|---|
| [Stabilization in] [place] | [0.0156] | 0.00029 | [N/A] | [0.0023] | 0.0020 | [0.0202] |
| East Gold Basin | [0.0131] | 0.00015 | negligible | [0.0036] | [0.0032] | [0.0201] |
| Chance Gulch | [0.0105] | 0.00015 | negligible | [0.0043] | [0.0038] | [0.0188] |

[a]Appendix H contains a discussion of the methods and assumptions used to estimate these health effects.

[b]The no action alternative would result in [0.0105] excess health impacts per year.

[N/A - Not applicable.]

[As presented in Appendix H, the percentage increase in radon released from the tailings due to construction activities would be small relative to the radon released prior to remedial action. This is because a large radon flux is released from the existing tailings under the no-action alternative. During construction, increases in gamma exposure rates and airborne radioactive particulate concentrations would be larger than for radon concentration compared to levels prior to remedial action. This is because gamma exposure rates increase as the pile is excavated and mounded as a result of exposure of more tailings. Airborne particulate concentrations also increase from near-zero background levels to measurable levels caused by disturbance of the tailings.

The elevated gamma exposure rate primarily increases health effects to the remediation workers on the site. During stabilization in place for remediation workers, the risk from inhalation of air particulates would be only one percent of that from exposure to gamma rays, and the air particulate exposure to the general population would be even less. Inhalation of radon daughters would be the dominant source factor in the general population health effects calculation.]

The excess health effects to the general public and nearby workers during remedial action are principally dependent on the amount of tailings and contaminated material to be moved and the number of people who live and work nearby. The excess health effects estimated for each of the alternatives are small in comparison to the natural incidence of cancer. In the United States, an individual has a 16 percent chance of contracting cancer (NAS, 1980).

As a comparison, the excess health effect to an individual in the general population during remedial action for stabilization in place was estimated to be 0.000[23] percent (based on an excess health effect of [0.0159] and an exposed population of 6,783). The excess health effects (cancer) [caused by] the remedial action alternatives [would] therefore [be] a small fraction of the normal cancer incidence rate.

Stabilization in place would result in [slightly more] total excess health effects [(0.0202)] during remedial action [than the other alternatives.] Stabilization in place has the [most] health effects [primarily] because [of radon daughter exposure to the general population, even though] it requires no off-site transportation of tailings, requires a shorter time to implement, and uses fewer remedial action workers than the other alternatives.

The no action alternative would result in [0.0105] excess health effects per year. This number of excess health effects is not directly correlated to the excess health effects listed in Table 4.1 because the health effects for the alternatives are for the duration of the project; 18 months for [stabilization in place] and 24 to 30 months for the other alternatives.

The East Gold Basin alternative would result in [0.0201] total excess health effects, **[essentially the same as stabilization in place]**. The[se] health effects are due to a greater distance for movement of the material, a longer time to implement the alternative, and a greater number of remedial action workers. Transportation health impacts to the general population for the East Gold Basin alternative are negligible.

The Chance Gulch alternative would result in **[slightly fewer]** total excess health effects **[(0.0188)]** as the East Gold Basin alternative. Fewer general population health effects would be incurred because Chance Gulch is farther from the town of Gunnison; but a larger work force would be needed over a longer period of time because of the longer transportation distance to Chance Gulch. Transportation health impacts to the general population for the Chance Gulch alternative are negligible. **[The total excess health effects during each remedial action alternative would be essentially the same, resulting in an impact similar to the total health effect caused by exposure for two years under no-action conditions.]**

### 4.1.3 Hypothetical accidents

The Gunnison tailings contain radioactive elements in low concentrations that emit low levels of radiation. A long exposure time is required to produce excess health effects. For any **[of the action alternatives,]**, spillage of tailings resulting from a traffic accident involving a truck loaded with tailings would be cleaned up immediately and would therefore cause a short exposure time to persons living or working near the spill. Contractors working for DOE would be required to establish approved procedures for cleaning spills.

The only spill which could not be cleaned up would be one that occurs as a truck crosses a perennial stream or flowing ephemeral drainage. The probability of such an accident is very low. Relocation of tailings to either alternate site has the possibility of this occurring since the transportation routes cross Tomichi Creek. In this case, much of the tailings could not be recovered but the concentration of radioactive elements[,] metals[,] and ions would be rapidly diluted by the flowing waters and little or no health impacts would occur.

### 4.1.4 Health effects following remedial action

The procedures used to calculate the excess health effects following remedial action for each of the alternat**[e sites]** are discussed in Appendix H. These procedures are based on realistic but conservative assumptions to estimate the level of excess health effects. Table 4.2 lists the estimated yearly excess health effects for each of the alternat**[e sites]** following remedial action.

Table 4.2[a] Yearly excess health effects following remedial action

| | General population radon daughter health effects per year | General population gamma health effects per year | Total health effects per year |
|---|---|---|---|
| **[Stabilization in place]** | 0.000[64] | 0 | 0.000[64] |
| No action | [0.0102] | 0.00029 | [0.0105] |
| East Gold Basin | 0.000[27] | 0 | 0.000[27] |
| Chance Gulch | 0.0001[2] | 0 | 0.0001[2] |

[a]Appendix H contains a discussion of the methods and assumptions used to estimate these health effects.

Following remedial action, the radon releases for each of the alternatives, except the no action alternative, would be no greater than allowed by the EPA standards (Appendix A). The design for each alternat[e site] incorporates a 5-foot-thick silty clay cover to assure that radon emanation will meet EPA standards.

Stabilization in place would result in [0.00064] general population excess health effects per year. These impacts would occur because the tailings would remain within one mile of the [city] of Gunnison.

The no action alternative would result in the greatest yearly excess health effect to the general population [(0.0105] excess deaths per year) which is at least [16] times greater than any other alternative [following remedial action]. These impacts would [primarily] occur because the tailings would not have a [thick] cover to inhibit radon emanation. The excess health effects to the general population resulting from radon emanation would exceed those from gamma radiation by a factor of [35] for the no action alternative.

The excess health effects calculations for the no action alternative assume that the tailings would not be dispersed by natural erosion or man in the future; there is no way to accurately predict the level or rate of dispersion. However, as discussed in Section 4.5.1, dispersion would occur over time and the actual health effects of the no action alternative might be greater than the [0.0105] per year as shown in Table 4.2.

The East Gold Basin alternative would result in 0.000[27 excess health effects per year to the general population following remedial action. The East Gold Basin site is relatively remote, but is close enough [to the city of Gunnison] to cause excess health effects from the small increase in radon concentrations.

The Chance Gulch alternative would result in [0.00012] excess health effects per year following remedial action. Chance Gulch is the most remote alternate site, but is within 4 straight line miles of Gunnison, and excess health effects would occur from the slightly increased radon concentrations from the Chance Gulch disposal site.

Table 4.3 lists the estimated excess health effects for each alternat[e site] that would occur 5, 10, 100, 200, and 1,000 years following remedial action. This table adds the health effects that would occur during remedial action to the integrated yearly health effects following remedial action. [It should be noted] [that] the data in Table 4.3 reflect a stable population[, assuming that the population in the vicinity of each site remains constant. The yearly excess health effect for any site would vary with changing population distribution around that site.]

Table 4.3 Total excess health effects 5, 10, 100, 200, and 1000 years following remedial action[a]

| | Number of years following remedial action | | | | |
|---|---|---|---|---|---|
| Alternative | 5 years | 10 years | 100 years | 200 years | 1000 years |
| [Stabilization in [place] | 0.023 | 0.027 | 0.084 | 0.015 | 0.66] |
| No action[b] | [0.053 | 0.105 | 1.05 | 2.1 | 10.5] |
| East Gold Basin | [0.021 | 0.023 | 0.047 | 0.074 | 0.29] |
| Chance Gulch | [0.019 | 0.020 | 0.031 | 0.043 | 0.14] |

[a]These estimates assume that the population in the vicinity of each site remains constant and includes the health effects during remedial action.

[b]The calculations for no action assume the tailings are not dispersed by natural forces or by man because there is no way to accurately predict the level or rate of dispersion. However, if the dispersion could be predicted and were factored in to the above estimates, the health effects for the no action alternative would greatly increase.

### 4.1.5 Vicinity property excess health effects

All of the remedial action alternatives, except the no action alternative, would include the cleanup of the 14 off-site vicinity properties. This cleanup would involve the removal and transportation [of] 1400 cubic yards of contaminated material from the vicinity properties to the existing tailings site. The contaminated materials would be consolidated with the stabilized tailings. Conservative estimates of the excess health effects during the 14-month vicinity property cleanup period [are 0.0074] excess health effects to the general population and [0.0001] excess health effects to the remedial action workers.

## 4.2 AIR QUALITY

The potential air quality impacts of stabilization in place and disposal at the East Gold Basin and Chance Gulch [alternate sites] were evaluated by estimating air emissions (from both fuel combustion and fugitive dust) and translating [these] emissions into ambient air [pollutant] concentrations through the use of computer simulation modeling. Details of this evaluation are presented in Appendix C.

