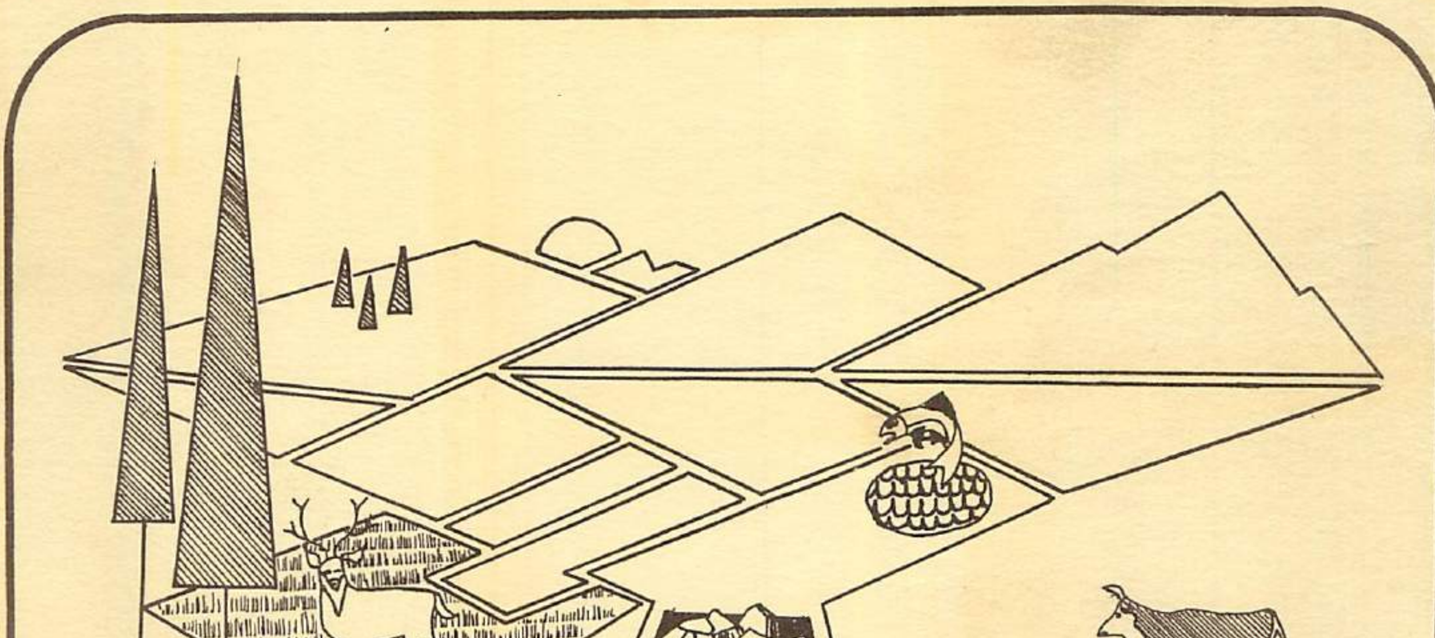
R Clark

HOMESTAKE MINING COMPANY
PITCH PROJECT

Pop of Saguache
150

P 2-43

FINAL
ENVIRONMENTAL STATEMENT



USDA FOREST SERVICE - ROCKY MTN. REGION
GRAND MESA, UNCOMPAHGRE, GUNNISON N.F.

NOTE TO READER

During the preparation of the Homestake Mining Company (HMC) Pitch Project Final Environmental Statement (FES), HMC was granted a patent (acquired title) by the Secretary of the Interior for 207 acres of land within the project area (see map in Appendix L). The granting of patent removes that land from Federal ownership and Forest Service jurisdiction. The State of Colorado and Saguache County jurisdictions apply, however.

The text of the FES was not changed to reflect this land status change because the patent affects ownership rights and regulatory jurisdictions and not environmental effects. In other words, the assumption is that the planned actions for the patented land will remain the same as before patent.

SUMMARY AND CONCLUSIONS

This Final Environmental Impact Statement was prepared by the staffs of the U.S. Forest Service and the U.S. Nuclear Regulatory Commission with cooperation and advice from governmental units of the State of Colorado. This Final Statement was issued by the U.S. Forest Service.

1. This action is administrative.

2. The proposed action is the issuance of approvals, permits, and licenses to the Homestake Mining Company for the implementation of the Pitch Project. The Pitch Project consists of mining and milling operations involving uranium ore deposits located in Gunnison National Forest, Saguache County, Colorado. Mining of uranium ore will take place over an estimated period of 20 years; a mill with a nominal capacity of 544 metric tons per day (600 tons per day) will be constructed and operated as long as ore is available. The waste material (tailings) from the mill, also produced at a rate of about 544 metric tons per day (600 tons per day), will be buried onsite.

3. The following is a summary of environmental impacts.

   a. The total site area will affect about 1% of the Agate C&H grazing allotment. Another use of the site is for recreation, including fishing, camping, hiking, and hunting (Sect. 2.11). The establishment of the Pitch Project would convert about 1206 ha (2978 acres) to mining and milling activities for up to 25 years. Mining activities would disturb (remove vegetation from) a total of about 304 ha (750 acres). The mill and tailings impoundment would disturb about 87 ha (215 acres), and another 67 ha (166 acres) would be used for roads, reservoirs, and ancillary facilities. There will be no surface disturbance on the remaining 748 ha (1847 acres).

      Reclamation of this 458 ha (1131 acres) will proceed concurrently with project operation. Short-term mitigating measures will be the reduction and prevention of erosion on disturbed areas. Long-term reclamation will be the reestablishment of appropriate vegetation on all disturbed areas. Eventually all of the land surface will be reclaimed although the 28-ha (69-acre) tailings impoundment, under present regulations, must be considered unavailable for the foreseeable future for further productive surface uses.

   b. The applicant has entered into an agreement with the Upper Gunnison River Conservancy District for the replacement use of 8.63×10^5 m^3 (700 acre-ft) of water per year from Marshall Creek. This water will be removed only during periods of high flow to prevent infringement on downstream water rights and then be stored in reservoirs. Water collected during pit dewatering will be used in the mill as process water. If more pit water is produced than required for the mill, it will be treated, if necessary, and used for dust control and reclamation purposes. It is unlikely that pit dewatering will produce quantities of water requiring discharge from the site. If such water is discharged, it will be closely monitored and treated, if necessary, to meet the requirements of the NPDES permit(s).

      The applicant should not require more than 3.69×10^5 m^3 (300 acre-ft) of water from the estimated 18.5×10^6 m^3 (1.5×10^4 acre-ft) average annual flow of Marshall Creek at the point of diversion, and no measurable downstream effect will be created if removal to storage reservoirs is accomplished during periods of high stream flow.

      Some 3.69×10^4 m^3 (30 acre-ft) per year of contaminated water flow from the old Pinnacle Mine and a similar amount of spring flow that does not presently reach existing streams will be diverted to the mine pit. An additional unknown amount (probably small) of groundwater will also enter the mine pit. The effect on regional groundwater will be negligible, and available excess water entering the mine pit will be used as a replacement for water that would otherwise be diverted from Marshall Creek. After reclamation of the mined area, a 12-ha (29-acre) lake will probably form in the northern portion of the mine pit.

c. There will be no discharge of liquid or solid effluents from the mill facility except to the tailings impoundment. Although seepage will be minimized by placement of a clay liner, some liquid percolation from the tailings impoundment (through the bottom and dam) will enter the underlying strata. Monitoring of regions with potential near-surface seepage will enable the applicant to return such seepage to the tailings impoundment before any significant contamination of downstream groundwater or surface water can occur.

The discharge of pollutants to the air will be small and the offsite effects negligible. The estimated annual dose commitments at the nearest potential points of full-time exposures are shown in the following table.

Annual dose commitments[a] to individuals from radioactive releases from the Homestake Mining Company Pitch Project mill and mine operation

Location	Exposure pathway	Dose (millirems per year)			
		Total body	Bone	Lung	Bronchial epithelium
Nearest permanent residence (Sargents), 8.5 km (5.3 miles) NW of the mill	Inhalation[b]	0.0023	0.045	0.30	1.9
	Ingestion	0.015	0.17	0.018	
	External	0.003	0.0054	0.0031	
Total		0.021	0.22	0.32	1.9
Nearest site of potential permanent residency, 5.1 km (3.2 miles) NE of the mill	Inhalation[b]	0.0043	0.058	0.11	1.7
	External	0.0070	0.0099	0.0062	
Total		0.011	0.068	0.12	1.7

[a]Doses integrated over a 50-year period from one year of inhalation or ingestion.

[b]Doses to total body, lung, and bone are those resulting from inhalation of particulates of U-238, U-234, Th-230, Ra-226, Pb-210, and Po-210. The doses to the bronchial epithelium are those from inhalation of radon daughters. Kidney doses calculated from the Pitch Project effluents are invariably lower than the indicated lung doses.

d. The Pitch Project contemplates the commitment of an estimated 6803 metric tons (7500 tons) of uranium for reactor fuel and relatively small commitments of labor, chemicals, fossil fuels, equipment, and building materials.

e. The mining operations will result in overburden dumps and a mine pit. During reclamation the slopes of waste dumps and benches within the open pit will be reforested. The flat areas of the waste dumps will be revegetated to rangeland. The south portion of the pit will be partially backfilled with overburden and waste from the north portion and then reforested. If one assumes that a lake does not form, the north portion of the pit will be similar to that existing before mining, but considerably reoriented.

f. The proposed milling operation will result in the impoundment of about 4.5 x 10^6 metric tons (5 x 10^6 tons) of tailings, and an area covering about 28 ha (69 acres). After milling has ceased, the mill buildings will be removed and any contaminated equipment or site soil will be disposed of with the tailings. Stabilization, reclamation, and control of the tailings area will be accomplished in accordance with State of Colorado regulations in effect at the time these activities are implemented.

g. The Pitch Project will provide employment and induced economic benefits to the region but will also result in socioeconomic stress. The stress will exist mostly in the communities of Gunnison and Salida. The demand for housing may be difficult to satisfy. There will be an increase in area traffic and some loss of recreational opportunities on the site, but these effects should be temporary and minor.

4. Principal alternatives considered are as follows:

a. regulatory alternatives,
b. mining alternatives,
c. reclamation alternatives,
d. alternative mill sites,
e. alternative tailings sites,
f. alternative mill processes,
g. alternative methods for tailings management,
h. alternative energy sources, and
i. alternative of no licensing action on mill.

5. The following Federal, State, and local agencies were asked to comment on the Draft Environmental Statement:

Council on Environmental Quality
Department of Commerce
Department of the Interior
Department of Health, Education, and Welfare
Federal Energy Regulatory Commission
Department of Energy
Department of Transportation
Environmental Protection Agency
Department of Agriculture
Advisory Council on Historic Preservation
Department of Housing and Urban Development
Office of the Governor, State of Colorado
Division of Wildlife, State of Colorado
Division of Mines, State of Colorado
Board of Commissioners, Chaffee County, Colorado
Board of Commissioners, Gunnison County, Colorado
Board of Commissioners, Saguache County, Colorado
County Planning Commission, Saguache County, Colorado
County Planning Commission, Gunnison County, Colorado
Socioeconomic Impact Office, State of Colorado
Department of Highways, State of Colorado
City of Gunnison
Chamber of Commerce of Gunnison
Council of Government, Region 10
Council of Government, Region 13
Council of Government, Region 8
Colorado State Clearing House

State agencies responsible for specific licensing and control actions have participated in the preparation of this document and provided significant portions of the content. (See paragraph 4 of the Foreword.) In addition, these agencies commented on the Draft Environmental Statement.

6. This Final Environmental Impact Statement will be made available to the public, the Environmental Protection Agency, and other specified agencies in April 1979.

7. On the basis of the analysis and evaluation set forth in this Statement, it is proposed that any approval, permit, or license issued for the Pitch Project should be subject to the following conditions for the protection of the environment:

a. If a tailings impoundment is required, the applicant shall construct it to incorporate the features discussed under Alternative 1 of Sect. 10.4.2.

b. If a tailings impoundment is required, it shall be constructed to withstand, when full, an earthquake of Modified Mercalli Intensity of VIII and shall meet the minimum specifications contained in the NRC Regulatory Guide 3.11. The design and construction shall be approved by the Colorado State Engineer Office, Dam Safety Branch and the U.S. Forest Service.

c. The proposed tailings management plan presented as Alternative 1 meets the performance objectives developed by NRC and adopted by the Colorado Department of Health and is therefore considered to be acceptable. The Colorado Department of Health, Radiation and Hazardous Wastes Control Division, has the responsibility for selecting the most environmentally acceptable method of tailings disposal within the present economic and engineering state of the art.

d. The applicant shall provide a bond satisfactory to the State of Colorado to guarantee stabilization of the tailings impoundment and surveillance thereafter consistent with the regulations of the State of Colorado and to the Forest Service assuring reclamation.

e. A pit wall stability program will be instituted and maintained during the operation of the open pit. This program must be approved by the Colorado Division of Mines.

f. The applicant shall institute reclamation procedures concurrent with mining. These procedures will be consistent with the Mining and Reclamation Plans submitted to the Colorado Mined Land Reclamation Board, Department of Natural Resources, and the U.S. Forest Service. Approvals will be required for changes in reclamation plans or procedures, and it is recognized that more environmentally acceptable reclamation methods may develop during the estimated 20-year project lifetime.

g. The applicant shall develop and submit plans for decommissioning the mill and reclamation of the mill site to the Colorado Department of Health, Radiation and Hazardous Wastes Control Division, as described in Sect. 3.4.

h. The applicant shall implement the environmental monitoring programs and shall take the necessary mitigating actions as described in Sect. 6 of this document.

i. The applicant will establish an emergency response capability to travel to the scene of any accident involving shipment of yellow cake to minimize release to the environment and to recover any spilled yellow cake. The response plan will be formally documented and subject to State and NRC approval. A yearly exercise of this quick-response team will be conducted.

j. The applicant will minimize the problem of airborne particulates from the dried-up areas of the tailings pile by any of several viable dust-suppression alternatives, including chemical methods (use of crusting agents) or such physical methods as keep the pond surface wet through tailings discharge and/or water sprinkling, covering it with earth, or covering it with other dust-reduction materials that will be subject to State approval.

k. The applicant shall establish a control program that will include written procedures and instructions to control all activities as prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of environmental protection conditions. The applicant shall maintain sufficient records to furnish evidence of compliance with all the environmental protection conditions herein.

l. Before engaging in any activity not evaluated by the agencies, the applicant will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated or that the impact is significantly greater than that evaluated in this Environmental Impact Statement, the applicant shall provide a written evaluation of such activities and obtain prior approval from the appropriate agency for the activities.

m. If unexpected harmful effects or evidence of irreversible damage not otherwise identified in this Statement is detected during construction or operations, the applicant shall provide to the agencies an acceptable analysis of the problem and a plan of action to eliminate or reduce significantly the harmful effects or damage.

n. The applicant shall be limited to the annual processing of that amount of ore from which can be extracted 369 metric tons (407 tons) of U_3O_8 per year.

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Grand Mesa, Uncompahgre, and Gunnison National Forests
P.O. Box 138, Delta, CO 81416

1950
May 25, 1979

Ralph Clark, III
519 East Georgia
Gunnison, CO 81230

Since publication of the Homestake Mining Company's Pitch Project Final Environmental Impact Statement, I discovered five Draft EIS comment letters which were inadvertently not published. These letters would normally have been included in the Final EIS.

Attached are the five comment letters, along with our responses to them. You will note that the substantive comments in the letters were responded to in Appendix A of the Final EIS.

I have determined that no significant new information has been identified relevant to the proposed action as explained in the Record of Decision which accompanied the Final EIS. Therefore, no formal supplementation of the Final EIS is deemed necessary. I am providing you this information to include in your copy of the Final EIS.

Sincerely,

Jimmy R. Wilkins

JIMMY R. WILKINS
Forest Supervisor

Enclosures

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Grand Mesa, Uncompahgre and Gunnison N. F.
P.O. Box 138, Delta, Colorado 81416

1950
April 27, 1979

A copy of the Final Environmental Impact Statement and Record of Decision Statement for the Homestake Mining Company, Pitch Project, on the Gunnison National Forest are enclosed. They were prepared under the provisions of Section 102(2)(C) of the National Environmental Policy Act and 40 CFR 1500. They were transmitted to the Environmental Protection Agency today.

Sincerely,

JIMMY R. WILKINS
Forest Supervisor

Enclosure

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FOREWORD

This Final Environmental Impact Statement is issued by the U.S.D.A., Forest Service, in compliance with the requirements of the National Environmental Policy Act of 1969 (NEPA).

This document was prepared as a cooperative effort by the U.S. Forest Service (FS), the State of Colorado, and the Nuclear Regulatory Commission (NRC) in response to an application by the Homestake Mining Company for authorization to mine and mill uranium ore at their Pitch Project location in Saguache County, Colorado.

The Forest Service, under the 1897 Organic Act, the Multiple Use Mining Act of 1955, and the Multiple Use-Sustained Yield Act of 1960, administers the surface uses of National Forest System lands under the U.S. Mining Laws through 36 CFR Parts 251 and 252. All aspects of the proposed operation, as they affect National Forest System surface uses, are subject to operating plan or special use permit approval.

The State of Colorado has the authority (as transferred by NRC) to issue or to deny the Radioactive Materials License necessary to operate the uranium mill (Radiation and Hazardous Waste Control Division), to approve the final design of the tailings disposal system (State Engineer, Dam Safety Branch), and to issue a Development and Extraction Mining Permit (Colorado Mined Land Reclamation Board, Department of Natural Resources).

In keeping with the standing Federal policy of interagency cooperation, a joint agreement was made among representatives of the NRC, the FS, and the State of Colorado that the FS would act as the responsible agency in conducting the environmental review required by NEPA relative to the proposed Federal actions described in this document. It was further agreed that the cooperating agencies would supply input to the Environmental Statement with regard to matters in which these agencies would have a jurisdictional interest or responsibility. Accordingly, this Environmental Statement is intended to meet the requirements of NEPA both with respect to the issuance of permits for operations described herein and with respect to the jurisdictional responsibilities of the cooperating agencies.

The NEPA states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the nation may

- fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
- assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;
- attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and intended consequences;
- preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice;
- achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
- enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects that cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

This detailed statement has been prepared pursuant to the foregoing considerations.

The applicant submitted an Environmental Report describing the proposed projects. In conducting the required NEPA review, the representatives of the agencies (staff) met with the applicant to discuss items of information in the Environmental Report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the agencies have a thorough understanding of the proposed project. In addition, the staff sought information from other sources to assist in the evaluation and to conduct field inspections of the project site and surrounding area. Members of the staff also met with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as were deemed useful and appropriate, the staff made an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA.

This evaluation led to the issuance of a Draft Environmental Statement by the U.S. Forest Service in July 1978. The Statement was distributed to Federal, State, and local governmental agencies and to other interested parties for comment. A summary notice was published in the *Federal Register* regarding the availability of the applicant's Environmental Report and the Draft Environmental Statement.

After comments on the Draft Environmental Statement were received and considered, a Final Environmental Statement was prepared that includes discussion of questions and comments submitted by reviewing agencies or individuals and any revised decisions. Further environmental considerations were made on the basis of these comments and combined with the previous evaluation; the total environmental costs were then evaluated and weighed against such benefits in regard to environmental, economic, and technical aspects as well as other benefits to be derived from the proposed project. The consideration of available alternatives and environmental costs and benefits provided a basis for denial or approval of the various Federal and State actions, with appropriate conditions to protect environmental values. In considering the energy value of the U_3O_8 produced, minimal radiological impacts, minimal long-term disturbance of land, and mitigable nature of the societal impacts, the overall benefit-cost balance for the Homestake mine and mill is favorable, and the indicated action is to grant a Colorado Department of Health Radioactive Materials License to construct and operate a uranium processing mill and such other licenses and approvals as are required for mine operation.

This Final Environmental Statement is being made available to the Environmental Protection Agency, to those agencies commenting on the Draft Environmental Statement, and to the public in April 1979.

1. INTRODUCTION

1.1 THE APPLICANT'S PROPOSAL

Homestake Mining Company plans to develop uranium ore deposits in Saguache County, Colorado. These proposed operations are collectively known as the Homestake Mining Company Pitch Project. The project consists of mining uranium from ore bodies over an estimated period of 20 years and the construction and operation of a mill with a nominal capacity of 544 metric tons (600 tons) per day. The waste material (tailings) from the mill, also produced at a rate of about 544 metric tons (600 tons) per day, will be buried onsite at the head end of a natural valley.

The proposed Pitch Project is located in the mountainous, forested area south of Monarch Pass in Gunnison National Forest. The nearest town, Sargents, about 8 km (5 miles) west of the project area, has about 15 year-round inhabitants. Surface ownership of the project area (generally in T48N, R6E, as shown on the U.S. Geological Survey Topographic Map, Pahlone Peak Quadrangle, Colorado) is held by the Federal Government and administered by the U.S. Forest Service. Homestake Mining Company holds several unpatented mineral claims for uranium on this land and is in the process of patenting a few of the claims in the vicinity of the pit, which will result in the removal of the patented area from Forest Service jurisdiction. The location of the proposed project is shown in Fig. 1.1.

1.2 FEDERAL AND STATE AUTHORITIES AND RESPONSIBILITIES

In considering the proposed project, it was recognized that the U.S. Forest Service (FS) and the State of Colorado have approving, permitting, or licensing authority. The U.S. Nuclear Regulatory Commission (NRC) has transferred its authorities to the State of Colorado. However, because the NRC has the technical expertise to address certain aspects of the proposed project, it was resolved that the preparation of an Environmental Statement would be a cooperative effort among the FS, State of Colorado, and the NRC, with the FS as the responsible agency and coordinator of the Statement. Therefore, a Statement of Understanding between the FS, State of Colorado, and the NRC was prepared to establish the basis for the preparation of the joint Environmental Statement prescribed by the National Environmental Policy Act (NEPA) of 1969 (Public Law 91/190, 42 U.S.C. 4321, et seq.) and Executive Order No. 11514, 7 March 1970.

This Statement of Understanding recognizes that the Forest Supervisor of the Grand Mesa, Uncompahgre, and Gunnison national forests is vested with the authority to administer the surface resources of National Forest System lands. The provisions of the Federal 1897 Organic Act, the Multiple Use Mining Act of 1955, and the Multiple Use-Sustained Yield Act of 1960 apply to the mining and milling proposal and will be implemented through 36 CFR Parts 251 and 252.

Forest Service mining regulations (36 CFR Part 252) apply to the surface use of unpatented mining or mill site claims. Within 30 days of receipt of the proposed plan of operations, the authorized officer will decide upon one of the following courses of action:

- notify the operator that he has approved the plan of operations;
- notify the operator that the proposed operations do not require an operating plan;
- notify the operator of any changes in, or additions to, the plan of operations deemed necessary to meet the purpose of the regulations in this part;
- notify the operator that the plan is being reviewed but that more time, not to exceed an additional 60 days, is necessary to complete such review, setting forth the reasons why additional time is needed; or

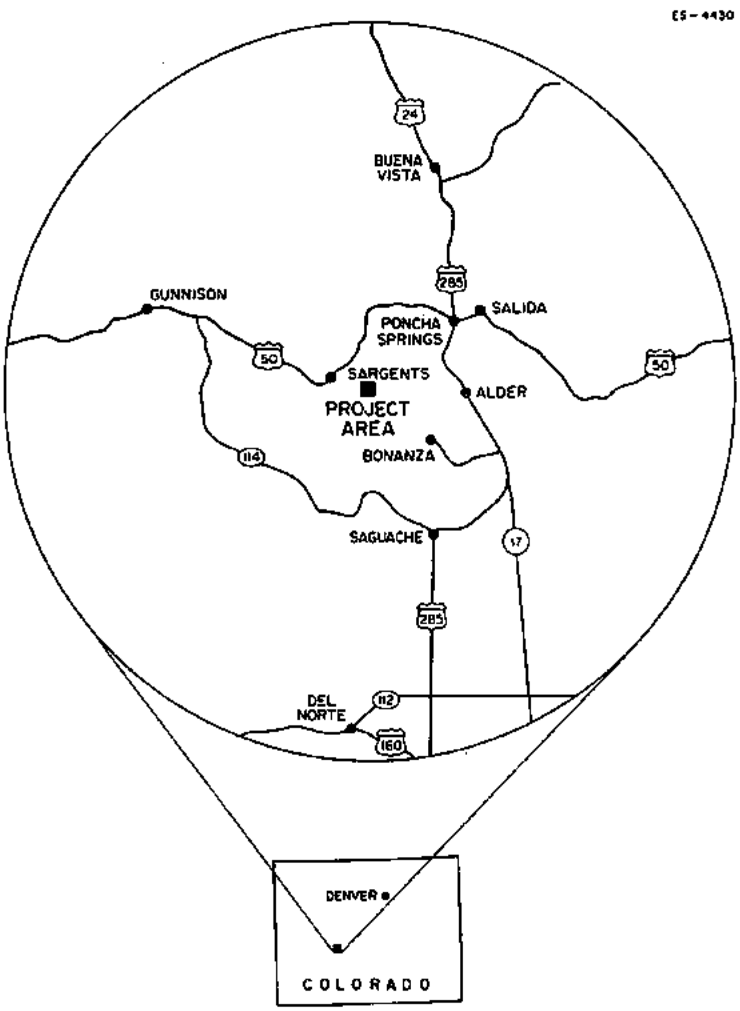

Fig. 1.1. Project area and regional map. Source: ER, Plate 2.1-1, p. 2-2.

- notify the operator that the plan cannot be approved until a Final Environmental Statement has been prepared and filed with the Environmental Protection Agency. This action was taken because the current operating plan did not cover adequately the disposal of radioactive materials or meet the requirements of NEPA. In addition, an independent study of the potential impacts and mitigating measures was deemed desirable.

The State of Colorado has authority (as transferred by NRC) to issue or deny the Radioactive Materials License necessary to operate the uranium mill (Department of Health) and a reclamation permit (Mined Land Reclamation Board) and numerous others.

Within this framework, each agency was assigned specific tasks for preparing the Environmental Statement. The FS and NRC were responsible for collecting and analyzing relevant data, preparing text, and contributing to the development of all sections of the Statement. Areas of responsibility covered by the FS included surface natural resources and reclamation of affected lands, while the NRC treated mining and subsurface resources, radiological health and safety, ore milling, and socioeconomics. The State of Colorado served as a source of data on socioeconomics, radiological hazard potentials, and mineral and other subsurface resources and also participated by providing reviews and comments on the proposed text. The complete text of this Statement of Understanding is provided in Appendix B. The objectives of this agreement were to produce an Environmental Statement intended to meet the requirements of NEPA both with respect to the issuance of permits described herein and with respect to the jurisdictional responsibilities of the agencies involved and to ensure the identification of all environmental impacts and measures to control, minimize, repair, or prevent them where necessary.

1.3 BACKGROUND INFORMATION

Major land uses of the project area are mining, grazing, and limited hunting and fishing. The Federal lands of the area are under use arrangements with local ranchers and are utilized for grazing by cattle. Many unimproved roads and trails traverse the area, providing access for ranching, minerals exploration, and recreation activities.

The uranium resource of the project site is subject to the 1872 U.S. Mining Laws whereby a citizen has the statutory right to locate and develop mining claims and mill site claims necessary for the development of the mineral. The area in the vicinity of the project site is completely covered by mining claims. Uranium was first discovered in the area in 1955. Exploration in the late 1950s revealed ore bodies, and the original Pitch Mine, also known as the Pinnacle or Erie No. 28 Mine, was developed. Approximately 90,700 metric tons (100,000 tons) of ore, yielding 454 metric tons (500 tons) of uranium concentrate, were extracted by underground mining from 1959 to 1962. Operations ceased in 1962 because of depressed uranium prices and high mining costs.

In 1967, spurred by new demand and higher prices for uranium, an attempt was made to reopen the mine. Dangerous ground caving and the presence of high levels of radon gas made reentry hazardous, and it was deemed to be impractical at that time. In 1969, an open pit mine and an experimental attempt to leach the uranium ore left in the old mine were begun. This operation was abandoned in the fall of 1972 because it was uneconomical.

Since 1972, Homestake Mining Company has acquired control of the project area and has planned its expansion of the open pit mine to avoid past hazards and difficulties of underground operations and to increase the overall recovery of uranium ore.

On 10 September 1975, Homestake Mining Company submitted to the FS a "Notice of Intent" to expand operations at the Pitch Project site. Based on information contained in the Notice and additional information submitted at a later date, the FS prepared an Environmental Analysis Report that was approved 26 March 1976. This report required submission of supplemental operation plans by Homestake Mining Company as provided for in 36 CFR Parts 252.4(d) and 252.4(e).

Homestake Mining Company, on 15 November 1976, submitted an *Environmental Report, Pitch Project, Saguache County, Colorado, for Homestake Mining Company* as required by the FS. The FS evaluated the Homestake Mining Company Environmental Report and prepared another Environmental Analysis Report that contained certain stipulations. This report was then approved.

Based on State of Colorado and FS review of the project, a determination was made to prepare an Environmental Statement dealing with the environmental aspects of the applicant's proposed mine and mill and the approvals, permits, and licenses involved. However, Homestake Mining Company has applied for a Development and Extraction Mining Permit from the Mined Land Reclamation Board (MLRB). The MLRB is required by law to act on the application within a certain time period. The MLRB granted a permit on 19 April 1978 to Homestake Mining Company with provision that revisions may occur as a result of the Final Environmental Statement. The decision regarding issuance of a Radioactive Materials License will be deferred until the filing of the Final Environmental Statement.

1.4 STATUS OF REVIEWS AND ACTIONS BY THE FOREST SERVICE

The following regulatory approvals and permits are required before realization of the Homestake Mining Company Pitch Project:

- approval of a reclamation plan;
- approval of an operating plan that considers mining and mill waste disposal, including radioactive materials; and
- issuance of special use permits for any needed ancillary facilities.

The current status of the approvals and permits issued by the FS is given in Table 1.1.