Air emissions inventory

The pollutants of regulatory concern are hydrocarbons (HC), nitrogen oxides ($NO_x$), sulfur oxides ($SO_x$), carbon monoxide (CO), and total suspended particulates (TSP). Table 4.4 presents total emissions for [stabilization in place] and for disposal at the East Gold Basin and Chance Gulch sites. [Stabilization in place] would result in the lowest levels of emissions, followed by, in ascending order, disposal at East Gold Basin and disposal at Chance Gulch. The highest level of emissions for the Chance Gulch alternat[e site] are attributed, in large part, to the greater haul distance involved compared to the East Gold Basin alternat[e] or [stabilization in place]. TSP emissions greatly exceed emissions of the other pollutants for each alternative.

Air pollutant concentrations

Emissions from the remedial actions were translated into ambient air concentrations through the use of computer simulation modeling. A conservative approach was used in the impact assessment which tends to overpredict impacts, and thereby provide [a] "safety factor." Model inputs for this conservative approach include meteorological data, consideration of the remedial action activity with the maximum emissions, and placement of emission-sensitive receptors directly downwind of the emissions sources.

Table 4.4 Summary of [air pollutant] emissions from the remedial action[a]

| Alternative[b] | Emissions (tons) | | | | |
| --- | --- | --- | --- | --- | --- |
| | HC | $NO_x$ | $SO_x$ | CO | TSP |
| Stabilization in place | 7.0 | 93.7 | 7.0 | 25.7 | 254.6 |
| East Gold Basin | 10.1 | 138.1 | 10.5 | 41.4 | 1,202.4 |
| Chance Gulch | 14.4 | 167.1 | 13.7 | 68.2 | 2,482.6 |

[[a]Summary of Table C.1.5, Appendix C.]

[b]The no action alternat[e] would not create emissions of hydrocarbons, nitrogen oxides, sulfur oxides and carbon monoxide; however, it would contribute suspended particulates to the ambient atmosphere due to dispersion of the tailing by winds. This contribution of particulates cannot be quantified but would be somewhat greater than that from undisturbed rangeland due to the sparse vegetative cover on the existing tailings pile.

Based upon the emissions in Table 4.4, it was determined that only TSP emissions would be of concern since they greatly exceed the levels of the other pollutants and since existing TSP levels in the area either exceed, or constitute a significant portion of, the State and Federal standards. Annual TSP concentrations were approximated, but not emphasized since activities are not expected to occur for several months of the year due to snow cover at the site; therefore, emphasis was placed on potential exceedances of the 24-hour TSP standard.

Twenty-four-hour TSP increments were estimated based on the use of the Industrial Source Complex Dispersion Model for short-term applications (ISCST). Modeling was performed for: (1) stabilization at the Gunnison site; (2) disposal at the East Gold Basin site; (3) disposal at the Chance Gulch site; and (4) impacts at the Gunnison site caused by complete removal of the tailings for eventual disposal at East Gold Basin or Chance Gulch.

Table 4.5 presents the predicted maximum 24-hour TSP increment for each alternative. When these increments are added to the maximum 24-hour TSP concentration that occur[s] in the area, the results allow a prediction as to whether the alternatives would result in violations of applicable standards. As shown in Table 4.5, stabilization in place is predicted to result in a maximum 24-hour TSP increment of 91 microg/$m^3$. When added to the highest TSP levels recorded in the area (98 microg/$m^3$), the maximum 24-hour TSP concentration is predicted to be 189 microg/$m^3$, which exceeds the State and Federal secondary standard of 150 microg/ $m^3$ but not the Federal primary standard of 250 microg/$m^3$.

Maximum 24-hour TSP increments for the East Gold Basin and Chance Gulch alternatives are predicted to be 108 microg/$m^3$ and 171 microg/$m^3$, respectively, at each site. In addition, removal of the tailings from Gunnison would result in an increment of 18 microg/$m^3$ at Gunnison for the East Gold Basin alternative, and 9 microg/$m^3$ at Gunnison for the Chance Gulch alternative. When added to the maximum TSP concentrations recorded in the area, it is predicted that levels produced at the East Gold Basin and Chance Gulch sites would result in violations of state and Federal, secondary and primary 24-hour TSP standards respectively.

Annual TSP increments were approximated by applying a factor to the modeled 24-hour TSP increments. The factor was derived by determining the percentage of the time that the remedial action activity under consideration would occur on an annual basis. Annual meteorological data were not used, and it should be noted that the 24-hour TSP increments greatly overestimate impacts since the 24-hour modeling uses steady-state and unidirectional winds and very conservative stability classes. Such worst-case meteorology would not occur 365 days out of the year as is assumed in the approximation of the annual TSP increments. It must also be stressed that this is a simplified approach and the results should be viewed as relative values rather than absolute concentrations.

Table 4.5 Predicted 24-hour TSP increments and maximum TSP concentrations for each remedial action alternative

| Alternative[a] | Location | Incremental 24-hour TSP level ($microg/m^3$) | Total 24-hour TSP level ($microg/m^3$) | State and Fe[d]eral 24-hour standards[b] ($microg/m^3$) | |
|---|---|---|---|---|---|
| | | | | Primary | Secondary |
| [Stabilization in Place] | Gunnison | | 189 | 250 | 150 |
| East Gold Basin | East Gold Basin | 108 | 206 | 250 | 150 |
| | Gunnison | 18 | 116 | | |
| Chance Gulch | Chance Gulch | 171 | 269 | 250 | 150 |
| | Gunnison | 9 | 106 | | |

[a]The no action alternative would not create emissions of hydrocarbons, nitrogen oxides, sulfur oxides and carbon monoxide; however, it would contribute suspended particulates to the ambient atmosphere due to dispersion of the tailing by winds. This contribution of particulates would be somewhat greater than that from undisturbed rangeland due to the sparse vegetative cover on the existing tailings pile.

[b]Not to be exceeded move than once per year.

The annual predicted TSP increments reflect the same trends as the 24-hour increments with the **[Stabilization in place]** alternative resulting in the lowest levels (27 microg/$m^3$), followed by the East Gold Basin alternative (37 microg/$m^3$), and the Chance Gulch alternative (59 microg/$m^3$). While such values are only approximate, existing annual TSP concentrations in the Gunnison area already exceed State and Federal secondary standards. Thus, any incremental TSP concentration would exacerbate this situation (Table 4.6).

## 4.3 SOILS

Each of the action alternatives would result in both the temporary disturbance and permanent loss of soils. Use of the Valco borrow site and borrow sites 1 and 6 would be required for all of the action alternatives (**[Stabilization in place]**, East Gold Basin, and Chance Gulch); however, the Valco borrow site and borrow site 1 have already been disturbed by previous borrow activities, and no new disturbance or loss of soils would be required for any of the action alternatives.

**[Stabilization in place]** would result in the temporary disturbance of 50 acres of soils at borrow site 6 and one acre for access road improvements. The soils would be scraped (6-inch depth) and stockpiled near the borrow site for future reclamation of the site and access road. Thirty-seven acres of soils would be permanently lost in the cleanup of the areas contaminated by the former ore storage and mill facilities (21 acres) and the windblown tailings (16 acres). These soils would be placed with the tailings during the remedial action.

The no action alternative would result in the continuing contamination (with radium-226) of soils adjacent to the tailings site due to dispersion of the tailings by wind and water erosion. The rate of this continuing contamination cannot be accurately quantified, but 16 acres of soil have been contaminated to date.

Disposal of the tailings at the East Gold Basin site would result in the temporary disturbance of 50 acres of soils at borrow site 6 and 15 acres of soils at the disposal site for a construction staging area. These 65-acres of soils would be scraped (6-inch depth) and stockpiled near the respective sites for future reclamation of the sites. Seventy acres of soil would be permanently lost with the East Gold Basin alternative. One acre would be lost in providing access to the disposal site and borrow site 6 because this road would remain intact after remedial action. Thirty-seven acres of soils would be lost in the cleanup of the former ore storage and mill areas (21 acres) and the windblown contamination adjacent to the existing tailings pile (16 acres). Another, 32 acres of soils would be lost at the disposal site because they would be used to construct the tailings cover.

Disposal of the tailings, at the Chance Gulch site would result in the temporary disturbance of 65 acres of soils at borrow site 6 **[and]** at the construction staging area at the disposal site. These soils would be used for site reclamation as in the East Gold Basin alternative.

Table 4.6 Predicted annual TSP increments and maximum TSP concentrations for each remedial action alternative

| Alternative[a] | Annual TSP increment (microg/m$^3$) | Maximum annual TSP level (microg/m$^3$) | State and Federal annual standards[b] | |
|---|---|---|---|---|
| | | | Primary | Secondary |
| **[Stabilization in place]** | 27 | 90 | 75 | 60 |
| East Gold Basin | 37 | 100 | 75 | 60 |
| Chance Gulch | 59 | 122 | 75 | 60 |

[a]The no action alternative would not create emissions of hydrocarbons, nitrogen oxides, sulfur oxides and carbon monoxide; however, it would contribute suspended particulates to the ambient atmosphere due to dispersion of the tailing by winds. This contribution of particulates cannot be quantified but would be somewhat greater than that from undisturbed rangeland due to the sparse vegetative cover on the existing tailings pile.

[b]Geometric mean.