Table 1.1. Status of reviews, approvals, and permits required by the applicant

Action (mode of approval or permit number)	Date issued	Issuing agency[a]	Activities affected
		Federal	
Operating plan (letter)	5-4-77	USFS	Timber removal and sale; construction of roads, mill, and tailings disposal facility, utilities; ponds; open-pit mining, waste dumps; reclamation – specific to National Forest System lands.
Preconstruction review		MESA	Construction and operation of tailings disposal system and mine waste dumps
Archaeological clearance		USFS	Disturbance and construction in areas where archaeological sites of unknown significance have been identified
Special use permits		USFS	All activities on National Forest System lands not covered by the operating plan and specified in 36 CFR Parts 251 and 252
Notice of mining and milling operations		MESA	None
		State of Colorado	
NPDES permit (CO-0022756; Saguache County)	2-13-77	WQ	Discharge of mine wastewater – Pitch Mine
Water quality certification (152; Saguache County)	6-29-77	WQ	All construction activities
Fugitive dust permits			
Mill facility site construction (C-11,373 (FD))	5-2-77	APC	Site preparation
Tailings disposal facility and water storage reservoir construction [C-11,372 (FD)]	5-2-77	APC	Site preparation and dam construction
Road construction (letter)	5-2-77	APC	Dust control during road construction
Tailings disposal facility operation (letters)	8-26-77	APC	Operation of tailings disposal facility
Open-pit mine [C-11,371 (FD)]	8-26-77	APC	Open-pit mining
Handling of ore and coal storage [C-11,371 (FD)]	8-26-77	APC	Storage and handling or ore and coal
Construction to enlarge tailings dam		APC	Construction activities to enlarge dam
Stabilization of mill tailings		APC	Removal, hauling, dumping, and grading of clay and overburden to cover tailings
Emission permits			
Boilers and reactivation furnace (C-11,408-1)	8-26-77	APC	Construction and operation of boilers and reactivation furnace
Ore-crushing area (C-11,408-2)	8-26-77	APC	Construction and operation of crusher
Fine ore bins (C-11,408-3)	8-26-77	APC	Construction and operation of bins
Transfer house (C-11,408-4)	8-26-77	APC	Construction and operation of transfer house
Yellow cake dryer and packaging (C-11,408-5)	8-26-77	APC	Construction and operation of yellow cake dryer and packaging
Fume vents (C-11,408-6)	8-26-77	APC	Construction and operation of fume vents
Approval of solid waste disposal sites (letter)	6-9-77	WQ and PHE	Disposal of mine wastes, tailings, and general refuse
Radioactive materials license		ORH	Milling and concentrating of uranium, release of radioactive materials, accidents, tailings disposal, stabilization, reclamation

Table 1.1. (continued)

Action (mode of approval or permit number)	Date issued	Issuing agency[a]	Activities affected
Mined land reclamation permit	4-19-78	MLRB	Implementation of activities not under development on 7-1-76; mining, milling, operations, reclamation
Approval of tailings reservoir plan		CSE	Construction of tailings dam
Approval of water reservoir plan		CSE	Construction of water reservoir dams
Groundwater well permit		CSE	Development and use of a groundwater well
NPDES permit amendments			
1. Site and road construction		WQ	Runoff from construction sites
2. Expansion of mine		WQ	Dewatering of mine
3. Construction of settling ponds		WQ	Construction of settling ponds and mine dumps and disposal of mine wastes
Certification of water system		WQ	Use of potable water system
Sewage system site approval		WQ	Construction and operation of sewage system
Open burning permit		APC	Open burning of waste materials and trees
Incinerator emission permit		APC	Construction and operation of an incinerator
Notice of intent to excavate		COSH	
Notice of intent to mine		DOM	
Explosive permit		DOM	Handling and use of explosives
Erosion control dam permit		CSE	Construction and placement of erosion control dams
Electrical permit		SEPB	Wiring of buildings and running of power lines
Saguache County			
Mineral resource development permit (form)	5-2-77	SBCC	All construction, operations, and reclamation
Mine waste disposal site permit [form (ES ENG 72)]	9-1-77	SBCC	Disposal of mine wastes and general refuse (includes radioactive mine wastes)
Tailings disposal facility permit [form (ES ENG 72)]	9-1-77	SBCC	Disposal of radioactive mill tailings

[a] USFS – U.S. Forest Service
MESA – Mining Enforcement and Safety Administration
WQ – Water Quality Control Division
APC – Air Pollution Control Division
PHE – Public Health Engineering Division
ORH – Occupational and Radiological Health Division
MLRB – Mined Land Reclamation Board
CSE – Colorado State Engineer
COSH – Colorado Occupational Safety and Health Division
DOM – Division of Mines
SEPB – State Electrical and Plumbing Board
SBCC – Saguache Board of County Commissioners

1.5 STATUS OF REVIEWS AND ACTIONS BY STATE AGENCIES

The State of Colorado requires that certain permits or licenses be obtained prior to various stages of construction, mining, or milling operations. In addition, in compliance with the agreement, Colorado issues the Radioactive Materials License normally issued by the NRC. Table 1.1 tabulates the reviews, approvals, and permits required. If action has been taken, the date is shown. The applicant will acquire other permits as needed.

1.6 REVIEW BASIS

Data for this analysis have been obtained by the staff from a variety of sources, including site visitation, oral and written statements, testing and sampling reports, published literature, and documentation supplied by the applicant. Homestake Mining Company submitted an Environmental Report (ER)[1] and supplements to the ER in response to questions by the staff. In this Environmental Statement, the ER is cited extensively; however, its full title and documentation are given only in the list of references for Sect. 1. Hereinafter the applicant's Environmental Report will be cited parenthetically as ER, with section, page, figure, table, appendix, or supplement number.

1.7 NEED FOR LICENSING ACTION

There is a need for new mill capacity prior to 1981 (probably as early as 1979). The customary interval from the issuance of a Radioactive Materials License for a new mill to the loading of reactor fuel is five years. This Homestake mill is one of a small number of new mills that have been proposed in the last several years; a deferral of its operation could extend the time required for the delivery of needed fuel and could affect adversely the ability of reactors now operating or under construction to deliver needed electrical power. Such a shortfall of electrical energy is generally construed to be harmful to the public interest. (See Sect. 10.6 and Appendix C.)

REFERENCE FOR SECTION 1

1. Homestake Mining Company, *Environmental Report, Pitch Project, Saguache County, Colorado,* Project M-5, October 1976.

2. THE EXISTING ENVIRONMENT

2.1 CLIMATE

2.1.1 General climatic considerations

The climate of the area surrounding the Homestake Mining Company Pitch Project is that of a continental mountain region characterized by low humidity, high solar insolation, and cool temperatures. The region is dominated by relatively dry air masses. Storms that originate over the Pacific and that follow the prevailing winds from the west lose much of their moisture over mountains west of the site. Storms from the north, embedded in continental polar air, also carry little moisture due to their continental origin. These storms are most prevalent in late fall and winter. Southerly air flows are more frequent during the spring and early summer. These maritime tropical air masses originate in the Gulf of Mexico and bring frequent showers and thunderstorms. Later in the summer, air flow from the southwest can occur, causing short periods of the hottest and driest weather annually.

The extreme topographic relief in the region plays a major role in modulating the climate. For example, precipitation increases and temperature decreases markedly with elevation; precipitation reaching the region from the west provides much greater moisture to slopes facing the west than to those facing the east. Winter blizzard conditions may prevail on the plains if continental polar air contacts moist air to the south. At the same time, the cold air may be too shallow to cross the mountains just west over the Rocky Mountain front; thus, the weather in the mountains can be mild.

2.1.2 Precipitation

Annual precipitation at the Pitch Project area varies from 400 to 500 mm/year, or 16 to 20 in./year (ER, p. 2-173). Over half of the annual total occurs from June through September at the National Weather Service cooperative station in Sargents [8 km (5 miles) west of the Pitch Project]. Daily precipitation values for the mine site for the period 23 December 1975 to 22 November 1976 are provided in the ER Suppl., Table 2.7-1.

Precipitation in the form of snow occurs normally from October through May. The U.S. Soil Conservation Service collected snow pack records from February to June 1960-1975 at 3200 m (10,500 ft) altitude, 5 km (3 miles) west of Monarch Pass (Section 30, T49N, R5E). The records indicate that snow pack is deepest during April [average 1070 mm (42 in.)] and generally measures over 790 mm (31 in.) during each of the four months recorded. The range was 150 to 1650 mm (6 to 65 in.) during the 16-year period of record.

2.1.3 Temperature

January daytime maximum temperatures at the project site average -4 to -1°C (25 to 30°F), and January nocturnal minima average -20 to -18°C (-4 to 0°F). July daytime temperature maxima average 18 to 21°C (64 to 70°F), and July minima average 2 to 4°C (36 to 39°F). Temperature extremes may range from -46°C (-50°F) in winter to 32°C (90°F) in summer (ER, p. 2-177). Average hourly temperatures from the proposed mine and mill sites for 22 November 1975 to 22 November 1976 are provided in the ER Suppl., Tables 2.7-4 and 2.7-5.

2.1.4 Humidity

Relative humidity at the mine site averages 62% and at the mill site 65%. The diurnal humidity range averages 85% (nocturnal) to 45% (daytime) at the mine site and 80% (nocturnal) to 45%

(daytime) at the mill site. Three-hour average values for relative humidity from the mine and mill sites are provided in the ER Suppl., Tables 2.7-8 and 2.7-9.

2.1.5 Winds

Winds at the mine and mill sites are under primary control of macroscale weather systems and under secondary control of topographic influences. Thus, wind direction frequency diagrams for both mine and mill sites (Figs. 2.1 and 2.2) reveal that winds from the west-northwest, west, and west-southwest prevail 53% and 41% of the time, respectively, due both to prevailing westerlies and to fair weather occurrence of upslope "valley" winds. A smaller wind frequency component from the east and east-northeast at the lower altitude mill site (Fig. 2.2) results from evening downslope "mountain" winds due to the sloping western exposure of the site. Average wind speed and direction by months for the mine and mill sites are presented in the ER Suppl. 1, Tables 2.7-12 through 2.7-15.

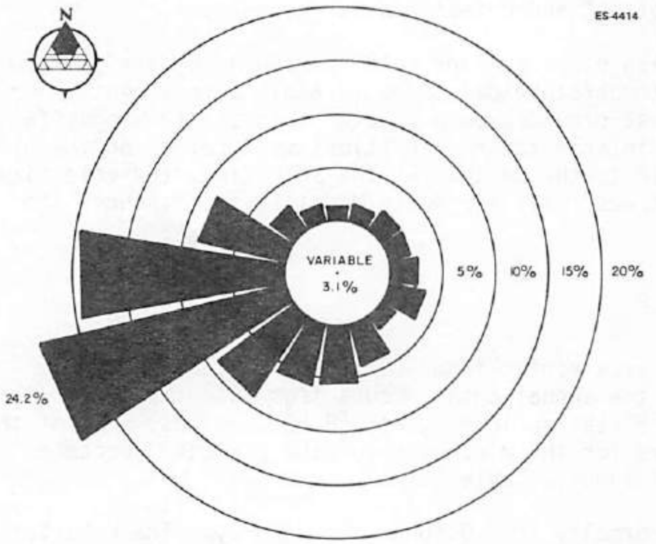

Fig. 2.1. Wind-direction frequency diagram from the mine site from 22 November 1975 to 22 November 1976. Source: ER Suppl., Plate 2.7-1, p. 2-88.

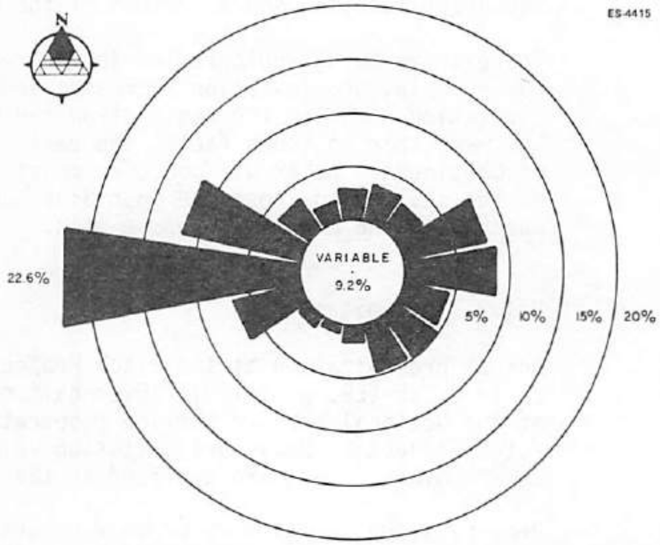

Fig. 2.2. Wind-direction frequency diagram from the mill site from 22 November 1975 to 22 November 1976. Source: ER Suppl., Plate 2.7-2, p. 2-92.

Atmospheric stability frequency classes were determined for the mill site (ER, Sect. 2.7.4). During the period of record, unstable conditions (Pasquill Classes B and C) prevailed 21% of the time, neutral conditions (Pasquill Class D) prevailed 35% of the time, and stable conditions (Pasquill Classes E and F) prevailed 44% of the time. During unstable and neutral conditions, predominant winds were from the western quadrant (WNW, W, WSW), while stable conditions were characteristically accompanied by winds distributed throughout the northern two quadrants (ER Suppl., Plates 2.7-3 through 2.7-5). The relative percentage frequency of surface wind direction by stability class is provided in the ER Suppl., Table 2.7-16, and joint wind speed-direction distributions are shown in the ER Suppl., Tables B1-B7.

2.1.6 Severe weather

Although there is a high potential for flash floods in small streams and dry washes of western Colorado from rapid snowmelt in spring and from locally heavy thunderstorms in late spring and summer, the position of the Pitch Project at and near the headwaters of most streams in this area minimizes potential floodwater effects. Hail is not uncommon in the project area, but hailstones are characteristically small with little possibility of damaging property. Recurrence intervals of extreme winds in south-central Colorado were taken from the work of Thom[1] and are given in the ER, Table 2.7-17. It is notable that the recurrence interval for winds over 130 km/hr (80 mph) is over 100 years. The recurrence interval for tornadoes is well over 10,000 years,[2] and the probability of tornado occurrence at any point on the project land is almost zero. Blizzards that regularly occur on the Homestake Mining Company Pitch Project site will have some influence because most operations may be conducted throughout the winter.

2.2 AIR QUALITY

Air quality standards for the National and the Colorado Air Quality Control Region 5 are given in Table 2.1. Total suspended particulates were measured at the proposed mine site from 21 December 1975 to 1 December 1976. The annual arithmetic mean of 22 $\mu g/m^3$ was well below the Colorado standard for nondesignated areas of 45 $\mu g/m^3$. The annual geometric mean of 17 $\mu g/m^3$ was also well below Federal primary (75 $\mu g/m^3$) and secondary (60 $\mu g/m^3$) standards (ER Suppl., Table 2.7-17). The highest individual sample value (61 $\mu g/m^3$ for 24 hr) did not exceed either the 24-hr Federal primary (260 $\mu g/m^3$) and secondary (150 $\mu g/m^3$) standards or the Colorado 24-hr standard (150 $\mu g/m^3$).

Sulfur oxides were also measured at the Pitch Project site (ER Suppl., p. 2-103). Sulfur dioxide estimates from SO_3 sulfation disks indicated that all samples contained sulfur dioxide concentrations near or below detectable levels (<0.1 average ppm/month). Sulfation (SO_4) estimates from acidic gas plates indicate background SO_4 levels to be extremely low. Unfortunately, the SO_4 measurement in parts per million per day per square centimeter cannot be converted directly to micrograms per cubic meter, which is the unit utilized in government standards.

Nitrogen dioxide (NO_2) was also measured by acidic gas plates. Background levels of NO_2 at the Pitch Project were, at most, barely detectable in the range of 0.1 to 10 $\mu g/cm^2 \cdot$day per plate.

2.3 LAND USE

2.3.1 Topography

The project area (Fig. 2.3) is in the Southern Rocky Mountain physiographic province. This province (except the San Juan Mountains) is composed of a series of north-south trending ranges, having an anticlinal structure, with cores of igneous and/or metamorphic rocks flanked by steeply dipping sedimentary units. The landscape of the province is the result of erosion and glaciation subsequent to the uplifts that occurred in the ranges 70 million years ago.

The project area is on the very southern flank of the Sawatch Range, which contains some of the highest peaks in Colorado, including the highest — Mount Elbert. Near the junction of the Sawatch Range, the Sangre de Cristo Range, the San Luis Valley, and the Cochetopa Hills, the area is a part of an exposed remnant of gently folded sedimentary rocks approximately 5 km (3 miles) in diameter.

The Continental Divide, which follows the crest of the Sawatch Range and then swings westward into the Cochetopa Hills, is only 4 km (2.5 miles) to the east of the proposed open pit at its closest approach. In the eastern and southeastern side of the divide, major areal drainage is by the Arkansas River and the closed internal drainage of the San Luis Valley. The western side of the divide is drained by Tomichi Creek and its tributaries (including Marshall, Indian, and Agate creeks). Tomichi Creek flows into the Gunnison River, which in turn empties into the Colorado River.

Elevation of the mine area is approximately 3078 m (10,100 ft) to 3292 m (10,800 ft) above sea level. The area is characteristically mountainous with small meadows and drainages that flow to the generally broad, flat-floored, underfit valley of Marshall Creek.

2.3.2 Land ownership

Table 2.2 gives the breakdown of land ownership in Saguache, Gunnison, and Chaffee counties. Federal land holdings account for more than 65% of each county.