Approximately, 75 acres of soils would be permanently lost with the Chance Gulch alternative. About 6 acres of soils would be lost providing access to borrow site 6 and the disposal site because this road would remain intact after remedial action. Another 69 acres of soils would be lost at the tailings and disposal sites as with the East Gold Basin alternative[, **(ore storage and mill areas, windblown acreage, cover material** at **the site).]**

For each **[action]** alternative, the areas disturbed during the clean-up of contaminated soils adjacent to the tailings site would be reclaimed by the spreading and contouring of a suitable plant growth medium, addition of necessary soil conditioners, and revegetation. Similar reclamation measures, including contouring and revegetation, would be performed at borrow sites 1 and 6 in accordance with the borrow permits issued for the sites by the Bureau of Land Management. No reclamation would be required at the Valco borrow site.

## 4.4 MINERAL RESOURCES

All of the alternatives, except no action, would result in the consumption of borrow materials (silty clay, gravel, rock). Stabilization in place would require approximately 841,000 cubic yards of materials. The no action alternative would not require the use of borrow materials. The East Gold Basin and Chance Gulch alternatives would require about 680,000 and 716,000 cubic yards of materials, respectively.

The consumption of borrow materials from local sources would have a negligible impact on the availability and cost of these resources in the region[,] as all of these materials are commercially available in large quantities throughout the Gunnison area. Access to sand and rock deposits beneath the existing tailings pile would be restricted by selection of the **[stabilization in place]** or no action alternative, but this is not expected to impact the local economy or availability of sand and gravel resources of the region. Relocating the tailings to the East Gold Basin or Chance Gulch alternate disposal sites would allow access to the sand and rock deposits underlying the existing tailings pile but would preclude access to similar deposits underlying either disposal site.

None of the alternat[e sites] would have any impacts on other mineral resources in the area. The Jurassic Morrison formation, heavily mineralized in some areas (uranium, vanadium, molybdenum), underlies the existing tailings site and the alternate disposal sites. This formation is not known to be mineralized in the vicinity of Gunnison. There are no mining claims on file for either of the alternative disposal sites.

## 4.5 WATER

### 4.5.1 Surface water

Section 4.5.1 describes the potential surface-water impacts from remedial action for each of the alternat[e] sites and summarizes water use during construction for each alternative. Additional details are contained in Appendix D.

Stabilization in place

[Because of the topography and location of the present tailings site with respect to the Gunnison River and Tomichi Creek, the primary hazards to long-term integrity at the site are the potential impacts from flooding and stream channel migration. High flow velocities could damage the rock erosion protection layer, or cause channel shifts and localized scour that would undercut and destabilize the embankment.

A conservative Probable Maximum Flood (PMF) resulting from the occurrence of a PMP over both the Gunnison river and Tomichi Creek drainage basins simultaneously was analyzed. Hydraulic analysis was performed for existing conditions and also for future predicted conditions assuming that channel migration through bank erosion on the Gunnison River has occurred to the edge of the embankment. The resultant PMF peak flows, velocities, and area flooded are fully described in Appendix D.

During a PMF, the Gunnison River and Tomichi Creek would combine as one flow upstream of the Gunnison site and surround the embankment. The depths would range from 4 to 5 feet above the base of the pile. The resultant overbank velocities adjacent to the embankment were calculated to be approximately 3 to 5 feet per second; and the mean channel velocities near the site were approximately 12 to 14 feet per second. Erosion would occur to an] elevation of 7640 feet adjacent to the west side of the embankment with water depths of 6 to 7 feet adjacent to the embankment. The calculated mean channel velocities would be approximately 13 to 15 feet per second.

Rock erosion protection on the sides and at the toe of the embankment has been designed to prevent undercutting and damage to the embankment from the maximum estimated flood conditions.]

No action

The no action alternative would result in the continued exposure of the site to a number of surface-water hazards. The present cover on the existing pile is not designed to assure long-term stability from sheet and gully erosion during large storm events. Eventual erosion of the present cover would lead to transport of the contaminants off the site by surface runoff.

[The Gunnison River is classified as having only moderate stability with a higher potential for channel and floodplain movement through gradual migration or during major flood events (100-year flood or greater). However, the likelihood of a channel shift due to gradual migration impacting the stabilized tailings is limited because of present and future cultural effects (e.g., roads, homes, commercial structures). On the other hand, a rapid channel shift during a major flood event would be difficult to prevent. Severe damage to the pile could occur with potential undercutting to depths of more than 5 feet and maximum flow velocities approaching 15 fps.]

East Gold Basin

No flood flows [would] impact this site because of its distance from and elevation above the closest stream channel. Therefore, flood protection and stream meander are not considerations for this remedial action alternative.

The East Gold Basin alternative would incorporate the same erosion protection measures as [stabilization in place] during and after remedial action to protect against impacts to surface-water quality and assure long-term stability against surface-water erosion.

Chance Gulch

The Chance Gulch alternative would encounter the same impacts from remedial action and incorporate the same erosion control measures for long-term stability as the East Gold Basin alternative.

4.5.2 Ground water

Stabilization in place

**[After stabilization in place, two design features would greatly reduce the amount of contaminants produced by the pile. First, the tailings will be covered by about 5 feet of low permeability materials which will reduce the amount of rain and snowmelt which percolates through the tailings. Second, the tailings will be placed on an earthen bench which will raise them about 5 feet above ground surface and prevent any groundwater from coming in contact with them.**

**Although stabilization in place will prevent the pile from acting as a major future source of contaminants, no alternative affects the residual contamination already present in the aquifer. Left to itself, the aquifer would begin to naturally flush itself of contaminants. The rate at which this flushing would occur depends upon the form in which the contaminants exist within the aquifer. If they are present only as dissolved species they would move at the speed of the ground water and be discharged to Tomichi Creek and the Gunnison River in a period of between 2 years and 33 years depending on ground-water velocities. It is likely, however, that some contaminants exist as sorbed species or as solid precipitates, in which case the contaminants would have to desorb or be dissolved before being flushed from the aquifer. The time required cannot be estimated with available information.]**

No action

If no remedial action is taken, levels of contamination would remain at present levels until the pile has been flushed by infiltrating precipitation and contaminants have been flushed from the aquifer. It is not [**currently**] known how much time this would take[. H]owever[,] it may require [**several**] hundreds of years.

East Gold Basin

If the tailings were moved to the East Gold Basin site they would be lined and covered, just as at the processing site (Appendix B, Section 2.5). Although not anticipated, if shallow ground water exists at the site, infiltration through the pile would probably degrade its quality, just as at the processing site. Before any effects can be estimated, a field program to gather data on flow directions, rates of flow, and water quality would have to be completed. This would be followed by a hydrodynamic and geochemical analysis of the type that is now being performed for the processing site.

Chance Gulch

The impacts of moving the pile to Chance Gulch would be much the same as those stated for the East Gold Basin site. The same type of data collection program and analysis would be required.

Aquifer restoration

**[Following additional data collection and analysis a decision will be made on the need for aquifer restoration or other measures to mitigate the existing ground water contamination. The purpose of aquifer restoration is to remove both the residual contamination and any ongoing contamination produced by the pile, from the aquifer. An aquifer restoration program is a major project in itself requiring thorough planning. A description of aquifer restoration is contained in Appendix D.]**

## 4.6 PLANTS AND ANIMALS

General

The loss of vegetation, habitat for wildlife, and grazing acreage for livestock would be the greatest impact to plants and animals from remedial action. Surface disturbance would be caused by the excavation of contaminated soils and the construction of haul roads, staging areas, and disposal facilities.

All vegetation and the majority of small mammals and reptiles [**at the disturbed areas**] would be destroyed or displaced. Large animals and birds would probably relocate into surrounding habitat. The transportation of the contaminated material to an alternate site would cause a limited increase in animal mortality from road kills [**compared to stabilization in place.**]

taminated soils and the construction of haul roads, staging areas, and disposal facilities.

All vegetation and the majority of small mammals and reptiles **[at the disturbed areas]** would be destroyed or displaced. Large animals and birds would probably relocate into surrounding habitat. The transportation of the contaminated material to an alternate site would cause a limited increase in animal mortality from road kills **[compared to stabilization in place.]**

[Stabilization in place]

Stabilization in place would destroy the sparse vegetation and the few small mammals that occur on the 56-acre site. Removal of the cottonwood and aspen trees along the irrigation ditches would eliminate the breeding and nesting sites for perching birds and herpetofauna.

After the remedial action, the 32 acres containing the stabilized tailings would be covered with a rock layer. The remaining acreage (24 acres) would be recontoured to match the surrounding area and then revegetated.

No action

Implementation of this alternative would have no impacts on the plants and animals or their habitats.

Alternat[e] sites

Relocation to the East Gold Basin site, or the Chance Gulch site, would permanently remove 32 acres of sagebrush shrubland at either site and destroy a few small mammals unable to relocate to adjacent lands. In each case, there would be an additional 15 acres temporarily disturbed for construction staging. Construction of haul roads would disturb an additional 1 acre for the East Gold Basin site and 6 acres for the Chance Gulch site. Limited removal of small mammals and reptiles from the area would occur during transportation along the haul roads and at the site during remedial action.

These sites represent potential feeding and nesting grounds for the sage grouse. Therefore, remedial action could result in increased competition in the surrounding area for suitable space and food. Disturbance of breeding and nesting activities of the sage grouse may also occur.

After the completion of the remedial action, all temporarily lost acreage would be recontoured **[with]** conform to the surrounding area, and revegetated. The permanent loss of grazing land would be a minor portion of the lands available for grazing purposes.