Table 2.1. Applicable Federal (primary and secondary) and Colorado State Air Quality Control Region 5 standards

Pollutant	Type of standard	Time interval	Compliance date	Concentration μg/m³	Concentration ppm
Carbon monoxide	Federal				
	Primary and secondary	1 hr	1977	40,000	35
		8 hr	1977	10,000	9
Hydrocarbons (nonmethane)	Federal				
	Primary and secondary	3 hr (6–9 AM only)	See ozone	160	0.24
Nitrogen dioxide	Federal				
	Primary and secondary	1 year (arithmetic)	Undetermined	100	0.05
Ozone (oxidants)	Federal				
	Primary and secondary	1 hr	1977	160	0.08
Particulates	Federal				
	Primary	24 hr	1975	260	
		1 year (geometric)	1975	75	
	Secondary	24 hr	1975	150	
		1 year (geometric)	1975	60	
	State				
	Nondesignated areas	24 hr	1970	150	
		1 year (arithmetic)	1970	45	
	Designated	24 hr	1973	200	
			1976	180	
			1980	150	
		1 year (arithmetic)	1973	70	
			1976	55	
			1980	45	
Sulfur dioxide	Federal				
	Primary	24 hr	1975	365	0.14
		1 year (arithmetic)	1975	80	0.03
	Secondary	3 hr	1975	1,300	0.5
	State				

	Maximum allowable increments over baseline[a] (μg/m³) Sulfur dioxide Category I (formerly nondesignated areas)	Maximum allowable increments over baseline[a] (μg/m³) Sulfur dioxide Category II	Maximum allowable concentrations[a] (μg/m³) Sulfur dioxide Category III (formerly designated areas)
Annual mean	3 (0.001)[b]	15 (0.005)	60 (0.021)
24-hr max.	15 (0.005)	100 (0.035)	290[c] (0.091)
3-hr max.	75 (0.026)	700 (0.245)	1300[c] (0.455)

[a]On the effective date (December 18, 1976) of this amended Ambient Air Standard for sulfur dioxide, all nondesignated areas of the State of Colorado are deemed to be Sulfur Dioxide Category I areas and all designated areas and the Denver Air Quality Control Region are deemed to be Sulfur Dioxide Category III areas.

[b]( ) = equivalent values in parts per million [1 ppm = 2360 μg/m³ at 0°C and 760 mm Hg (torr)].

[c]Not to be exceeded more than once in a 12-month period.

Source: ER, Table 2.7-18.

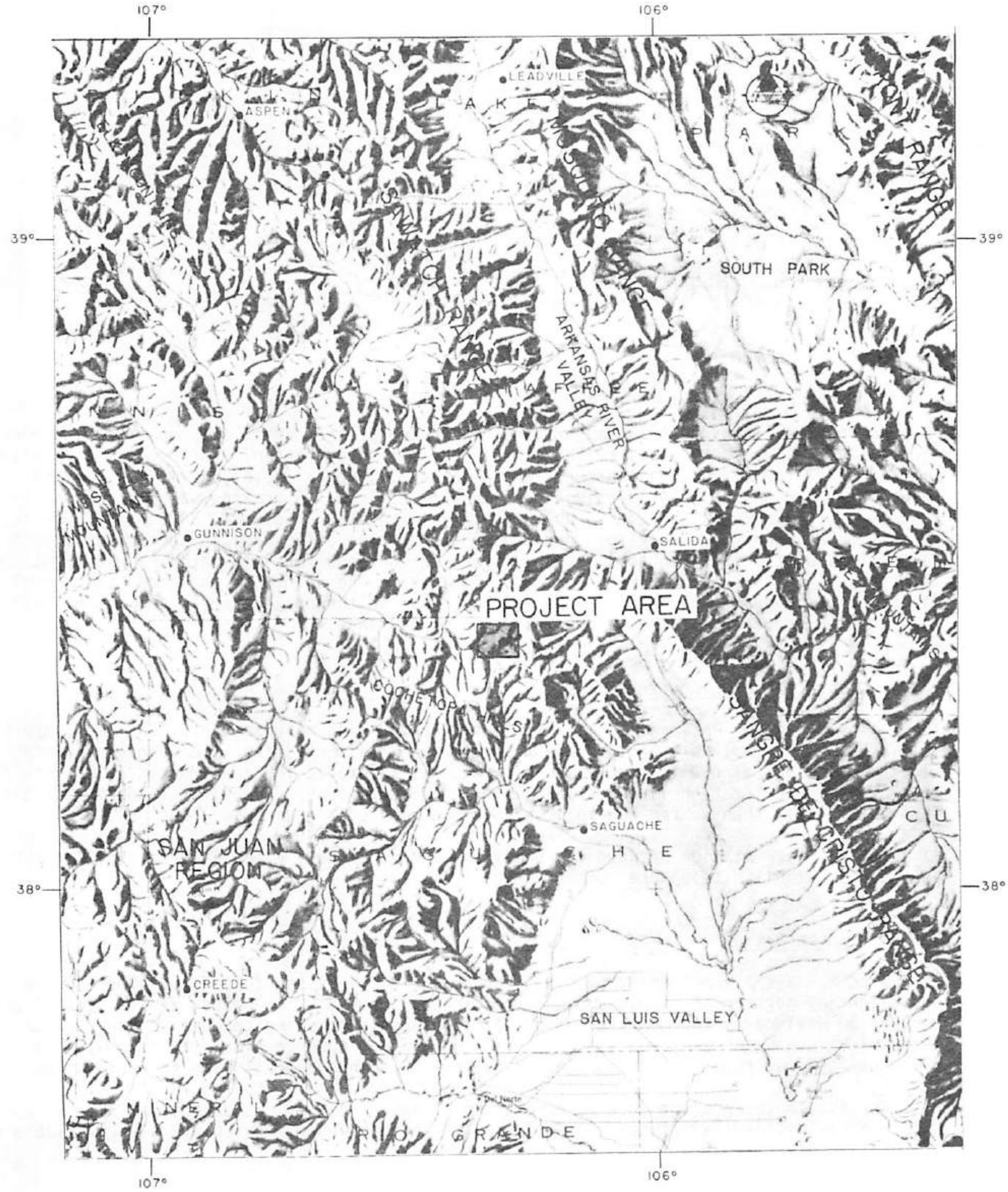

Fig. 2.3. Regional physiography. Source: ER, Plate 2.4-1, p. 2-98.

Table 2.2. Land ownership in the three-county region (from County Information Service, 1973)

	Saguache County	Gunnison County	Chaffee County
Total area, ha[a]	814,691	834,332	269,474
(acres)	(2,012,288)	(2,060,800)	(665,600)
Private ownership, %	29.3	20.6	20
Federal ownership, %	66	78.7	76
Percent National Forest Service	72	76	89
Percent Bureau of Land Management	27	22	10
Percent National Park Service	1	2	
State ownership, %	4.7	0.648	3.02
County and municipal ownership, %	0.009	0.01	0.50

[a]Hectares (ha) is the metric equivalent of acres.

2.3.3 Agriculture

Although cattle ranching is the major land use in the project area, only one ranching operation will be affected directly by the mining and milling operation. The project lies within the boundaries of the Agate C&H Allotment, which covers 17,681 ha (43,673 acres) of National Forest land and 380 ha (939 acres) of privately owned land. A grazing permit to this land is held by George E. Means and Sons. Approximately 14% of the allotment, 3036 ha (7500 acres), is considered usable for livestock grazing. Maximum productive capacity of the allotment is 2165 animal unit months (an AUM provides forage for one cow for one month), and current use averages 65% of capacity, or 1400 animal unit months. The allotment is fenced to control livestock use. Grain and forage crops are not grown in the project area, and the nearest hay farming is along Marshall Creek, about 5 km (3 miles) away.

2.3.4 Commercial and industrial

There is a Bureau of Reclamation 115-kV electric power line near Sargents, Colorado, approximately 8 km (5 miles) northwest of the project. It is expected that the Gunnison County Electrical Association will supply the estimated 12 kV needed for the project by hooking into the Bureau of Reclamation line near Sargents. A 25-kV tap will run underground to the site. The voltage will then be reduced to 12 kV and distributed by overhead lines onsite.

A microwave relay station between the Homestake Mining Company Pitch Project and Gunnison will be used to establish telephone communication.

2.3.5 Transportation

Access to the area is primarily by U.S. Highway 50, which passes through Sargents in the north-central portion of Saguache County and comes within 8 km (5 miles) of the project area. Highway 50 will carry the majority of project personnel commuting to Gunnison and Salida from the project area. Access from Highway 50 to the project area is along the Marshall Pass Road. This unpaved road runs east and north and follows an abandoned rail line to U.S. Highway 285.

Rail service to the project area is nonexistent. Rail freight is available at Salida, approximately a 56-km (35-mile) distance. Rail freight and passenger service are also available at Alamosa, about 121 km (75 miles) south.

2.3.6 Mining

The Pinnacle or Erie No. 28 mine, an underground mine, located at groundwater monitoring site GW-3 (discharge from the mine) operated from 1959 to 1962. The ion-exchange circuit has been dismantled. Although most of the buildings remain and are being utilized for storage, warehousing, and maintenance, old processing areas are boarded off and closed to entry. Some mined ore from Pinnacle remains in a stockpile. Existing waste from the Pinnacle operation will eventually be disposed of in the proposed Pitch Project waste dumps.

2.4 WATER RESOURCES

2.4.1 Groundwater

2.4.1.1 General groundwater characteristics

Groundwater occurs in all the rock formations in the permit area. The geologic map on Fig. 2.4 shows the distribution of these formations and the location of the proposed open-pit mine, mill, and tailings impoundment. Data presented in this section are derived from pump tests conducted on 21 wells (water level measured from four piezometers) and from results obtained by logging data from more than 500 drill holes.

Most groundwater recharge occurs during springtime when the snowpack begins to melt. As the ground becomes saturated, a large volume of water will form rivulets that eventually flow into larger streams draining from the site. Some water, however, may seep into the near-surface groundwater zone and then may ultimately recharge deeper water-bearing rocks such as the Precambrian, Paleozoic, and Cenozoic rocks in the area.

Near-surface groundwater

From a few feet to many feet below the surface, the rock over much of the site has been weathered into poorly consolidated debris. Water in this zone that does not seep into deeper bedrock will tend to move downhill and discharge at lower elevations. Figure 2.5 shows the near-surface groundwater regime in the project area. It is believed that the near-surface groundwater is the major source of springs in the area. The locations of all springs are shown in Fig. 2.4, and a summary of spring characteristics is given in Table 2.3.

Groundwater in Precambrian rocks

Information has been gathered on the groundwater hydraulics in the Precambrian igneous and metamorphic rocks at the site. This information suggests that groundwater occurs along fractures and that the volume of water stored in the rock body is small. Based on drill hole data, fractures are more common near the surface and within fault zones.

The Chester Fault zone, which generally separates Precambrian rocks from younger rocks (Figs. 2.4 and 2.5), is a 1.6-km (1-mile) belt containing 27 springs and seeps with a cumulative discharge of approximately 88 m^3/day (16 gpm). The springs and seeps probably originate from groundwater flowing westward through the Precambrian rocks and southward from Lime Ridge. Some water along the fault zone may also originate from Paleozoic rocks to the west.

Groundwater in Paleozoic rocks

Paleozoic rocks are a mixture of fine to coarse clastic and carbonate rocks. Important water-bearing units are sandstones and carbonates that may be separated by impermeable claystones and mudstones. As in the Precambrian rocks, fracturing has produced a secondary permeability in the Paleozoic rocks that is well developed along the Chester Fault zone.

Groundwater in the Cenozoic volcanic rocks

Oligocene andesites and tuffs blanket the southern and western parts of the permit area. Based on pump tests conducted at the proposed tailings disposal area and the mill site, the volume of groundwater stored in the volcanic rocks is small. In addition, permeability and transmissivity are low. It is probable that storage and movement of groundwater in the volcanic rocks occur mainly along fractures.

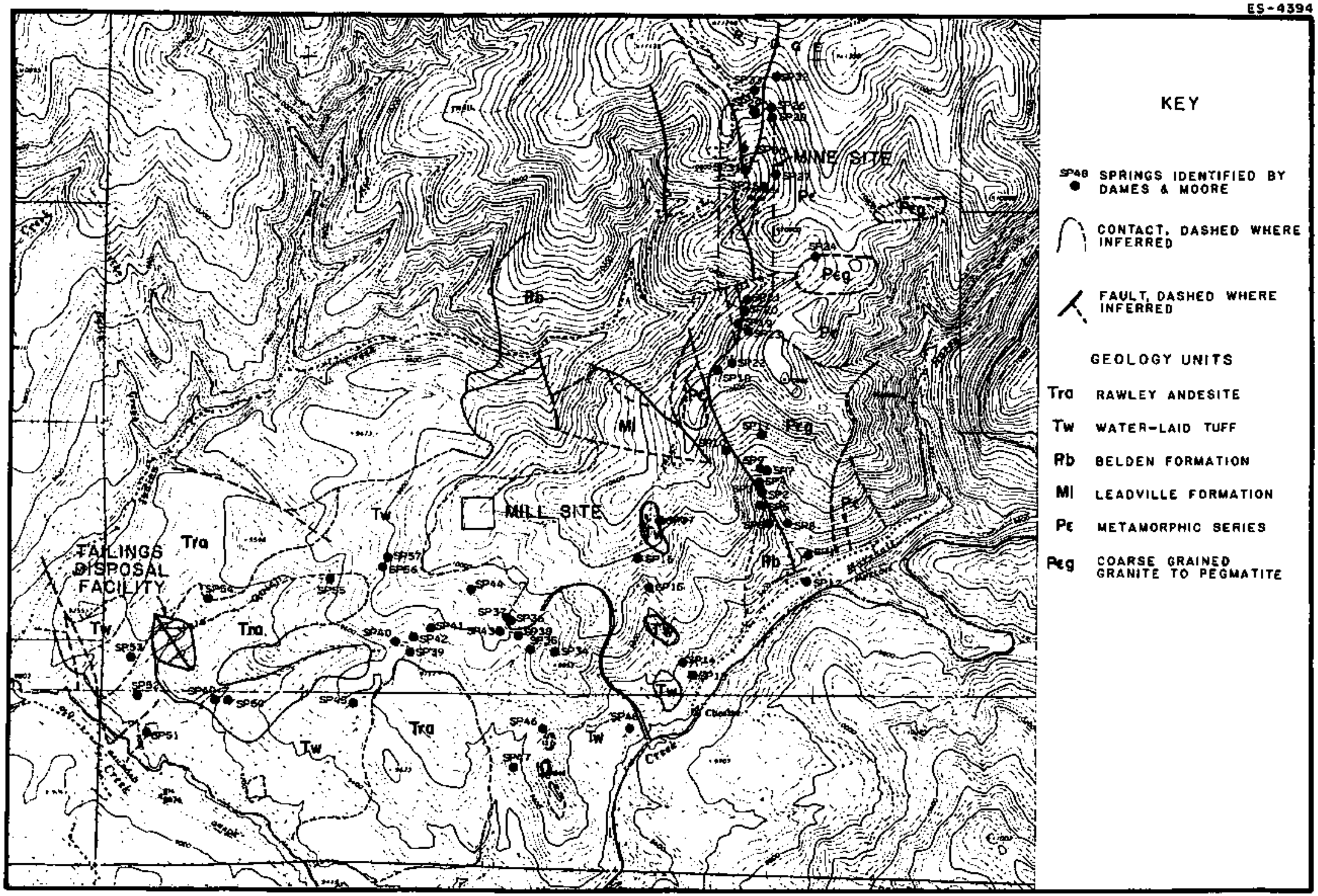

Fig. 2.4. Location map of springs and seeps identified in field reconnaissance: June 14-17, 1976. Source: ER Suppl., Plate 2.6-2, p. 2-15.