### Vicinity properties

Remedial action at vicinity properties would disturb an estimated 3 acres. These properties are mostly commercial and residential lots. [Excavation and cleanup at these vicinity properties would cause the] loss of landscape vegetation and the small animals associated with each lot.

After remedial action, these areas would be recontoured and landscaped.

### Borrow sites

At the Valco sand and gravel pit and borrow site 1, there would be no additional impacts to plants or animals as [the area is already] highly disturbed by current borrow activities. At borrow site 6, there would be an additional 50 acres of sagebrush shrubland habitat destroyed. The impacts expected would be similar to those described for the alternate sites: the removal of small animals, the minimal loss of feeding and nesting ground, and possible disturbance of the productive activities of the sage grouse.

After remedial action, borrow site 1 and borrow site 6 would be recontoured to be compatible with the surrounding area and revegetated. Reclamation would be conducted in accordance with applicable permit requirements. There would be no reclamation of the [privately owned] Valco gravel pit.

### Endangered and threatened species

There are no threatened or endangered wildlife species currently occupying the Gunnison or alternat[e] disposal sites. The Whooping crane and Greater sandhill crane, which would not be expected to use the sites, rest and feed along Tomichi Creek and the Gunnison River during their migrations. The [Whooping] crane is listed as endangered [on] the [s]tate and Federal endangered species list and the sandhill crane is listed as endangered on the [S]tate list.

The use of either East Gold Basin or Chance Gulch sites or borrow site 6, may effect the Skiff milkvetch (Astragalus microcimbus). The Milkvetch has been found less than three miles southwest from the alternate disposal sites and borrow site 6 in similar habitats. [Due to its proximity to] either alternat[e] or borrow site 6, the [specific] area to be impacted would be examined for endangered and threatened species[. The] DOE would initiate consultation with the USFWS as required under Section 7 of the Endangered Species Act of 1973.

## 4.7 LAND USE IMPACTS

Stabilization in place would prevent the use of 32 acres of land near the city of Gunnison. The stabilized tailings site would be under the direct control of the Federal government and would be permanently restricted from any additional use. However, the remaining 24 acres of the 56-acre designated site would be cleaned up, restored and released for unrestricted use.

The stabilized tailings pile should not have an appreciable effect on land use in the surrounding area. Studies of unstabilized tailings piles have indicated that the development and values of adjacent lands were not affected by the piles. At the Vitro tailings site near Salt Lake City, Utah, a study revealed that land values at and adjacent to the pile were dependent primarily on the current and planned uses of the lands. In Grand Junction, Colorado, residential and commercial development adjacent to the tailings pile have increased over the last 10 years. During that time, a sawmill and lumber yard, several warehouses and businesses, and fifty to sixty housing units have been located near the tailings site (Metzner, 1984).

The no action alternative would have no effect on current land use; however, the 56-acre tailings site would not be available for the uses envisioned in local planning documents. In addition, continued dispersion of the tailings by wind and water erosion would continue to contaminate lands adjacent to the site rendering them unsuitable for human use.

Relocation of the tailings to the East Gold Basin site would permanently prevent the use of 33 acres of land for grazing purposes (32 acres for the disposal site and 1 acre for an access road). This acreage represents a very small portion of the lands available for grazing. The East Gold Basin site is approximately 2500 feet from an active housing development, and relocation of the tailings to the site could have some effect on expansion of this development. The magnitude of these effect[s] cannot be estimated at this time.

Disposal of the tailings at the Chance Gulch site would permanently prevent the use of 38 acres of land for grazing (32 acres for the disposal site and 6 acres for access road). This acreage represents a very small portion of similar lands available for grazing purposes. The Chance Gulch site is 2.5 miles from the nearest residence; therefore, disposal of the tailings at th[is] site should have no effect on the residential developments near Gold Basin Road.

Relocation of the tailings to either the East Gold Basin or Chance Gulch alternat[e] disposal sites would allow release of the existing 56-acre tailings site for unrestricted use. While a portion of the site might still be restricted from use as an airport clear zone easement, the remainder of the site would be suitable for the uses envisioned in local planning documents.

All of the action alternatives would involve temporary disturbance of various acreages of lands. Any action alternative would require the disturbance of 37 acres of land at and adjacent to the tailings site for cleanup of the former ore storage and mill areas and the area contaminated by windblown tailings. These areas would be restored as necessary and released for unrestricted use. Any action alternative would require the disturbance of 50 acres of land at borrow site 6. This land would be reclaimed and released for use in accordance with the borrow permit issued by the [U.S.] Bureau of Land Management. Relocation of the tailings [to] either alternate disposal site would require the disturbance of 15 acres of land at either site for a construction staging area. This land would be reclaimed and released for use in accordance with the applicable permits issued by the [U.S.] Bureau of Land Management. Borrow activities at the Valco borrow site and borrow site 1 would not create additional land disturbance as these sites have experienced previous borrow activities. Reclamation would not be required at the Valco site, but borrow site 1 would be reclaimed and released for use in accordance with the borrow permit issued by the [U.S.] Bureau of Land Management. The temporary land disturbances described above would not create a major impact because they are compatible with current land usage (e.g., Valco borrow site) or the lands would be restored and returned to their present or unrestricted use.

## 4.8 NOISE IMPACTS

A noise prediction model (Kessler et al., 1978) was used to estimate the maximum A-weighted sound level emitted from each of the sites during remedial action. The model inputs [utilized] the numbers and types of equipment that would be used for remedial action, the maximum sound levels generated by this equipment (Table 4.8), and the distances from the sites to the nearest noise-sensitive receptors. The model tends to overpredict the resulting noise levels by assuming that the equipment is clustered as a point source when, in reality, the equipment would be operating over an area of acres. In addition, model inputs do not account for the use of the same equipment for more than one phase of remedial action. [For purposes of analysis] it is assumed that each remedial action phase has its own fleet of equipment, and the overlapping of phases results in a maximum number of equipment on a site at a particular time.

Table 4.8 Sound levels for equipment used for remedial action

| Equipment | Maximum sound level at 50 feet (dB) |
|---|---|
| D-8 bulldozer | 88 |
| Front-end loader | 85 |
| Scraper | 87 |
| Water truck | 89 |
| Haul truck | 86 |
| Compactor | 87 |
| Grader | 83 |

Source: Kessler et al., 1978.

The maximum estimated equivalent sound level at the Gunnison site resulting from stabilization in place would be approximately 94 dBA at a location 50 feet from the center of activity. The nearest residences to the Gunnison site are approximately 1,050 feet away. The maximum noise levels would be attenuated by approximately 25 dBA over this distance, resulting in a 67-dBA noise level at the nearest residences. These sound levels would be greater than the EPA-recommended level for outdoor activity and annoyance of 55 dB ($L_{dn}$), but less than the 70-dB ($L_{eq}$) level established for the protection of hearing (EPA, 1974).

The no action alternative would have no impacts on noise levels.

The maximum noise level produced by remedial action at both the East Gold Basin and Chance Gulch sites would be 94 dBA at a distance of 50 feet from the center of activity. The nearest residence to the East Gold Basin site is approximately 2500 feet away. The maximum noise level would be reduced by about 33 dBA over this distance, resulting in a 61 dBA noise level at the nearest residence. This would exceed the EPA level for annoyance but would be less than the established level for hearing protection. The Chance Gulch site is approximately 2.5 miles from the nearest residence. The maximum noise level of 94 dBA would be reduced [to] background levels over this distance, thereby precluding any noise impact from the remedial action.

There would also be noise produced by the haul trucks travelling to and from the sites for all action alternatives. The haul trucks would produce intermittent high levels of noise along the routes. Noise produced by the trucks can be expected to be approximately 84 decibels at a location of 50 feet removed from the roadway. Such sound levels are high, but would not represent a major impact since the noise-sensitive receptor population is small and the noise levels would be intermittent.

All of the action alternatives include remedial action at the 14 vicinity properties. The largest noise impacts at the vicinity properties would result from the use of backhoes and small (10 cy) dump trucks. Much of the excavation would be performed by hand shovel. The resultant noise levels may disturb persons in adjacent residences but these activities would be of short duration and would be conducted only during normal work hours.

## 4.9 SCENIC, HISTORIC[AL], AND CULTURAL RESOURCES

Impacts to scenic resources

Stabilization in place would have a minor impact on scenic resources in the area. There would be a permanent but inconsequential change in the immediate viewshed around the site due to the new shape and height of the pile. Foreground views of areas surrounding the tailings pile would be temporarily altered due to removal of vegetation and earthmoving during decontamination activities. Excavation at the borrow sites would alter the elements of color, contrast, and texture until surface reclamation was complete.

Disposal of the tailings at either the East Gold Basin or Chance Gulch alternat[e] sites would cause the views across the selected disposal site to be changed due to the truncated pyramid appearance of the final tailings cover configuration. The rock-covered disposal site would contrast in texture, color, and shape with surrounding terrain. Land user visual sensitivity is higher with the East Gold Basin alternative due to the location of the site within the viewshed of several homes in adjacent residential subdivisions.

The no-action alternative would have no impact on scenic resources.

Impacts on historic cultural resources

No sites currently listed on the National Register of Historical [Places] would be impacted by any of the alternatives. Two sites that are eligible for nomination to the National Register of Historic Places are located within [0].25-mile of the tailings pile and within [0.5] mile of the Chance Gulch alternat[e] disposal site. Neither of these sites would be impacted by any of the alternatives. Impacts to historic sites in the town of Gunnison as a consequence of vicinity property decontamination may occur, but are unlikely. A [definitive] assessment of these potential impacts cannot be done until a decision is made to include specific vicinity properties in cleanup activities.

The no-action alternative (Alternative 2) would have no impact on cultural resources.

Cultural resources may be adversely affected by the [stabilization in place] due to excavation of borrow materials at the previously undisturbed borrow site 6. Assuming a density of 6.8 sites per square mile (Section 3.11), the 50-acre borrow site would affect less than one (0.53) archaeological site.

The East Gold Basin alternat[e] would impact 98 acres of previously undisturbed land which would affect an estimated one archaeological sites [assuming a density of 6.8 sites per square mile is accurate.]

Selection of the Chance Gulch alternative would cause impacts to the Chance Gulch archaeological district. Assuming a site density of 28.57 archaeological sites per square mile, remedial action at this site and road construction would impact 4 archaeological sites. Borrow material excavation would impact an additional 1.1 archaeological sites assuming a site density of 6.8 archaeological sites per square mile for the borrow site area.

Prior to affecting previously undisturbed lands as part of any of the action alternatives, Class III archaeological [field] surveys would be completed. Archaeological sites that are deemed to be significant by the State Historic Preservation Officer (SHPO) or the BLM would be avoided if feasible. [S]ites that could not be avoided would be studied further, excavated (if necessary), and salvaged to maximize the recovery of archaeological data. Mitigation by avoidance, fencing, excavation, or salvage would be determined in consultation with the SHPO, BLM, and the surface land owner.

A benefit of the Chance Gulch alternative would be the opportunity to obtain additional information about the extent of the Chance Gulch archaeological district. The geographic boundaries of the district have not been delineated, especially in the higher elevations of Chance Gulch where the alternative site is located.

## 4.10 POPULATION AND WORK FORCE

The following section analyzes the impacts of the various remedial action alternatives on the Gunnison area's population and labor force. This section summarizes more detailed analyses which are provided in Appendix G.

Stabilization in place would involve an overall average employment of 65 workers over an 18-month period. The 8-month period when activities would be at their highest level would involve 102 workers. It is estimated that 84 of these workers would be Gunnison County residents, with 18 workers inmigrating from outside the County. Some of these inmigrants would bring their families with them; total direct employment-related inmigration is estimated to be 38 individuals. Using an indirect employment multiplier of 1.7 (0.7 new indirect jobs for each direct job created), an additional 71 indirect jobs would be created, resulting in a total indirect employment-related population increase of 87 persons. In summary, over an 8-month peak period, stabilization in place would involve the creation of a total of 173 new jobs and a population increase of 85 persons. This would represent an increase in total County employment of 2.9 percent over 1983 levels, and an increase in County population of 0.7 percent, also over 1983 levels.

The no-action alternative would have no impacts on the local population or employment.

Tailings disposal at East Gold Basin would involve an overall average work force of 78 workers over a 24-month period. The 14-month extended peak period would involve 111 workers. Using the same assumptions as for stabilization in place regarding local and inmigrant labor for both direct and indirect employment, 189 new direct and indirect jobs would be created for a 14-month period, involving a total population increase of 114 individuals. This would represent a roughly 1 percent increase in County population and a 3.1 percent increase in total County employment (both over 1983 levels).

Tailings relocation to Chance Gulch would involve an average employment of 74 workers over a 30-month period, and 108 workers during the 20-month extended peak period. Using the same assumptions as for the other two action alternatives, a total of 184 new direct and indirect jobs would be created for a 20-month period. The total population increase would be 111 persons. These values represent an increase of 0.9 percent (population) and 3 percent (employment) over 1983 County levels.

## 4.11 HOUSING, SOCIAL STRUCTURE, AND COMMUNITY SERVICES

Project housing demand is estimated at 36 (stabilization in place) to 44 (East Gold Basin) units. This would [affect] from 65 to 80 percent of the available rental units in the City of Gunnison, if all of the inmigrants seek housing in the City and if 1980 vacancy rates exist at the time of the remedial action. However, some inmigrants might arrange for rental housing elsewhere in Gunnison County, or stay in motels in the area.

Because of the importance of tourism to the area and because of the presence of Western State College in Gunnison, the area deals regularly with transient populations (tourists and students). Thus, none of the action alternatives would be expected to have a significant adverse impact on the social structure of the Gunnison area.

The peak inmigrant population associated with any of the action alternatives would be 85 people for stabilization in place, 114 people for East Gold Basin and 111 people for Chance Gulch. Between 22 and 26 school age children would be expected to be included in this inmigrant population. Given the ample capacity in the local public schools, no adverse impact would be expected.

Project-related water consumption would not be expected to tax the local water supply system. Although project demand would be a small fraction of the capacity of the local sewer systems, the City of Gunnison's sewage treatment plant is overloaded during the summer months because of ground-water infiltration problems. The incremental project demand would contribute slightly to this problem, although the City hopes to receive Federal grants to allow development of a new and larger treatment plant by 1986 or 1987.

None of the action alternatives would have an appreciable adverse impacts on local police, fire, health care, or recreational agencies/facilities. The no action alternative would have no impact on local housing, social structure, or community services.

## 4.12 IMPACTS ON ECONOMIC STRUCTURE

Implementation of any of the action alternatives would impact the local economy through wages and salaries to direct and indirect employees, through the project's local spending for materials, equipment, and supplies, and through indirect expenditures as project dollars spent locally are respent on other goods and services. There also would be sales tax revenues that would accrue to local governments, as well as state (and Federal) income tax payment by the recipients of the wages and salaries.

The total direct input to the economy of Gunnison County **[for stabilization in place]** is estimated at $2,630,000 in both direct and indirect wages and salaries and $4,300,000 in local expenditures for materials and equipment. Using a multiplier for local wage and salary expenditures of 1.85 (every dollar in wages and salaries would generate an additional

$0.85 in secondary spending), an additional $2,236,000 in local expenditures would be generated. Thus, the total impact of the stabilization in place alternat[e] on the local economy is estimated at approximately $9,166,000.

Tailings relocation to East Gold Basin would produce $3,835,000 in local wages and salaries and $4,300,000 in local expenditures for equipment and materials. Applying the 1.85 secondary spending multiplier results in an additional $3,250,000 in local spending. Total impact of the East Gold Basin alternative on the County economy is thus estimated at $11,385,000.

Relocating the tailings to Chance Gulch would involve $4,660,000 in local wages and salaries and $4,700,000 in local spending for materials and equipment. Applying the 1.85 secondary spending multiplier results in an additional $3,960,000 in local spending. The total impact of the Chance Gulch alternative on the Gunnison County economy thus would be approximately $13,390,000.

The no-action alternative would have no impact on the local economy.

Table 4.9 Economic impacts on Gunnison County

| | Direct | Direct and indirect |
|---|---|---|
| Stabilization in place | $ 6,930,000 | $ 9,166,000 |
| No action | 0 | 0 |
| East Gold Basin | 8,135,000 | 11,385,000 |
| Chance Gulch | 9,360,000 | 13,390,000 |

## 4.13 TRANSPORTATION NETWORKS

The only public roadway that would be substantially affected by the remedial action alternatives would be Gold Basin Road, as the route between the existing tailings site, both alternat[e] disposal sites, and the borrow sites involve only Gold Basin Road and access roads developed for the remedial action. The portion of Gold Basin Road extending from the site to borrow site 1 would be the primary area of impact; all commuter traffic from remedial action workers would be from areas north of the site.

Impacts, however, would be short-term (i.e., the duration of the remedial action); no long-term impacts would occur. All project vehicular traffic would occur during normal weekday working hours. Impacts of any of the remedial action alternatives on U.S. Highway 50 would be minor. Assuming one commuting worker per car, and that all workers use U.S. Highway 50, traffic volumes at the intersection of U.S. 50 and State Highway 135 would increase as follows:

- o Stabilization in place: 130 one-way trips per day (average for 18 months)

  214 one-way trips per day (peak month).

- o East Gold Basin alternative: 156 one-way trips per day (average for 24 months)

  232 one-way trips per day (peak month)

- o Chance Gulch alternative: 148 one-way trips per day (average for 30 months)

  232 one-way trips per day (peak month)

The above values would represent a maximum increase (peak month) of 2.3 percent over the estimated 10,000 trips per day recorded on U.S. 50 at State 135 in 1981.

All of the action alternatives would require the excavation and removal of 1,200 feet of Gold Basin Road to the north and east of the Gunnison site to remove windblown contamination. Traffic would be routed around (adjacent) the excavation activities and the road would be resurfaced following removal of the contaminated material.

Removal of windblown material would occur within 50 feet of the main Gunnison County Airport runway and the emergency runway. Full consultations with the Federal Aviation Administration and the Gunnison County Airport would be maintained to reduce or eliminate any impacts on airport traffic.

Gold Basin Road is a lightly travelled two-lane roadway. Each of the remedial action alternatives would represent a substantial, although relatively short-term[,] addition to traffic volumes on Gold Basin Road and could cause congestion, with the extent and duration of this impact varying among the alternatives.

Stabilization in place would involve an average of 543 trips per day on Gold Basin Road over the 18-month construction period. During the peak month of activity an estimated 1,020 trips per day are predicted.