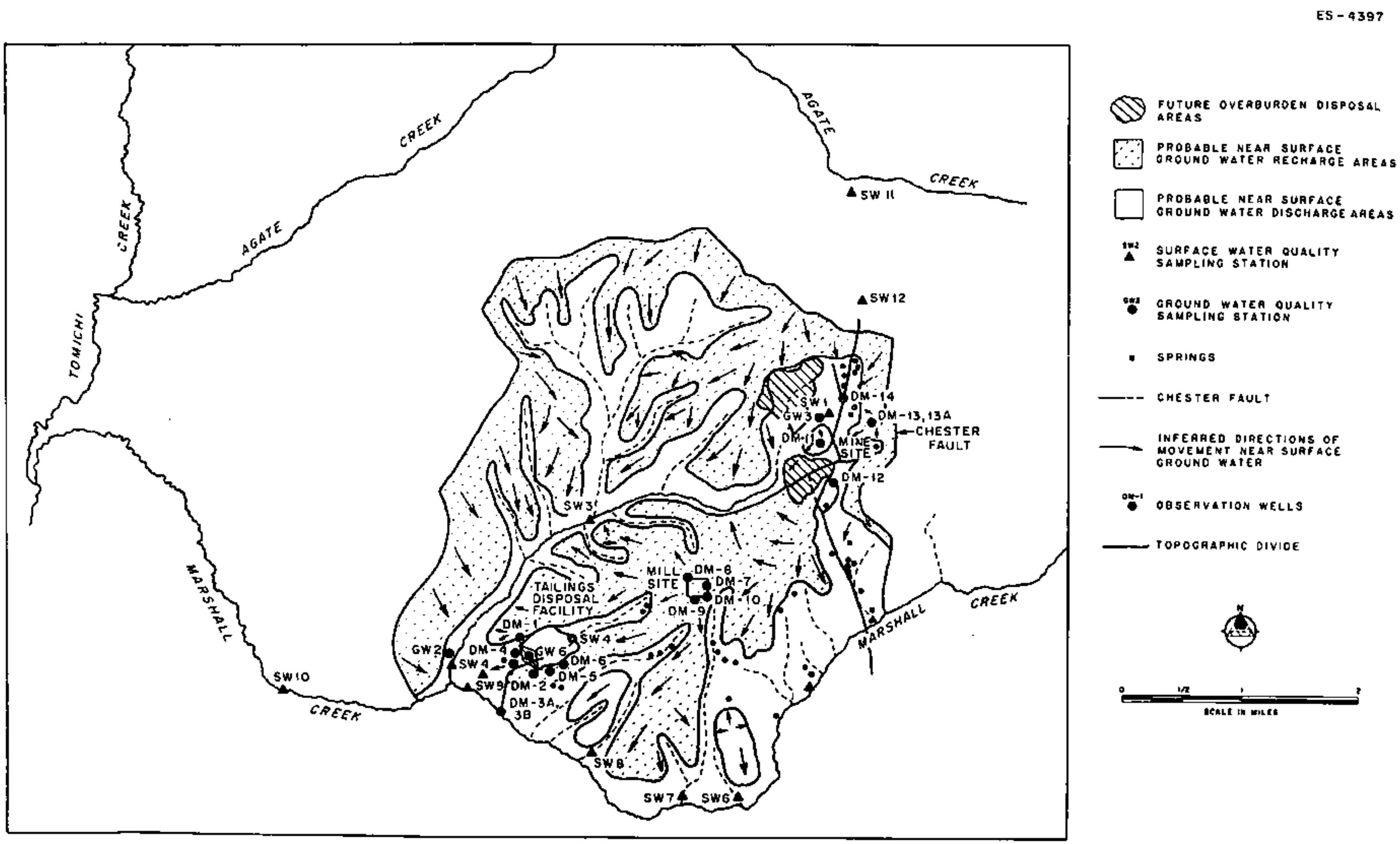

Fig. 2.5. Groundwater regime of the project area. Source: ER Suppl., Plate 2.6-1, p. 2-11.

Table 2.3. Summary of spring and seep survey data June 14–17, 1976

Date	Time	Spring designation[a]	Probable geologic source[b]	Temperature (°C)	pH	Specific conductivity (μmhos/cm)	Estimated flow rate
14 June 1976	1130	SP-1	P€g	7.0	7.3	145	0.2 gpm
	1220	SP-2	P€g	4.8	7.5	230	~1.0 gpm
	1245	SP-3	P€	5.5	8.0	37	~0.5
	1315	SP-4	P€	4.5	7.7	170	0.5–1.0 gpm
	1340	SP-5	Contact of Tra & Pb	9.0	7.4	280	No distinguishable flow
	1400	SP-6	Pb	8.5	7.8	380	1.0–2.0 gpm
	1500	SP-7	P€	9.5	8.0	75	~0.1 gpm
	1530	SP-8	P€g	8.0	8.0	70	~0.5 gpm
	1530	SP-9	P€	10.0	8.1	45	<0.5 gpm
	1600	SP-10	Tra	7.0	7.7	210	~0.5 gpm
	1700	SP-11	P€	c	c	c	No distinguishable flow
	1730	SP-12	Tra	10.0	7.9	211	0.2–0.5 gpm
15 June 1976	0815	SP-13	Tra	6.0	7.0	70	1.0–2.0 gpm
	0845	SP-14	Tra	5.0	7.3	53	No distinguishable flow
	0850	SP-15	Tra	6.0	7.0	170	0.2 gpm
	0915	SP-16	Tra	6.5	7.6	29	<0.1 gpm
	0930	SP-17	Pb	6.0	7.5	120	0.1–0.3 gpm
	1045	SP-18	Pb	2.5	7.9	50	~0.5 gpm
	1115	SP-19	Pb	6.0	7.9	100	<0.1 gpm
	1130	SP-20	Pb	2.5	7.6	410	No distinguishable flow
	1145	SP-21	P€	5.5	8.1	55	~0.2 gpm
	1240	SP-22	P€	12.0	8.0	90	No distinguishable flow
	1250	SP-23	P€	2.0	8.3	19	1.0–2.0 gpm
	1315	SP-24	P€	7.0	8.0	29	2.0–3.0 gpm
	1430	SP-25	P€	6.0	7.2	55	~0.5 gpm
	1515	SP-26	P€	6.0	7.6	35	~1.0–2.0 gpm
	1530	SP-27	P€	7.0	7.6	35	~1.0 gpm
	1630	SP-28	P€	6.0	7.8	29	~0.1 gpm
	1700	SP-29	Ml	7.0	8.1	48	~0.5–1.0 gpm
	1730	SP-30	Pb	6.0	8.1	100	~0.1 gpm
	1745	SP-31	Pb	7.5	8.0	140	~0.1 gpm
16 June 1976	0845	SP-32	P€g	2.5	7.2	36	~0.1 gpm
	0915	SP-33	Ml	c	c	c	
	1300	SP-34	Tw	7.0	7.4	52	<0.1 gpm
	1315	SP-35	Tw	7.0	7.4	50	5.0–10.0 gpm
	1330	SP-36	Tw	5.5	7.5	52	1.0 gpm
	1330	SP-37	Tw	c	c	c	5.0–10.0 gpm
	1340	SP-38	Tra	c	c	c	~2.0–3.0 gpm
	1430	SP-39	Tw	6.0	7.4	64	~10–15 gpm
	1500	SP-40	Tw	15.0	7.2	370	No distinguishable flow
	1515	SP-41	Tw	c	c	c	No distinguishable flow
	1515	SP-42	Tw	c	c	c	No distinguishable flow
	1530	SP-43	Tw	c	c	c	No distinguishable flow
	1530	SP-44	Tw	13.0	7.7	66	<0.1 gpm
	1630	SP-45	Tw	c	c	c	No distinguishable flow
	1700	SP-46	Tw	c	c	c	No distinguishable flow
	1715	SP-47	Tw	c	c	c	No distinguishable flow
	1730	SP-48	Tw	8.5	7.1	80	<0.1 gpm
	1900	SP-49	Tra	c	c	c	No distinguishable flow
	1900	SP-50	Tra	c	c	c	No distinguishable flow
17 June 1976	0845	SP-51	Tra	6.0	6.5	225	0.5 gpm
	0900	SP-52	Tra	c	c	c	No distinguishable flow
	0930	SP-53	Tra	6.0	6.7	100	1.0 gpm
	1000	SP-54	Tm-Tw?	c	c	c	No distinguishable flow
	1030	SP-55	Tw	5.5	7.2	34	0.1–0.3 gpm
	1100	SP-56	Tw	4.5	7.2	38	1.0–2.0 gpm
	1115	SP-57	Tw	6.5	7.1	28	1.0 gpm

[a]Plate 2.6–2 in the ER shows spring locations.
[b]Tw = Tertiary waterlaid tuff
Ml = Paleozoic Leadville formation
Pb = Paleozoic Belden formation
Tra = Tertiary Rawley andesite
P€ = Precambrian metamorphosis (schist)
P€g = Precambrian granite
[c]No field water quality data taken.

2.4.1.2 Specific groundwater characteristics

Groundwater regime at the proposed open-pit mine

Five wells were constructed in the vicinity of the proposed open-pit mine (ER Suppl., Plate 2.6.4). Based on the low discharge rate of springs, the relatively small area for recharge and low values for permeability and transmissivity in Precambrian and Paleozoic rocks, the total volume of groundwater at the proposed mine site is small. Water levels measured from September 1976 through January 1977 and from February 1977 through September 1978 are shown in Table 2.4.

Well DM-11 was completed to a depth of 169 m (555 ft) in Paleozoic siltstone and sandstone. The well yielded 11 to 16 m^3/day (2 to 3 gpm) during development with air. Water-level recovery was extremely slow after development, indicating very low values for permeability and transmissivity. Because of the large drawdown and low yield, a pump test was not conducted.

Well DM-12 was completed to a depth of 107 m (351 ft) in Paleozoic limestone, shale, and some sandstone. The well yielded 16 to 22 m^3/day (3 to 4 gpm) during development with air, and because water-level recovery was moderately fast, a pump test was conducted. Permeability was estimated at 1.35 m^3/day per square meter (0.33 gpd/ft^2), assuming the entire 30-m (100-ft) screened interval contributed water. Transmissivity was calculated at 0.44 m^3/day per meter (35 gpd/ft), based on residual drawdown data.

Well DM-13 was completed to a depth of 262 m (861 ft) in Precambrian schist, pegmatite, and granite. Water occurred at depths of 48 to 49 m (156 to 160 ft), 67 to 79 m (220 to 260 ft), and 93 to 122 m (305 to 400 ft). At 117 m (385 ft), a prominent fracture zone yielded 109 to 220 m^3/day (20 to 40 gpm). The total yield from Well DM-13 was about 275 m^3/day (50 gpm). Because the groundwater in the Precambrian rocks comes mainly from fractures, the storage volume is probably small. Continued pumping of Well DM-13 at a maximum yield would probably dewater the fractures in a relatively short time and reduce, or possibly stop, the water yield of the well.

Well DM-13A was completed to a depth of 18 m (60 ft) in weathered Precambrian schist. During development, the well yielded 5 to 10 m^3/day (1 to 2 gpm). The low yield, however, may be the result of an early to late fall sampling period, when water in the near-surface is at a minimum.

Well DM-14 was completed to a depth of 120 m (395 ft) in Paleozoic rocks that overlie Precambrian schist. The well was screened in both the Paleozoic and Precambrian rocks. During development, the well yielded 110 to 160 m^3/day (20 to 30 gpm). Average transmissivity calculated from a 300-min pumping test was 1.2 m^3/day per meter (98 gpd/ft). Permeability, calculated on the basis of the entire 43-m (140-ft) screened interval, was estimated at 0.03 m^3/day per square meter (0.70 gpd/ft^2). Because this well was completed in the Chester Fault zone at the proposed open pit, mining operations will eventually destroy it.

In addition, over 500 exploratory drill holes were logged at the mine site. Information developed from data retrieved from these drill holes and the wells listed above has been incorporated into Fig. 2.6 to show the pieziometric surface at the mine and waste dump sites. Water level measurements, shown in Table 2.4, show fluctuations up to 9 m (27 ft) with maximum recharge levels reached in July.

Groundwater regime at the proposed tailings disposal site

Seven wells, ranging from 3 to 47 m (10 to 154 ft) deep, were constructed in the vicinity of the proposed tailings disposal site (Fig. 2.7). All wells penetrated Tertiary andesite and/or tuff. In general, wells in the andesite yielded almost no water, and wells in the tuff yielded very small amounts of water. Water levels measured from September 1976 through January 1977 and from February 1977 through September 1978 are shown on Table 2.4.

Well DM-1 was constructed in andesite to a depth of 45 m (147 ft) and yielded no water. As the tailings disposal area fills up, this well will monitor infiltration into the ridge.

Well DM-2 was constructed in tuff to a depth of 45 m (148 ft). During development, this well yielded 5 to 10 m^3/day (1 to 2 gpm) with large downdraws.

Table 2.4. Water levels[a] on selected dates in monitoring wells
(September 1976 to January 1977)

Well number	1976 Sept. 20 m	ft	Oct. 5 m	ft	Oct. 10 m	ft	Oct. 15 m	ft	Oct. 25 m	ft	Oct. 28 m	ft	Oct. 29 m	ft	Nov. 5 m	ft	Nov. 6 m	ft	Dec. 12 m	ft	Jan. 12 m	ft
DM–1			41.9	137.5	41.9	137.5	41.9	137.5									41.9	137.5	42.0	137.8	42.0	137.7
DM–2					27.5	90.4	27.5	90.3									27.5	90.3	27.5	90.4	27.5	90.4
DM–3A					2.0	6.6	2.0	6.5									2.1	7.2	2.1	6.9	2.1	7.0
DM–3B					1.9	6.3	1.9	6.2									2.1	6.9	1.9	6.5	1.9	6.6
DM–4[b]					33.2	109.2	29.0	95.4									25.3	83.2	23.8	78.4	25.3	83.2
DM–5					41.3	135.5	41.3	135.5									41.3	135.6	41.3	135.6	41.3	135.7
DM–6					11.2	36.9	11.2	36.9									11.2	36.8	11.2	36.9	11.2	36.9
DM–7	10.7	35.4	11.4	37.7	11.5	37.9	11.5	37.9					11.5	37.9	11.6	38.2			11.7	38.5	11.6	38.3
DM–8	45.6	149.9	46.1	151.5	46.4	152.5	46.7	153.5					47.1	154.6	47.3	155.5			48.6	159.6	50.6	166.3
DM–9	14.5	47.6	14.3	47.0	14.7	48.3	14.9	48.9					15.1	49.8	15.3	50.3			15.8	52.1	15.8	51.3
DM–10	13.8	45.6	13.5	44.4	13.8	45.5	13.9	45.8					14.0	46.0	14.0	46.2			14.1	46.5	14.0	46.3
DM–11[b]									36.5	119.9	72.6	238.3					41.3	135.6	37.3	122.4	37.0	121.7
DM–12[c]							18.7	61.5	37.9	124.6							57.4	188.6	33.5	110.0	33.7	110.7
DM–13[d]							32.0	105.2			63.2	207.5					63.0	206.9	62.7	206.0	63.0	206.7
DM–13A							9.8	32.4									10.2	33.5	11.3	37.3	11.3	37.1
DM–14									2.4	8.0	2.4	7.9					2.8	9.2	3.9	12.9	4.9	16.4

Well number	1977[e] Feb. m	ft	Mar. m	ft	Apr. m	ft	May m	ft	June m	ft	July m	ft	Aug. m	ft	Sept. m	ft
DM–1	42.0	137.9	42.1	138.1	42.1	138.2	42.1	138.1	42.1	138.1	42.1	138.2	43.2	141.8	42.1	138.2
DM–2	27.5	90.4	27.6	90.8	27.6	90.7	27.6	90.8	27.6	90.8	27.6	90.8	27.7	91.1	27.7	91.1
DM–3A	2.2	7.3	2.3	7.5	2.1	6.9	2.0	6.8	2.1	6.9	2.2	7.2	2.3	7.6	2.4	8.0
DM–3B	2.1	6.9	2.1	6.9	1.5	5.0	0.9	3.0	1.9	6.3	2.2	7.2	2.3	7.4	2.4	8.1
DM–4[b]	25.3	83.1	25.4	83.5	25.4	83.5	25.5	83.8	25.5	83.9	25.6	84.0	25.3	83.2	25.6	84.3
DM–5	41.3	135.8	41.4	135.9	41.4	136.0	41.4	136.0	41.4	136.0	41.4	136.0	41.4	135.9	41.4	136.0
DM–6	11.2	37.0	11.3	37.1	11.2	36.9	11.3	37.1	11.3	37.2	11.3	37.3	11.3	37.3	11.3	37.3
DM–7	11.6	38.3	11.8	38.8	11.7	38.5	11.8	38.9	11.8	38.8	11.9	39.1	11.8	39.0	11.9	39.3
DM–8	51.3	168.4	52.1	171.2	52.6	172.9	48.7	159.8	48.7	159.8	48.4	159.1	48.4	159.0	51.1	167.9
DM–9		Dry		Dry		Dry		Dry		Dry		Dry		Dry		Dry
DM–10	14.1	46.4	14.2	46.5	13.8	45.4	14.0	46.0	36.2	46.4	14.5	46.5	14.2	46.7	14.2	46.7
DM–11[b]	37.3	122.5	37.8	124.1	37.9	124.5	36.2	118.9	35.8	117.5	36.1	118.5	36.2	118.8	36.4	119.6
DM–12[c]	33.6	110.5	33.8	111.2	33.7	110.8	33.2	109.2	33.1	108.8	33.3	109.5	33.5	110.0	33.6	110.5
DM–13[d]	62.9	206.4	63.0	206.8	63.1	206.9	62.8	206.3	63.0	206.8	63.1	206.9	63.2	207.3	63.3	207.8
DM–13A	11.6	38.3	12.1	40.0	12.5	41.3	12.9	42.5	12.9	42.4	13.1	43.1	13.2	43.3	13.3	43.6
DM–14	4.7	15.5		Snow	2.5	8.3	0.9	3.0	3.2	10.5	4.2	13.9	4.7	15.7	5.3	17.5