The no-action alternative would have no impact on local transportation/networks.

Relocation of the tailings to East Gold Basin would involve an average of 695 trips per day on Gold Basin Road and an unimproved dirt road to the site over a 24-month period. During the peak month of activity, 1,272 trips per day are expected.

Implementation of the Chance Gulch alternative would involve an average of 586 trips per day on Gold Basin Road and an unimproved dirt road to the site over a 30-month period. During the peak month, 1,067 trips per day are estimated.

All of the action alternatives include remedial action at the 14 off-site vicinity properties. This activity involves excavating 1,400 cubic yards (cy), 100 cy at each property, and transporting this material, in 10 cy trucks to the Gunnison site. Since the vicinity properties are an average of [0].54 miles from the Gunnison site the total number of miles traveled would be 151 and the resulting impact would be minor. The road upgrading would include the widening (to 40 feet) of the road and the construction of sub-base and base (gravel) layers.

As shown in Table 4.10[,] existing unimproved dirt roads would be upgraded for each of the action alternatives.

Table 4.10 Road construction for remedial action

| | |
|---|---|
| Stabilization [in place] | Upgrade 0.8 miles from Gold Basin Road to borrow site 6 |
| East Gold Basin | Upgrade 0.8 miles from Gold Basin Road to East Gold Basin site |
| Chance Gulch | Upgrade 4.4 miles from Gold Basin Road to Chance Gulch site |

## 4.14 ENERGY AND WATER CONSUMPTION

All of the alternatives except the no-action alternative would require the expenditure of energy to operate equipment and to provide electricity for on-site operations, and would consume water. Water would be needed for on-site operations and would be used by the inmigrant population necessary to perform the proposed action. Table 4.11 lists fuel, water, and electrical requirements for [stabilization in place] and for disposal at the East Gold Basin and Chance Gulch sites. Appendix B provides additional details on energy use and Section 4.11 addresses [the impacts of project] water consumption [on local water supply systems.]

## 4.15 IMPACTS FROM ACCIDENTS NOT INVOLVING RADIATION

The various remedial action alternatives would involve extensive use of heavy construction machinery (e.g., dozers, scrapers, front-end loaders) and many heavy truck trips as tailings, other contaminated material, and clean cover material[s are] transported between the tailings disposal and borrow sites. Project workers would also be commuting between their homes and the work site. Because a high proportion of the project work force is expected to be available locally and based on historic commuting patterns for workers in the Gunnison area (BMML, 1980), an average commuting distance of 10 miles (one-way) is assumed for project workers.

Table 4.11 Fuel, water, and electricity consumption

| Alternative | Fuel use (gallons) | Water use (000 gallons)[a] | Electrical use (kilowatt-hour) |
|---|---|---|---|
| [Stabilization in] [place] | 800,000 | 23,320 | 216,000 |
| East Gold Basin | 1,434,000 | 27,028 | 293,000 |
| Chance Gulch | 1,894,000 | 33,450 | 621,000 |

[a]Includes inmigrant domestic water consumption and remedial action water consumption rates.

The construction equipment used and transportation activities associated with each alternat[e] pose the risk of accidents and resulting injuries and fatalities. Based on nationwide data, the operation of all types of machinery (e.g., tractors, forklifts, cranes, bulldozers, and trucks) would result in about 0.15 non-fatal accidents leading to loss of work time per man-year (DOT, 1977).

The following 1983 motor vehicle (including both trucks and autos) accident rate data for Gunnison County are based on data obtained from personnel of the Colorado State Patrol (Smith, 1984). Fatal accidents occurred at the rate of one fatal accident for each 24,708,000 miles travelled (6 fatal accidents in an estimated 148,250,000 vehicle miles travelled); injury accidents occurred at the rate of one for each 1,336,000 vehicle miles travelled (111 injury accidents in 148,250,000 vehicle miles travelled). Based on a 1982 report, (Ramano et al.[, 1982]), truck travel (nationwide in both urban and rural areas) resulted in 1 fatality per 20,833,000 miles travelled and 0.82 injuries per million miles travelled (equivalent to 1 injury per 1,270,000 miles travelled). The analyses presented below express expected transportation fatalities and injuries in terms of both of the above accident rate factors.

Non-radiological accident impacts associated with the various remedial action alternatives are estimated below based on the vehicle miles travelled and man-years of labor associated with each alternat[e]. It should be noted that the equipment use accident data include truck use, and thus appear to be partly redundant with the purely transportation accident data. It also should be noted that a significant percentage of the vehicular travel associated with disposal at East Gold Basin and Chance Gulch (particularly Chance Gulch), would be on access roads used solely by project vehicles, and not on public roads. The historical traffic accident rate data used are for public roadways. The likelihood of accidents such as collisions between project vehicles and other vehicles obviously would be less on the dedicated access roads than on public roadways. Thus, the accident data presented below can be considered as conservative (over-predicting accidents).

Stabilization in place

Stabilization in place would have the least off-site vehicular travel among the various alternatives because there would be no off-site transport of large volumes of tailings. As shown in Table 4.12, 242,400 total vehicle miles would be involved (including worker commuting and vicinity properties cleanup). Based on historical Gunnison County accident rate data, 0.01 fatalities and 0.18 injuries would occur. Based on the nationwide truck-only accident rate (which is very similar to the Gunnison County combined truck and auto accident rate), 0.01 fatalities and 0.20 injuries would occur.

Stabilization in place would involve an estimated 89.1 man-years of labor (including vicinity properties cleanup). Assuming an equipment use accident factor of 0.15 injury accidents per man-year of labor, 13.4 injury accidents leading to loss of work time would be expected. In summary, the stabilization in place alternative would be expected to produce a total of 0.01 fatality and 13.6 injuries.

Table 4.12 Non-radiological accident impacts

| Alternative | Total off-site vehicle miles travelled[a] | Total man-years of labor[a] | Traffic accident fatalities | Traffic accident injuries | Equipment use accident injuries[b] | Total fatalities | Total injuries |
|---|---|---|---|---|---|---|---|
| Stabilization in place | 242,400 | 89.1 | 0.01 | 0.18-0.20 | 13.4 | 0.01 | 13.6 |
| East Gold Basin | 531,800 | 138.5 | 0.02-0.03 | 0.40-0.44 | 20.8 | 0.02-0.03 | 21.2 |
| Chance Gulch | 1,349,700 | 165.4 | 0.06-0.07 | 1.01-1.11 | 24.8 | 0.06-0.07 | 24.8-24.9 |

[a]Includes vicinity properties cleanup.

[b]Injury accidents are defined as those leading to loss of work time.

No action

The no action alternative would have no impacts in terms of traffic or construction-related accidents.

East Gold Basin

Tailings disposal at East Gold Basin would involve a total of 531,800 vehicle miles travelled. Traffic accident fatalities would be expected to range from 0.02 (local data) to 0.03 (nationwide truck-only data); traffic accident injuries would be expected to range from 0.40 (local data) to 0.44 (nationwide truck-only data). The 138.5 man-years of labor associated with disposal at East Gold Basin would produce an estimated 20.8 equipment use-related accidents. Thus, in summary, the East Gold Basin alternative would result in 0.02 to 0.03 fatalities and 21.2 injuries leading to loss of work time.

Chance Gulch

The Chance Gulch alternative would involve an estimated 1,349,700 miles in vehicular travel. Traffic accident fatalities would range from 0.06 (local data) to 0.07 (nationwide truck-only data). Traffic accident injuries would range from 1.01 (local data) to 1.1 (nationwide truck-only data). Based on an estimated total of 165.4 man-years of labor, equipment use would result in 24.8 injury accidents. In summary, the Chance Gulch alternative would result in 0.06 to 0.07 fatalities and 24.8 to 24.9 injuries.

## 4.16 MITIGATIVE MEASURES

As stated in Section 2.3, the engineering designs for all alternatives, except the **[stabilization in place]**, are based on existing published data. If an alternative other than the preferred alternative is selected, additional site-specific data would be obtained before the final engineering designs are **[prepared]**.

### 4.16.1 Mitigative measures during remedial action

The following mitigative measures were incorporated into the design and approach for each of the **[relocation]** alternatives in order to reduce the environmental impacts.

- o Application of water **[and/or]** chemical dust suppressants to dirt and gravel haul roads to inhibit dust emissions.
- o Construction of silty clay tailings covers to inhibit radon emanation (consistent with EPA standards) and surface-water infiltration.
- o Use of local labor whenever possible to reduce the sociological impacts to the local communities and **[maximize]** economic benefits.

- o Covering of haul trucks to prevent dispersion of tailings during relocation.

- o Construction of surface runoff diversion channels to direct runoff away from the stabilized tailings and prevent long-term erosion.

- o Construction of a rock cover on the stabilized tailings to assure that the stabilized pile could withstand the erosive effects of a Probable Maximum Precipitation (PMP).

- o Design of the stabilized tailings to withstand a Maximum Credible Earthquake (MCE).

- o Selection of borrow sites which are as close to the disposal sites as possible to reduce costs and eliminate the impacts of long haul distances.

- o Reclamation, including filling, grading, topsoiling, and revegetating of borrow sites (as required).

- o Removal of all contaminated soils (consistent with EPA standards) adjacent to the tailings piles and consolidation of the contaminated soils with the tailings.

- o Stockpiling of various soils encountered at the borrow sites for future use during reclamation.

- o Immediate cleanup of any off-site spills.

- o Implementation of complex cover designs [for the tailings piles] to prevent inadvertent human intrusion after remedial action.

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

- o Construction of evaporation ponds to prevent dispersal of tailings by runoff during remedial action.

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

- o Cleanup of any equipment used before release for use on other projects to prevent the spread of contaminated materials.

- o Construction of temporary berms at each site to prevent surface water from leaving the site during remedial action.

The following mitigative measures were incorporated into individual alternatives:

Stabilization in place

- o Construction of an elevated foundation for the pile on the south side of the designated site to elevate the stabilized tailings above the shallow ground water.
- o Construction of a tailings embankment with a capillary break and filter layer to prevent contamination of ground water.
- o Consolidation of the tailings in the southern portion of the existing site to increase the amount of land available for unrestricted use.

East Gold Basin

- o Construction of a tailings embankment with a capillary break and filter layer to prevent contamination of ground water.
- o Backfilling, grading, topsoiling, and revegetating the areas disturbed at the Gunnison site as required during removal of tailings, contaminated soils, and borrow material.
- o Grading, topsoiling, and revegetating areas disturbed at the East Gold Basin site for a temporary staging area.
- o Release of the Gunnison site for unrestricted use following remedial action.

Chance Gulch

- o Construction of a tailings embankment with a capillary break and filter layer to inhibit contamination of ground water.
- o Backfilling, grading, topsoiling, and revegetating the areas disturbed at the Gunnison site as required during removal of tailings, contaminated soils, and borrow material.
- o Grading, topsoiling, and revegetating areas disturbed at the Chance Gulch site for a temporary staging area.
- o Release of the Gunnison site for unrestricted use following remedial action.

### 4.16.2 Worker protection during remedial action

Training sessions applicable to the degree of radiation hazards present at the site [will] be conducted for all employees prior to the start of work. These sessions would include discussion of the industrial and radiological safety procedures, emergency procedures, and the effects of prenatal radiation exposure. Records would be maintained which document successful completion of training by employees.

Controlled areas would be designated and conspicuously marked. Access to these areas would be restricted, and all personnel and equipment would be monitored for contamination. Access control records would be maintained. Those records would include a log of personnel and equipment entering and leaving the restricted area and a log of dosimeters issued.

Protective clothing would be distributed to employees at the access control point when conditions warrant. Change and cleanup facilities would be provided.

Thermoluminescent dosimeters (TLDs) or film badges would be supplied to permanent employees working in controlled areas. Dosimeters would be changed quarterly or more frequently if necessary. Urinalysis would be used to monitor employees['] internal exposures where potential ingestion of radioactive material is indicated by air sampling data. Additional dosimetry might be required if positive results were noted. A system of employee health records would be maintained which documents individual radiation exposures and the results of personnel dosimetry and bioassays.

Air particulate samples would be collected in work areas and at site boundaries. Samples would be analyzed for gross alpha levels, and would be stored for later isotopic analyses, if necessary. Additional samples would be collected in work areas where ventilation was limited, and analyzed for radon daughter concentrations.

A respiratory protection program [would be developed by the Remedial Action Contractor (RAC),] with procedures [developed] for training employees and checking for adequate fit of respirators. Respirators would be used in work areas where air particulate concentrations exceeded a projected monthly concentration of 25 percent of the regulatory limit for a given radionuclide. Industrial hazards would be controlled in accordance with OSHA regulations.

Additional details of the health and safety plan are available in the draft Remedial Action Plan (DOE, 1984).

### 4.16.3 Maintenance and surveillance

Title I of the UMTRCA defines the authority and roles of the Department of Energy (DOE), the Nuclear Regulatory Commission ("Commission"), and the intent of licensing regarding inactive tailings sites in the various states. In part, Section 104(f)(2) of the UMTRCA reads:

> "...upon completion of the remedial action program...(the site) shall be maintained pursuant to a license issued by the Commission in such manner as will protect the public health, safety, and the environment. The Commission may, pursuant to such license or rule or order, require...monitoring, maintenance, and emergency measures necessary to protect public health and safety and other actions as the Commission deems necessary to comply with the standards (EPA) of Section 275..."

Accordingly, the remedial action must demonstrate compliance with the EPA standards (40 CFR 192) and thus, the prime objective of licensing is to ensure continued compliance with the EPA standards via a post-remedial action maintenance and surveillance program.

DOE would conduct the maintenance and monitoring [program] pursuant to the requirements of the Commission's license until termination of the UMTRCA (i.e., March 7, 1990). At that time, the DOE or another agency to be designated by the President would maintain the site as required by the Commission.

A detailed custodial maintenance and surveillance program would be defined jointly by the DOE and the NRC during the NRC license application and approval process. The following are the basic elements of this program as proposed by DOE at this time.

#### Site inspections

Site inspections constitute a visual and definitive verification that the disposal site continues to function as designed and assures continued compliance with the design standards. Inspections would consist of two phases: Phase I, which is a systematic walk-over, is designed to qualitatively evaluate the condition of the disposal site; Phase II constitutes investigations to quantitatively assess changes in the disposal site that could lead to functional failure of the design in the absence of custodial maintenance. The Phase I inspection would be conducted on a specific schedule, such as annually, by a team of qualified professionals. The inspection team would review as-built drawings, engineering details, aerial photographs, and supporting documentation. A site walk-over would then be performed to evaluate any changes at the site with regard to factors such as erosion, flood effects, slope cover stability, settlement, displacement, plant or animal intrusion, and access control.

Based upon the evaluation and recommendations of the inspection team, Phase II studies might be conducted to quantitatively determine the magnitude and rate of effect of changes in the above factors. From these studies, the need for a corrective action (i.e., custodial maintenance) would be ascertained.

Aerial photography

Aerial photography might be used to supplement site inspections. The objectives might be to identify changes in site conditions (e.g., patterns of developing erosion that might affect the function of the design), provide visual documentation of year-to-year variation in site conditions, and to identify activities (e.g., road conditions, storm drainage construction) adjacent to the site that might affect its function.

Aerial photography might be conducted on the same schedule as site inspection. Photographs would be taken at both low (i.e., high resolution) and higher (i.e., for adjacent activities) altitudes, and at oblique and vertical angles. The types of film, ground control, camera specifications, amount of aerial overlap, interpretative keys, and other requirements, would be established prior to completion of remedial action.

Ground-water monitoring

Certain existing wells would be preserved during construction for use as monitoring wells after completion of the remedial action. In addition to those wells, a series of both shallow and deep wells might be installed for the purpose of monitoring ground-water quality. Locations for these wells would be selected in order to monitor the performance of the tailings embankment. Details of the ground-water monitoring monitoring would be developed during the NRC licensing process.

Reporting

Summary surveillance and monitoring reports that evaluate the results of these activities and recommend needed custodial maintenance (i.e., corrective actions) and future surveillance and monitoring would be prepared. Reports and supporting documentation would be placed on file with DOE, NRC, the State of Colorado, and Gunnison County.

Custodial maintenance

The need for custodial maintenance (i.e., corrective action) can only be determined following site inspection and monitoring, and by NRC and DOE evaluation of the reports of these activities. However, it is anticipated that custodial maintenance would consist primarily of the following:

- Limited soil/rock replacement because of unanticipated erosion, human or animal intrusion, or cover disturbance. These activities would be expected to be required infrequently.

- Control of deep-rooted plants by infrequent application of herbicides or physical removal as required.

- Mechanical repairs to security fence, gates and locks, and warning signs, when necessary.

Contingency plans

In case of severe meteorological events (e.g., extreme rainfall, or seismic events) or unusual human intrusion, procedures would be developed to initiate inspection and to institute custodial maintenance of the disposal site.

## REFERENCES FOR CHAPTER 4.0


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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **[ADT** | **Average Daily Traffic]** |
| ANL | Argonne National Laboratories, Argonne, Illinois |
| AQCR | Air Quality Control Region |
| AUM | Animal Unit Month |
| BEIR | Advisory Committee on the Biological Effects of Ionizing Radiation of the National Academy of Sciences (also their report) |
| BLM | Bureau of Land Management, U.S. Department of the Interior |
| **[CEQ** | **Council on Environmental Quality]** |
| CFR | Code of Federal Regulations |
| **[cm** | **Centimeter]** |
| cfs | Cubic feet per second |
| CO | Carbon monoxide |
| **[cy** | **Cubic yard]** |
| dBA | Decibels on the A scale; a logarithmically based unit of sound intensity weighted to account for human auditory responses |
| DOE | U.S. Department of Energy |
| [EIS] | Environmental Impact Statement |
| EGR | External gamma radiation |
| EPA | U.S. Environmental Protection Agency |
| FWS | U.S. Fish and Wildlife Service |
| FBDU | Ford, Bacon, & Davis, Utah, Inc. |
| FR | Federal Register |
| g | Grams; a unit of weight = 0.035 ounce |
| **[gpd** | **Gallons per day]** |
| gpm | Gallons per minute |
| HC | Hydrocarbon |
| kw | Kilowatt |