Table 2.4 (continued)

	1978[e]													
	Mar.		Apr.		May		June		July		Aug.		Sept.	
	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m	ft
DM–1	42.3	138.8	42.3	138.9	42.3	138.8	42.3	138.9	41.6	136.7	42.3	138.8		
DM–2	27.8	91.3	27.9	91.5	27.7	90.8	27.6	90.6	27.7	90.8	27.7	91.2	27.6	90.8
DM–3A		Snow	1.1	3.6	1.8	6.2	1.6	5.4	1.7	5.8	2.1	6.9	2.1	7.0
DM–3B	2.5	8.2	2.4	7.9	0.7	2.2	0.6	2.0	1.0	3.5	1.9	6.5	2.2	7.3
DM–4[b]	25.7	84.5	25.7	84.5	25.6	84.1	25.6	83.9	25.5	83.7	25.6	84.0	25.5	83.8
DM–5	41.6	136.6	41.5	136.4	41.5	136.4	41.6	136.5	41.5	136.3	41.4	136.1	41.4	136.1
DM–6		Snow		Snow	11.5	37.7	11.4	37.6	11.4	37.6	14.6	48.1	11.3	37.4
DM–7	12.1	39.8	12.2	40.0	12.3	40.2	12.2	40.0	12.2	40.1	12.3	40.2	12.1	39.9
DM–8	53.5	175.8	53.9	177.0	54.2	177.8	54.3	178.3	43.8	143.8	45.2	148.5	45.6	149.8
DM–9		Dry		Dry		Dry		Dry		Dry		Dry		Dry
DM–10	14.3	46.9	14.4	47.2	13.5	44.3	13.4	44.2	14.0	46.0	14.7	48.5	14.9	48.9
DM–11[b]	37.7	124.0	37.9	124.5	35.4	116.2	33.9	111.3	31.7	104.1	32.9	108.1	33.4	109.7
DM–12[c]	34.2	112.5	34.4	113.1	34.5	113.3	33.6	110.25	31.8	104.3	32.2	105.8	31.4	103.3
DM–13[d]	64.0	210.0	64.3	211.1	64.2	210.8	63.5	208.4	61.5	201.8	61.7	202.6	61.8	202.9
DM–13A	14.1	46.5	14.2	46.9	14.6	48.1	10.6	35.0	6.1	20.1	7.7	25.3	8.2	27.0
DM–14	9.2	30.3	9.1	30.1	8.2	27.0	1.5	5.2	2.5	8.2	4.4	14.5	4.9	16.2

[a]All measurements in meters (feet) below measurement reference point.
[b]Very low transmissivity, resulting in slow recovery of water level after development.
[c]Mud used during drilling clogged well up to time of development – leading to fall in water level.
[d]Development of well resulted in opening up of fault zone – leading to fall in water level.
[e]Data for October 1977 through February 1978 and October 1978 through December 1978 were not available.

Table 2.5. Water quality analyses by the applicant's consultant according to monitoring well station and collection date

All units in milligrams per liter unless otherwise designated.

	Proposed tailings area monitoring wells — Hale Gulch							Proposed mill site monitoring wells		Proposed mine site monitoring wells				
	DM-1 11/12/76	DM-2 11/12/76	DM-3A 11/02/76	DM-3B 11/24/76	DM-4 11/12/76	DM-5 11/12/76	DM-6 11/11/76	DM-7 11/11/76	DM-8 11/05/76	DM-11 11/15/76	DM-12 11/04/76	DM-13 11/22/76	DM-13A 11/22/76	DM-14 11/02/76
Specific conductivity (field), micromhos	250	200	240	310	500	210	230	140	75	220	330	65	50	275
Total suspended solids	830[a]	36[a]	2.1	61[a]	61[a]	400[a]	41[a]	240[a]	80[a]	23	60[a]	1.0	310[a]	31[a]
Total dissolved solids	165 (175)[b]	210 (240)	345 (345)	310 (330)	545 (260)	220 (230)	280 (280)	190 (175)	145 (110)	305 (235)	330 (310)	58 (69)	39 (56)	290 (240)
Total alkalinity	49	105	105	95	200	165	60	120	24	125	275	40	25	185
Bicarbonate	<0.1	130	130	110	245	200	73	145	30	150	340	49	30	225
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1[a,c]	0.02[a,c]	<0.01	0.01[a]	<0.01	<0.01	<0.01	<0.01
Iron	3.7[a,c]	0.3[a]	0.8[a,c]	0.6[a,c]	0.8[a,c]	6.0[a,c]	2.8[a,c]	8.3[a,c]	3.6[a,c]	4.0[a,c]	0.9[a,c]	0.07	8.7[a,c]	1.2[a,c]
Magnesium	1.0	2.7	4.3	2.2	8.9	5.1	12	6.3	2.0	1.0	26	3.8	1.8	7.9
Ammonia nitrogen	<0.1	<0.1	<0.1	0.8[a]	7.9[a]	0.2[a]	<0.1	<0.1	<0.1	1.6[a]	<0.1	0.6[a]	<0.1	0.6[a]
Phosphorus	0.1[a]	0.6[a]	0.2[a]	0.2[a]	0.2[a]	<0.1	0.2[a]	<0.1	0.1	0.2[a]	<0.01	<0.1	<0.1	<0.1
Sodium	55	75	90	65	30	50	70	35	40	80	15	20	12	15
Turbidity	195[d]	3.6[d]	<0.05	10[d]	52[d]	43[d]	7.4[d]	79[d]	9.2[d]	120[d]	9.7[d]	1.4[d]	38[d]	16[d]
Manganese	0.6[a,c]	0.1[a,c]	0.8[a,c]	0.4[a,c]	0.3[a,c]	3.3[a,c]	1.6[a,c]	1.1[a,c]	0.4[a,c]	<0.05	0.1[a,c]	<0.05	0.3[a,c]	0.4[a,c]
Aluminum	9.5[a]	0.4[a]	0.6[a]	0.8[a]	0.8[a]	10[a]	3.3[a]	4.9[a]	3.0[a]	3.7[a]	1.1[a]	0.2[a]	1.5[a]	0.6[a]
Barium	0.07	0.02	<0.01	0.2	0.2	0.6	0.4	0.4	<1.0	0.2	<1.0	<0.1	0.6	<1.0
Boron	<0.1	<0.1	<0.1	0.1	1.3[c]	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.2	0.1	<0.1
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	0.02[a]	0.04[a]	0.04[a]	0.01[a]	0.02[a]	0.04[a]	0.02[a]	0.02[a]	0.08[a,c,d]	0.2[a,c,d]	0.05[a]	<0.01	0.02[a]	0.04[a]
Molybdenum	<0.1	<0.1	<0.1	<0.1	0.8[a]	<0.1	<0.1	<0.1	<0.01	0.1	<0.01	<0.1	<0.01	<0.01
Phenols	<0.001	<0.001	<0.001	0.004[a,c,d]	0.039[a,c,d]	<0.001	<0.001	0.009[a,c,d]	<0.001	<0.001	<0.001	<0.001	< 0.001	<0.001
Zinc	0.1[a]	0.2[a]	2.7[a]	0.1[a]	0.1[a]	0.2[a]	0.1[a]	0.3[a]	0.3[a]	<0.1	<0.01	<0.1	<0.1	<0.1
Thorium-230 (dissolved), pCi/liter	4.6 ± 1.1	0.6 ± 0.4	0.0 ± 0.2	0.1 ± 0.3	0.3 ± 0.3	0.1 ± 0.2	0.2 ± 0.3	1.4 ± 0.6	0.2 ± 0.3	1.1 ± 0.5	0.0 ± 0.2	0.2 ± 0.4	0.1 ± 0.3	3.6 ±1.0
Uranium (dissolved)	0.008	0.002	<0.002	0.002	0.016	0.006	0.002	0.003	<0.002	0.026	0.008	0.002	<0.002	0.54[a]
Radium-226 (dissolved), pCi/liter	1.0 ± 1.3	0.6 ± 0.8	2.4 ± 1.7	0.2 ± 0.3	0.5 ± 0.9	0.6 ± 0.4	0.3 ± 0.4	0.5 ± 0.4	0.6 ± 1.0	5.4 ± 2.3[a]	1.5 ± 1.3	0.0 ± 0.8	0.9 ± 1.1	410 ± 50[a,d]
Gross alpha, pCi/liter	11.1 ± 3	2.2 ± 1.3	0.6 ± 1.0	2.6 ± 1.4	20 ± 4[a,c]	4.1 ± 1.7	0.9 ± 0.9	1.9 ± 1.2	1.6 ± 1.0	27 ± 4[a,d]	6.6 ± 2.5	2.2 ± 1.0	2.0 ± 0.9	1050 ± 30[a,d]
Gross beta, pCi/liter	20 ± 8	8 ± 7	19 ± 8	3 ± 7	57 ± 12[a]	0 ± 7	5 ± 7	10 ± 7	10 ± 7	8 ± 11	9 ± 8	5 ± 7	0 ± 7	1590 ± 40[a]

[a] Exceeds State of Colorado proposed standards for some or all uses; see Appendix I, Table I.1.
[b] Total dissolved solids reported in evaporation with calculated value in parentheses.
[c] Exceeds 1962 USPHS Standards (Appendix I, Table I.2).
[d] Exceeds 1974 EPA Recommended Standards (Appendix I, Table I.2).

Source: ER, Table 2.6-9.

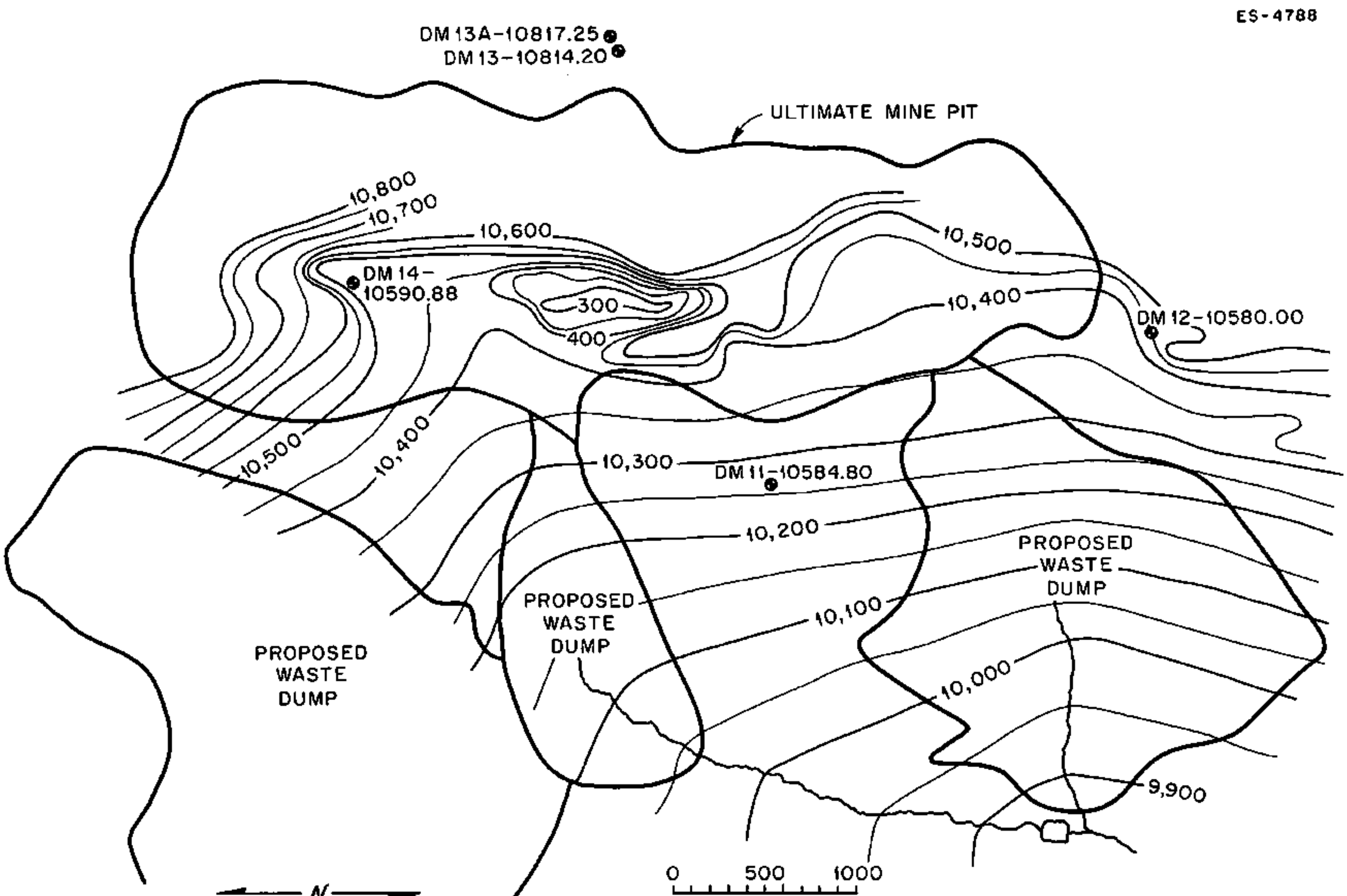

Fig. 2.6. Piezometric surface in the mine and waste dump area and monitor well locations.

ES-4790

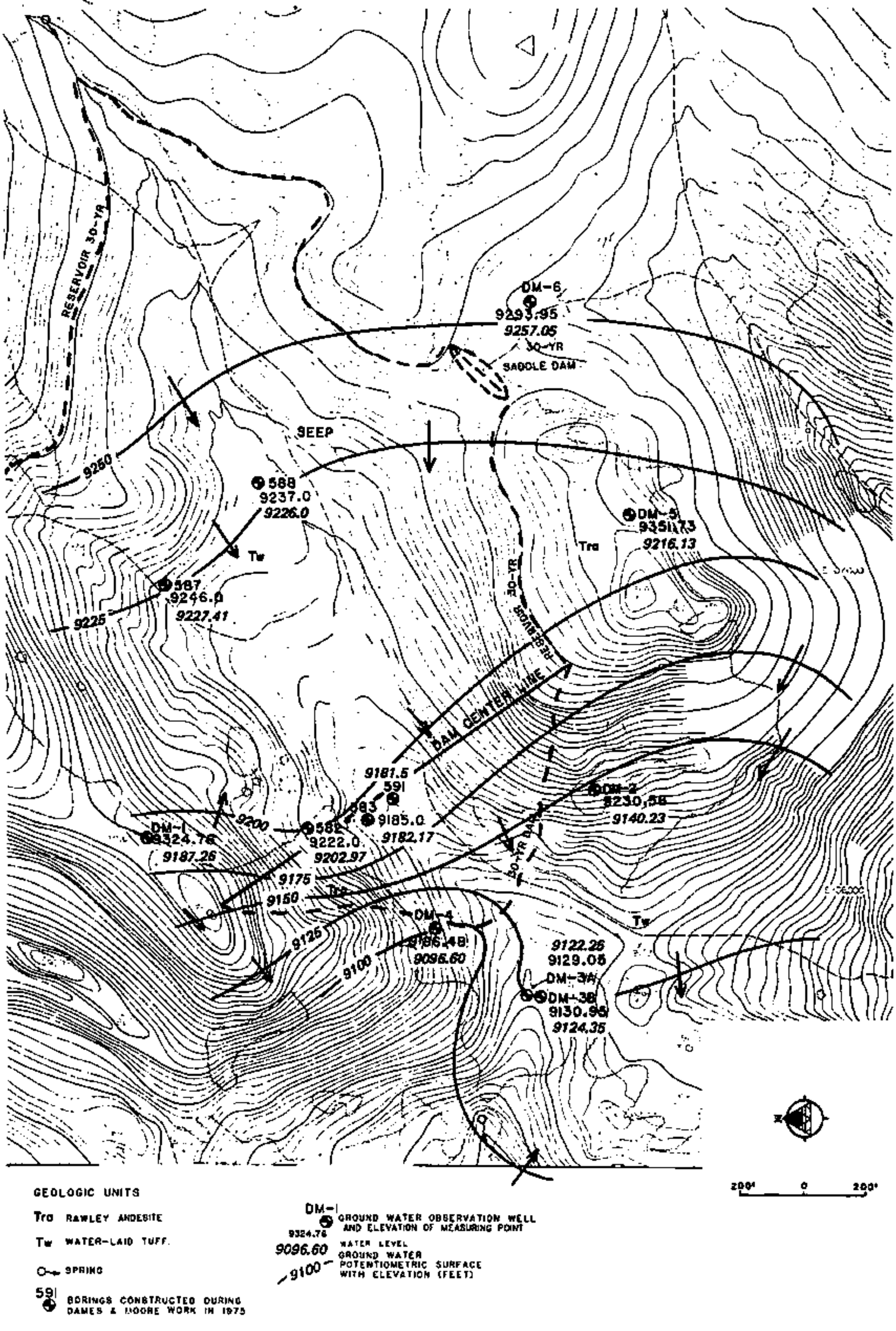

Fig. 2.7. Location map and potentiometric surface for groundwater investigation: Hale Gulch. Source: ER Suppl., Plate 2.6-5, p. 2-30.

Well DM-3A was constructed in tuff to a depth of 16 m (51 ft). During development, this well yielded 16 to 27 m^3/day (3 to 5 gpm), and a pump test was conducted. The permeability calculated for the entire 6-m (20-ft) screened interval was 1.6 m^3/day per square meter (38 gpd/ft^2). Estimated transmissivity was 9.3 m^3/day per meter (750 gpd/ft).

Well DM-3B was constructed next to DM-3A to a depth of 3 m (10 ft). The well is located in Hale Gulch and yielded 2.7 m^3/day (0.5 gpm) from altered tuff and alluvium. During the pump test of Well DM-3A, the water level in Well DM-3B remained stationary. This test suggests either that there is no water communication between deep and shallow aquifers in this area or that leakage between the two aquifers is too slow to be detected by the pump test.

Well DM-4 was constructed in andesite and tuff to a depth of 48.8 m (153.5 ft). The screened interval was entirely in tuff and yielded no water.

Well DM-5 was constructed in andesite to a depth of 46.5 m (152.5 ft). The well yielded 2.7 m^3/day (0.5 gpm) and will monitor seepage through the ridge south of the tailings disposal area.

Well DM-6 was constructed in tuff to a depth of 16 m (51 ft) and yielded 2.7 m^3/day (0.5 gpm). As the tailings disposal area fills up, this well will monitor seepage below the saddle spillway.

A potentiometric map of the Hale Gulch area is included in Fig. 2.7. Contour lines are based on four piezometers (582, 587, 588, and 591) and the water levels in nearby wells. Groundwater levels in Hale Gulch fluctuate less than 2 m/year (6 ft/year). Yearly fluctuations of groundwater levels in higher areas are about 0.3 m (1 ft). Based on the potentiometric map, the hydraulic gradient is about 0.05 m/m (0.05 ft/ft) down Hale Gulch. The flow through the tuff through an 268-m (880-ft) wide by 6-m (20-ft) high area at the tailings dam has been estimated by the applicant to be approximately 164 m^3/day (30 gpm).

Groundwater regime at the proposed waste dumps

One well has been drilled downgradient from the proposed north waste dump site. The three dumps will cover the upper drainage areas of Indian Creek. Because most of the bedrock in this area dips gently to the south, it is probable that groundwater moves to the south and discharges, in part, along Indian Creek above the proposed new settling pond.

Groundwater regime at the proposed mill site

Four wells were constructed at the proposed mill site and are shown in Fig. 2.8. Water level fluctuations from September 1976 to September 1978 are shown in Table 2.4.

Wells DM-7, DM-8, and DM-9 were completed in volcanic tuff, and Well DM-10 was completed in andesite. No distinct water-bearing zones were penetrated in Wells DM-7, DM-9, and DM-10, all of which were about 15 m (50 ft) deep. As a result, Well DM-8 was drilled downslope and down the hydraulic gradient from the mill site to a depth of 85 m (280 ft). At 49 m (160 ft) and between 50 and 59 m (165 and 195 ft), flows of 5 m^3/day (1 gpm) and 50 to 82 m^3/day (10 to 15 gpm), respectively, were obtained from the well.

A pump test was conducted on Well DM-8 at a constant pumping rate of 44 m^3/day (8 gpm). Because of excessive drawdown, the test ended after 90 min. Transmissivity was calculated from residual drawdown data at 12 m^3/day per meter (1000 gpd/ft).

Assuming that the screened interval of Well DM-8 was 12 m (40 ft) and that this thickness makes up the entire water-bearing zone, the permeability was calculated at 1 m^3/day per square meter (25 gpd/ft^2).

2.4.1.3 Groundwater quality

Groundwater quality analyses were conducted by the applicant in November 1976 at the proposed mine site, the tailings impoundment, and the mill site. Analytical results are shown in Tables 2.5 and 2.6. Except as noted, all other parameters meet proposed drinking water

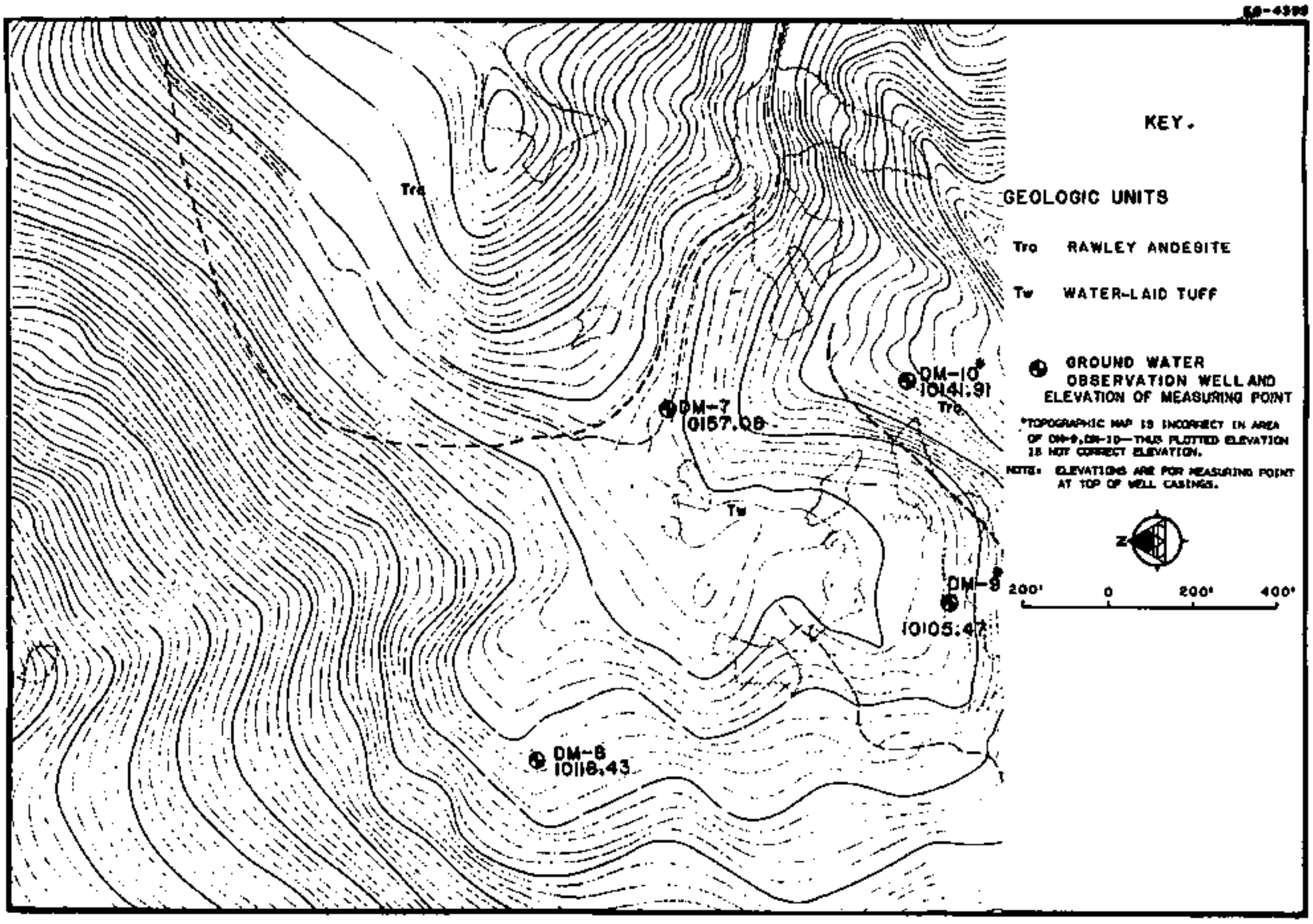

Fig. 2.8. Location map for groundwater investigation: mill site. Source: ER Suppl., Plate 2.6-3, p. 2-19.

standards. Appendix I contains EPA and proposed Colorado Water Quality Standards. Wells used in the water quality analyses were the same as those used to test the hydraulic characteristics of the aquifer. In addition, analyses of seven groundwater quality sampling wells (GW-1 to GW-7) are shown in Table 2.6. The locations of the groundwater sampling stations are shown in Figs. 2.5 and 6.2. Sampling station GW-3 monitors the discharge from the Pinnacle mine.

Laboratory analyses were performed by LFE Laboratories, Richmond, California. LFE has maintained a quality assurance program for environmental monitoring and radioanalytical programs for three years. This plan was developed to ensure compliance with identified requirements related to the production of analytical data. All concurrent processes affecting sample integrity, sensitivity, reproducibility, and accuracy of the data are controlled and audited in the prescribed manner.

The EPA has approved the State of Colorado to perform qualification and certification of commercial laboratories for radiochemical analysis. LFE has obtained certification from the State of California, Department of Public Health. Additionally, the laboratory is State-certified for complete chemical, bioassay, and bacteriological analyses.

Proposed mine site

The five wells sampled at the mine site penetrate Precambrian igneous and metamorphic rocks, Paleozoic sedimentary rocks, and altered fault breccia. As a result, groundwater chemistry is variable.

Table 2.6. Water quality analyses according to groundwater station and collection data

All units in milligrams per liter unless otherwise designated.

	Station GW-1			Station GW-2					Station GW-3				
	11/17/75	12/22/75	02/26/76[a]	11/17/75	12/22/75	02/26/76	05/19/76	08/24/76	11/17/75	12/22/75	02/25/76	05/19/76	08/24/76
Specific conductivity (field), micromhos	150	150	20	200	190	27	320	330	500	440	60	520	670
Total suspended solids							14					23	
Total dissolved solids	98 (92)[c]	130 (110)	92 (100)	130 (135)	170 (140)	150 (140)	190 (220)	130 (130)	450 (420)	470 (420)	470 (510)	440 (410)	465 (445)
Total alkalinity	90	90	95	120	115	115	130	120	265	290	295	280	290
Bicarbonate	110	110	115	150	140	140	160	145	320	360	360	340	355
Cyanide	<0.01		<0.01	<0.01		<0.01	<0.01	0.06	<0.01		<0.01	<0.01	<0.01
Iron	0.4[b]	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.08	1.5[b,c]	3.6[b,c]	1.0[b,c]	1.6[b,c]
Magnesium	9.2	8.0	10	6.4	13	12	13	9.2	33	27	51	24	31
Ammonia nitrogen	<0.1		0.6	<0.1		0.3[b]	<0.01	<0.01	<0.1		<0.1	0.2[b]	<0.1
Phosphorus	<0.1		0.1[b]	0.1[b]		0.3[b]	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1
Sodium	6.0	10	2.0	20	9.8	15	45	6.0	30	25	70	38	23
Turbidity	1	<1	29[b]	<1	<1	<1	<0.1	0.8	5[d]	12[d]	8[d]	0.5	3.8[d]
Manganese	<0.05	<0.05	0.06	<0.05	<0.05	0.06	<0.05	1.1[b]	<0.05	0.2[b,c]	0.2[b,c]	0.1[b,c]	0.2[b,c]
Aluminum	0.2[b]		<0.1	<0.1		<0.1	<0.1	0.1	0.5[b]		<0.1	0.2[b]	0.2[b]
Barium	<1.0		<1.0	<1.0		<1.0	<1.0	1.0	<1.0		<1.0	<1.0	3.6[c,d]
Boron	<0.1		<0.1	<0.1		<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	1.2[b,c]
Cadmium	<0.01		<0.01	<0.01		<0.01	<0.01	0.02	<0.01		<0.01	0.02[b,c,d]	0.03[b,c,d]
Phenols			<0.001			<0.001	<0.001	<0.01			<0.001	<0.01	<0.001
Lead	<0.01		0.05[b]	<0.01		<0.01	<0.01	0.04[b]	<0.01		<0.01	0.02[b]	0.03[b]
Molybdenum	<0.01		<0.01	<0.01		<0.01		<0.05	<0.01		<0.01		<0.05
Zinc	<0.1		<0.1	<0.1		1.0[b]	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1
Thorium-230 (dissolved), pCi/liter	1.1 ± 0.4	0.0 ± 0.3	0.0 ± 0.2	0.0 ± 0.2	0.0 ± 0.4	0.0 ± 0.2	0.0 ± 0.2	0.1 ± 0.3	1.6 ± 0.5	0.8 ± 0.6	0.8 ± 0.4	0.3 ± 0.3	2.5 ± 0.8
Uranium (dissolved)	0.005	0.0068	0.0050	0.0067	0.0090	0.0062	0.007	0.007	3.6[c,b]	3.2[b]	2.6[b]	1.1[b]	4.1[b]
Radium-226 (dissolved), pCi/liter	0.8 ± 0.5	0.7 ± 0.5	0.4 ± 0.8	0.0 ± 0.2	0.2 ± 0.3	0.2 ± 0.2	0.1 ± 0.2	0.1 ± 0.2	86 ± 9[b,d]	76 ± 7[b,d]	71 ± 8[b,d]	40 ± 5[b,d]	75 ± 9[b,d]
Gross alpha, pCi/liter	5.3 ± 1.7	4.1 ± 1.5	4.6 ± 1.6	5.7 ± 1.8	6.1 ± 1.3	5.1 ± 1.2	2.4 ± 1.4	6.9 ± 2.1	750 ± 60[b,d]	1960 ± 60[b,d]	1680 ± 40[b,d]	540 ± 20[b,d]	2580 ± 70[b,d]
Gross beta, pCi/liter	5 ± 6	2 ± 6	4 ± 6	1 ± 6	0 ± 7	5 ± 4	8 ± 6	3 ± 6	730 ± 40[b]	1500 ± 40[b]	940 ± 20[b]	860 ± 20[b]	1890 ± 40[b]

Table 2.6 (continued)

	Station GW-4			Station GW-5			Station GW-6	Station GW-7
	02/26/76	05/20/76	08/25/76	02/26/76	05/20/76	08/25/76	05/19/76	05/19/76
Specific conductivity (field), micromhos	50	190	310	60	480	670	380	220
Total suspended solids		45,460[b]			6340[b]		19	13
Total dissolved solids	400 (430)	90 (110)	220 (225)	440 (470)	385 (385)	435 (405)	285 (290)	215 (185)
Total alkalinity	30	25	40	205	160	210	150	105
Bicarbonate	37	30	49	250	195	255	185	130
Cyanide	<0.01	<0.01	<0.01	<0.01	0.02[b]	<0.01	<0.01	<0.01
Iron	28[b,c]	37.8[b,c]	3.4[b,c]	4.2[b,c]	0.9[b,c]	0.9[b,c]	<0.05	<0.05
Magnesium	5.5	12	5.5	6.6	13	8.5	14	8.8
Ammonia nitrogen	3.1	0.5	0.3	1.4[b]	0.8[b]	0.1[b]	<0.1	<0.1
Phosphorus	<0.1	1.7[b]	0.2[b]	0.2[b]	<0.1	<0.1	<0.1	<0.1
Sodium	80	30	46	90	77	33	54	50
Turbidity	8300[d]	800[d]	640[d]	6660[d]	190[d]	38[d]	0.6	3.5[d]
Manganese	18[b,c]	0.2[b,c]	2.0[b,c]	1.0[b,c]	0.3[b,c]	2.2[b,c]	<0.05	<0.05
Aluminum	<0.1	0.1	2.2[b]	<0.1	<0.1	0.2[b]	<0.1	<0.1
Barium	<1.0	<1.0	1.0	<1.0	<1.0	2.9[b,c]	<1.0	<1.0
Boron	<0.1	0.2	0.1	<0.1	0.2	0.2	0.1	0.2
Cadmium	0.02[b,d]	0.02[b,d]	0.02[b,d]	0.01[b]	0.02[b,c,d]	0.02[b,c,d]	0.01[b]	
Phenols	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Lead	0.03[b]	0.01	0.02[b]	0.04[b,c,d]	<0.01	0.05[b,c]	<0.01	<0.01
Molybdenum	<0.01		<0.05	<0.01		<0.05		
Zinc	1.2[b]	0.21	0.1[b]	<0.1	<0.1	<0.1	3.8[b]	<0.1
Thorium-230 (dissolved), pCi/liter	0.6 ± 0.4	3.7 ± 0.9	1.6 ± 0.7	1.8 ± 0.5	1.6 ± 0.6	0.3 ± 0.4	0.0 ± 0.2	0.0 ± 0.2
Uranium (dissolved)	0.059	0.029	0.010	0.0094	0.007	0.002	<0.002	<0.002
Radium-226 (dissolved), pCi/liter	0.8 ± 1.5	2.3 ± 1.3	0.8 ± 0.3	1.0 ± 1.5	2.4 ± 1.4	0.5 ± 0.3	0.0 ± 0.2	0.2 ± 0.3
Gross alpha, pCi/liter	135 ± 10[b,d]	40 ± 6[b,d]	16 ± 4[b,d]	34 ± 4[b,d]	13 ± 3[b,d]	3.8 ± 2.2	0.5 ± 0.9	0.6 ± 1.1
Gross beta, pCi/liter	160 ± 20[b]	22 ± 9	34 ± 8	67 ± 7[b]	34 ± 9	24 ± 7	0 ± 6	0 ± 6

[a]On two additional collection dates, May 1976 and August 1976, the well was not flowing.
[b]Exceeds State of Colorado proposed standards for some or all uses; see Appendix I, Table I.1.
[c]Exceeds 1962 USPHS standards (Appendix I, Table I.2).
[d]Exceeds 1974 EPA recommended standards (Appendix I, Table I.2).
Source: ER, Table 2.6-12.