| | |
|---|---|
| kwh | Kilowatt hours |
| l | Liter; a unit of volume = 1.057 quarts |
| $L_{dn}$ | Day-night sound level, measured in decibels |
| $L_{eq}$ | Equivalent sound level, measured in decibels |
| m | Meter; a unit of length = 3.28 feet; also milli, a prefix meaning one-thousandth ($10^{-3}$) |
| MCE | Maximum Credible Earthquake |
| mg | Milligrams; a thousandth of a gram |
| [MGD/microg | Microgram; a millionth of a gram] |
| mR/hr | Milliroentgens per hour |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | National Environmental Policy Act of 1969 (PL91-190) |
| NOAA | National Oceanic and Atmospheric Administration |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Nitrogen oxides |
| NRC | U.S. Nuclear Regulatory Commission |
| NRHP | National Register of Historic Places |
| $O_3$ | Ozone |
| ORNL | Oak Ridge National Laboratory, Oak Ridge, Tennessee |
| p | Pico, a prefix meaning one trillionth ($10^{-12}$) |
| pCi/g | Picocuries per gram |
| pCi/l | Picocuries per liter |
| [$pCi/m^2sec$ | Picocuries per square meter per second] |
| PMF | Probable Maximum Flood |
| PMP | Probable Maximum Precipitation |
| ppm | Parts per million |
| Rn-222 | Radon-222 |
| Ra-226 | Radium-226 |

| | |
|---|---|
| RDC | Radon-daughter concentration |
| SCS | Soil Conservation Service, U.S. Department of Agriculture |
| **[SHB** | **Sergent, Hauskins, and Beckwith]** |
| SHPO | State Historic Preservation Officer |
| **[SIP** | **Stabilization in place]** |
| $SO_2$ | Sulfur dioxide |
| **[$SO_x$** | **Any oxide of sulfur]** |
| TSP | Total suspended particulates |
| UMTRA Project | Uranium Mill Tailings Remedial Action Project |
| UMTRCA | Uranium Mill Tailings Radiation Control Act of 1978 (PL95-604) |
| USBR | Bureau of Reclamation, U.S. Department of the Interior |
| USGS | U.S. Geological Survey |
| VRM | Visual Resource Management Program of the U.S. Bureau of Land Management |
| WL | Working level (a measure of radon-daughter-product concentration) |
| WLM | Working-level month (exposure to 1 WL for 170 hours) |

# GLOSSARY

| | |
|---|---|
| absorbed dose, radiological | Radiation energy absorbed per unit mass, usually given in units of rads. |
| **[aeolian erosion** | **Land erosion caused by wind.]** |
| 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. |
| animal unit month (AUM) | The amount of feed or forage required by one mature cow and calf for one month. |
| anisotropy | A variation in the general water flow direction within an aquifer. Water in an anisotropic aquifer may not flow parallel to the hydraulic gradient. |
| 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. |
| A-weighted scale | Sound pressure 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. |
| beta particle | Charged particle emitted from the nucleus of an atom during radioactive decay, with mass and charge equal to those of an electron. |
| bioassay | A method for quantitatively determining the concentration of radionuclides in a body by measuring the quantities of those radionuclides that are eliminated from the body, usually in the urine or the feces. |

| | |
|---|---|
| Class I to III archaeological surveys | Relates to an archaeological investigation of probable occurrence of cultural resources within a given locale. A Class I survey is a literature search for predetermined archaeological features of historic significance; a Class II survey is a combination of a literature review and a partial but cursory excavation of an area to determine the presence of cultural resources; a Class III survey is an in-depth inspection of an area to determine the presence of archaeological materials where the likelihood of their occurrence is high, based on the history of the area. |
| colluvium | Weathered geologic material transported by gravity. |
| confined aquifer | An aquifer bounded above and below by relatively impermeable rock layers. |
| confining layer | A stratum immediately above or below an aquifer with a hydraulic conductivity less than that of the aquifer. |
| curie (Ci) | The unit of radioactivity of any nuclide, defined as precisely equal to $3.7 \times 10^{10}$ 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 radioactive contamination from 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 | The planned safe permanent placement of radioactive 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. |
| 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 results and will result from exposure to radioactive materials over a discrete time period; given in units of rems. |

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| 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." |
| endemic | Belonging to or native to a locality or region. |
| escarpment | A steep face terminating high lands abruptly, a cliff. |
| **[excess health effects** | **Adverse physiological response from radiation exposure (in this report, one health effect is defined as one cancer death from exposure to radioactivity).]** |
| exposure | The presence of gamma radiation that may deposit energy in an individual; given in units of roentgens. |
| 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. |
| floodplain | Lowland or relatively flat areas that are subject to flooding. A 100-year floodplain has a 1 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. |
| gamma | A high energy and deep 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 bore hole. |
| gamma ray | High energy electromagnetic radiation emitted from some radiation 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. |
| grazing allotment | An entitlement given by a government agency or Indian tribe to a person or persons to use a specified parcel of land for the grazing of livestock. |
| ground water | Water below the land surface, generally in a zone of saturation. |
| half life | The time required for 50 percent of the quantity of a radionuclide to decay into its daughters. |

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| hydraulic conductivity | Ratio of flow velocity to driving force (for viscous flow under saturated conditions of a specified liquid in a porous medium). |
| hydraulic gradient | Pressure gradient; rate of change of pressure head per unit of distance of flow at a given point. |
| 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. |
| lek | A mating and display area for various upland game birds, including the sage grouse. |
| 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. |
| 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. |
| man-rem | Unit of population exposure obtained by summing individual dose-equivalent values for all people in the population. Thus, the number of man-rems attributed to 1 person exposed to 100 rems is equal to that attributed to 100 people each exposed to 1 rem. |
| mass wasting | The slow downslope movement of rock debris (due to gravity). |
| micro | A prefix meaning one millionth (x 1/1,000,000 or $10^{-6}$). |
| milli | A prefix meaning one thousandth (x 1/1000 or $10^{-3}$). |
| Modified Mercalli (scale) | A standard scale for the evaluation of the local intensity of earthquakes based on observed phenomena such as the resulting level of damage. Not to be confused with magnitude, such as measured by the Richter scale, which is a measure of the comparative strength of earthquakes at their sources. |
| 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.

**native ground water** — Naturally occurring ground water which has not had its chemical character altered as a result of human activities.

**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.

[**orographic** — Weather patterns influenced by mountains.]

**passive institutional controls** — Those controls which preclude human contact with the waste or require a continuing social order. Examples include Federal ownership of a disposal site, monuments on the site, records with agencies, and physical barriers (e.g., riprap covers, vegetation, waste burial).

**perched ground water** — Ground water separated from an underlying body of ground water 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** — Same as man-rem.

**pico** — A prefix meaning one trillionth (1 x 1/1,000,000,000,000 or $10^{-12}$).

**picocurie** — A unit of radioactivity defined as 0.037 disintegrations per second.

**piezometric surface** — The potentiometric surface of an aquifer. This represents the pressure exerted on a confined aquifer, or the water table in an unconfined aquifer.

**pit run rock** — Rock materials (sometimes with a rock diameter specification) that are not screened for size segregation prior to use in the construction industry.

**primary succession type** — A plant that colonizes an area not previously covered by vegetation.

**proton** — An electrically positive elementary particle found in the nucleus of an atom. Also, the nucleus of a hydrogen atom.

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| 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 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 | A radioactive nuclide. |
| radium-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 | 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. |
| range type | A distinctive kind of rangeland that has a certain potential for producing rangeland plants. Each type has its own combination of environmental conditions and characteristic plant communities. |
| recharge | Resupply, replenish. |
| rem | A unit of dose equivalent equal to the absorbed dose in rads times quality factor times any other necessary modifying factor. It represents the quantity of radiation that is equivalent in biological damage to 1 rad of x-rays. |
| roentgen | A unit of measure of ionizing radiation in air; 1 roentgen in air is approximately equal to 1 rad and 1 rem in tissue. |
| soil infiltration rate | The rate at which water enters the soil surface and moves vertically. |
| soil percolation rate | The rate at which water moves through soil in all directions. |
| stabilization | The reduction of radioactive contamination in an area to a predetermined level by a standards-setting board such as the EPA, by encapsulating or covering the contaminated material. |
| surveillance | The observation of the disposal site for purposes of visual detection of need for custodial care, evidence of intrusion, and compliance with other license and regulatory requirements. |

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| tailings, uranium-mill | The wastes remaining after most of the uranium has been extracted from uranium ore. |
| thorium-230 | A radioactive-daughter product of uranium-238; it has a half life of 80,000 years and is the parent of radium-226. |
| transmissivity, hydraulic | A measure of the ability of an aquifer to transmit water equal to the product of the permeability and the thickness of the aquifer, expressed in gallons per day per foot of drawdown. |
| UMTRA Project | Uranium Mill Tailings Remedial Action Project of the 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 Gunnison site that is determined by the DOE, in consultation with the NRC, to be contaminated with residual radioactive material derived from the Gunnison site, and which is determined by the DOE to require remedial action. |
| water table | The surface of a body of unconfined ground water at which pressure is equal to that of the atmosphere. |
| working level (WL) | A measure of radon-daughter-product concentrations. Technically, it is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of alpha particles with a total energy of 130,000 MeV. |
| working-level month (WLM) | The exposure resulting from inhalation of air with a month (WLM) concentration of 1 WL for 170 working hours. Continuous exposure of a member of the general public to 1 WL for one year results in approximately 53 WLM. |

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