Wells DM-11 and DM-12, which produce water from Paleozoic sedimentary rocks, exceed one or more of the State and Federal standards as indicated in Table 2.5 for cyanide (DM-11), iron, ammonia nitrogen (DM-11), phosphorus, aluminum, lead, dissolved radium-226 (DM-11), and gross alpha (DM-11).

Wells DM-13 and DM-13A produce water from Precambrian rocks. Concentrations of the following substances exceed one or more of the State and Federal standards as shown in Table 2.5: iron (DM-13A), ammonium nitrogen (DM-13), manganese (DM-13A), aluminum, and lead (DM-13A).

Well DM-14 produces water from the Chester Fault zone. Based on the high concentrations of dissolved uranium, radium-226, gross alpha, and gross beta, water from this well has been circulating throughout the ore body. In addition, concentrations of the following substances exceed one or more of the State and Federal standards as shown in Table 2.5: iron, ammonia nitrogen, manganese, aluminum, and lead.

Water at sampling station GW-3 is discharged from the old Pinnacle Mine portal. In general, water quality is very poor (Table 2.6), and concentrations of radiological materials are higher compared to water from DM-14. In addition, concentrations of the following substances exceed one or more of the State and Federal standards shown in Table 2.6: iron, ammonia nitrogen, manganese, aluminum, barium, boron, cadmium, and lead.

Proposed tailings disposal area

Seven wells (DM-1 to DM-7, Table 2.5) and two groundwater quality wells (GW-4 and GW-5, Table 2.6) were sampled to determine groundwater quality.

Wells DM-1, DM-2, DM-3A, DM-3B, DM-6, GW-4, and GW-5 produce water from volcanic tuffs. Wells DM-4 and DM-5 produce water from andesites. In general, concentrations of the following substances exceed one or more of the State and Federal standards shown in Tables 2.5 and 2.6: iron, phosphorus, manganese, aluminum, lead, zinc, cadmium (GW-4 and GW-5), and gross alpha (GW-4 and GW-5). Several wells exceed State and Federal standards for oil and grease, cyanide, nitrate, nitrite, ammonia nitrogen, barium, copper, mercury, molybdenum, silver, gross beta, and phenols.

Proposed mill site

Wells DM-7 and DM-8 were sampled to determine the water quality at the mill site. Both wells penetrated volcanic tuffs, but the water-bearing zones were different. Iron and manganese concentrations in the water are high for use as a domestic water supply. Trace metal analyses indicate that the amounts of aluminum, cyanide, lead, and zinc exceed proposed State of Colorado standards for aquatic life and that the level of lead exceeds these standards as a potable water supply. Turbidity and suspended solids also exceed limits for a potable water supply, but these values are probably due to fine material collected in the water sample in the bottom of the well.

2.4.1.4 Groundwater use

The only local use of groundwater is for stock watering and domestic supplies. The closest domestic use is by the town of Sargents, approximately 8 km (5 miles) west of the project area. As of April 1976, only six wells were being pumped by Sargents, and all produce from the alluvium of Marshall Creek. The exact volume of water pumped by these wells is not known but is estimated to be in the range of 6000 to 12,000 m^3 (5 to 10 acre-ft) per year.

Within the permit area, some groundwater is used for stock watering. Springs SP-39, SP-44, and SP-57 (Fig. 2.5) are tapped with PCV pipe and discharge into stock watering tanks. Cumulative flow of these three springs is 16 to 27 m^3/day (3 to 5 gpm) or 5900 to 10,000 m^3 (4.8 to 8.1 acre-ft) per year. There is evidence that springs SP-15 and SP-37 had also been tapped for stock watering in the past. Livestock drink directly from spring SP-51. Of these springs, only SP-57 5.4 m^3/day (1 gpm) will be potentially affected by the project.

Deep groundwater flow from the project area may support streamflow offsite, but there is no evidence in Figs. 2.6 and 2.7 or in Table 2.4 to support this conclusion.

2.4.2 Surface water

The project area, including the mine and mill sites, is drained by two small, adjacent streams of Indian and Marshall creeks. Indian Creek is a first-order tributary to Marshall Creek, and Marshall Creek is a second-order tributary of Tomichi Creek (Fig. 2.5). Tomichi Creek is a tributary of the Gunnison River which it joins at Gunnison. The watersheds of both of these streams are mountainous, with slopes often reaching 30%. Elevations within the basin of Indian Creek range from 3444 m (11,300 ft) at the top of the ridge to 2682 m (8800 ft) MSL at the confluence with Marshall Creek. The average slope of the stream is approximately 87 m/km (462 ft/mile) or 8.7%. The drainage area of Indian Creek is estimated to be 23.6 km^2 (9.1 sq miles). Elevations in the Marshall Creek basin range from 3917 m (12,850 ft) at the Continental Divide to 2682 m (8800 ft) MSL at the confluence of Indian Creek. The average slope of Marshall Creek above the confluence of Indian Creek is approximately 78 m/km (411 ft/ mile) or 7.8%. The drainage area of Marshall Creek above the confluence of Indian Creek, as shown in Fig. 2.9, is 83.1 km^2 (32.1 sq miles).

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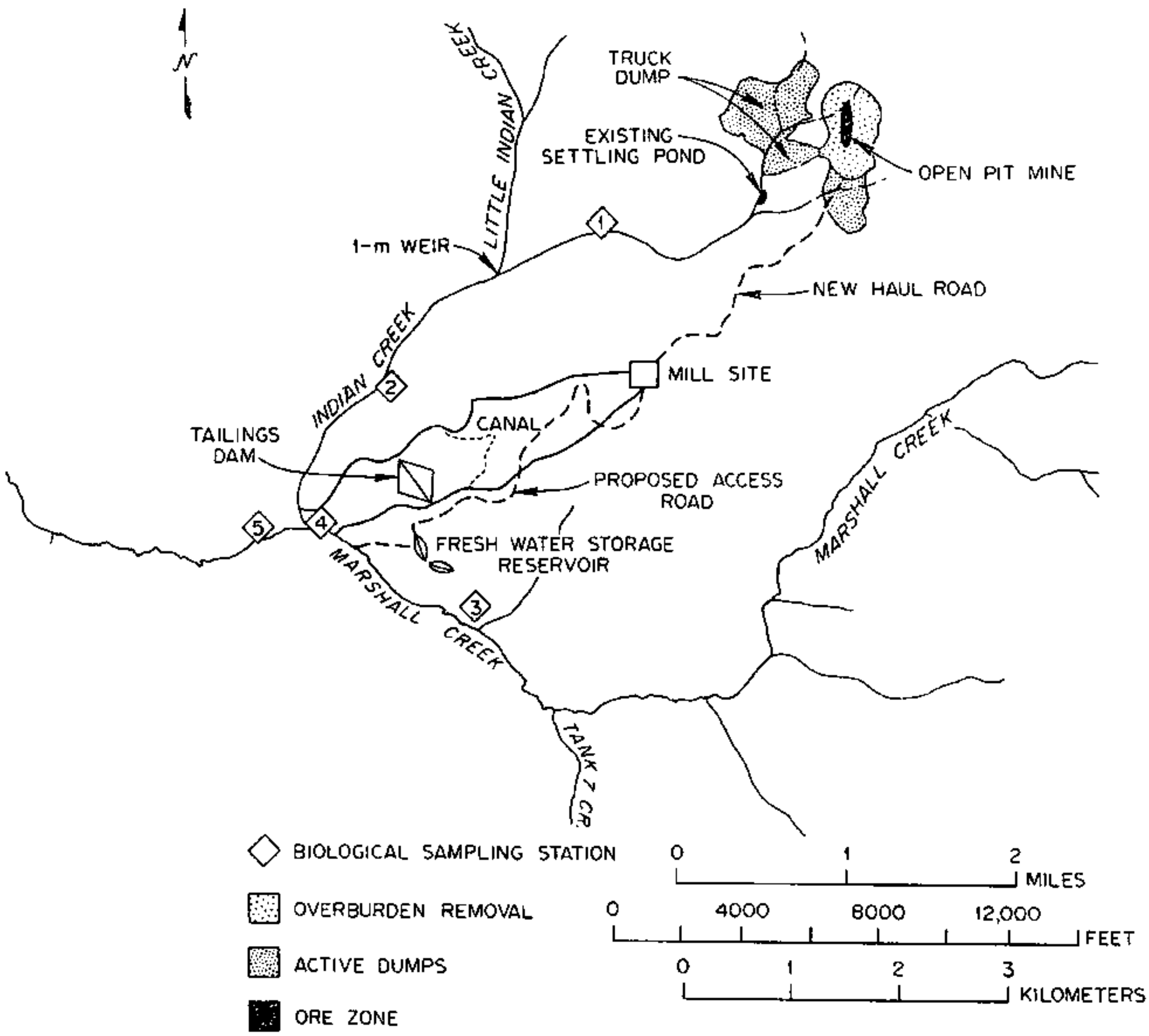

Fig. 2.9. Relationship of Indian Creek and Marshall Creek to project area. Source: ER, Plates 2.6-1 and 3.6-3, pp. 2-127 and 3-45.

The Tomichi Creek drainage basin comprises approximately 2750 sq km (1060 sq miles) of the lower Gunnison River basin's 20,800 sq km (8020 sq miles). The Gunnison River joins the Colorado River at Grand Junction. On the Gunnison River near Sapinero, Colorado [approximately 72 km (45 miles) west of the project site], lies the Blue Mesa Reservoir, the nearest reservoir downstream of the site. This reservoir of 1.1×10^{10} m^3 (9.4×10^5 acre-ft) capacity drains an area of 8870 sq km (3426 sq miles). The project drainage area [107 sq km (41.2 sq miles)] represents 1.2% of Blue Mesa Reservoir's total drainage area. Several small irrigation and recreation reservoirs lie in the Tomichi Creek basin, but all are hydrologically isolated from the Marshall Creek drainage.

2.4.2.1 Subbasins

Impoundment on Indian Creek

Approximately 1.2 km (0.75 mile) downstream of the old Pinnacle Mine, Indian Creek is obstructed by a 4.5-m (15-ft) high earthen dam, creating a small impoundment of approximately 0.2 ha (0.5 acre) in surface area. This reservoir has been used as a settling basin in connection with the operation of the Pinnacle Mine in previous years (Fig. 2.9).

Hale Gulch

An impoundment is proposed in Hale Gulch to retain ore tailings from the milling operation. Hale Gulch is an intermittent watercourse carrying flow only at the time of adequate precipitation. The total watershed of Hale Gulch is approximately 1.7 km^2 (0.65 sq mile). The drainage area of Hale Gulch at the proposed tailing dam is 1.0 km^2 (0.40 sq mile), as indicated in the ER, Table 2.6-1.

Water supply reservoir

A storage reservoir for potable water supply is proposed to be constructed on an intermittent watercourse adjacent to Hale Gulch (Fig. 2.9). The proposed storage reservoir will have a drainage area of 98 ha (240 acres). It will receive water from the watershed and makeup water from Marshall Creek. However, it will not receive any waste effluents. At the proposed 3.7×10^5 m^3 (300 acre-ft) of storage, the reservoir area would be about 4.4 ha (11 acres).

2.4.2.2 Stream flows

Permanent gauging stations were lacking on both Indian and Marshall creeks; therefore, long-term discharge measurements are not available. Temporary gauging stations have been established at five locations on the creeks to provide stream flow information. Stream discharge measurements were recorded from late April through mid-August 1976 and November 1977 through September 1978. Maximum flows occurred in May and June during both years of record, coinciding with the period of snowmelt.

Discharge data for Tomichi Creek just below its confluence with Marshall Creek are available for the period 1938 through 1971. The average annual flow for this period was 5.3×10^7 m^3 (4.35×10^4 acre-ft), or 1.7 m^3/sec (60 cfs). Average monthly flows peaked in May [1.4×10^7 m^3 (1.17×10^4 acre-ft), or 5.4 m^3/sec (190 cfs)] and June [1.3×10^7 m^3 (1.09×10^4 acre-ft), or 5.1 m^3/sec (180 cfs)]. The minimum annual flow for the period was 2.4×10^9 m^3 (1.94×10^4 acre-ft), or 0.8 m^3/sec (27 cfs), and the maximum was 1.1×10^8 m^3 (8.63×10^4 acre-ft), or 3.4 m^3/sec (120 cfs). Based on the Tomichi Creek data, the percentage of the Tomichi Creek drainage basin contributed by the Marshall Creek basin, and the assumption that water yield per acre of the Marshall Creek basin equals that of Tomichi Creek, the staff estimated the average annual flow of Marshall Creek at Mean's Pasture, approximately 4.5 stream miles below the confluence of Marshall and Indian creeks, to be 1.9×10^7 m^3 (1.60×10^4 acre-ft) per year or 0.6 m^3/sec (22 cfs). The maximum and minimum annual flows for 1938 through 1971 were estimated to be 3.8×10^7 m^3 (3.16×10^4 acre-ft) per year, or 1.2 m^3/sec (44 cfs), and 8.6×10^6 m^3 (7.0×10^3 acre-ft) per year, or 0.3 m^3/sec (9.8 cfs), respectively. Just above the confluence of Marshall Creek with Indian Creek, the maximum, average, and minimum annual flows were estimated at 2.3×10^7 m^3 (1.86×10^4 acre-ft) per year, or 0.07 m^3/sec (2.6 cfs), 11.2×10^7 m^3 (9370 acre-ft) per year, or 0.4 m^3/sec (13 cfs), and 5.1×10^6 m^3 (4170 acre-ft) per year, or 0.2 m^3/sec (5.8 cfs), respectively.

The same method was applied to the Indian Creek watershed, resulting in the following estimated flows for Indian Creek at its confluence with Marshall Creek:

average annual flow — 3.2 x 10^6 m^3 (2660 acre-ft) per year, or 0.1 m^3/sec (3.7 cfs),

maximum annual flow — 6.5 m^3 (5270 acre-ft) per year, or 0.2 m^3/sec (7.3 cfs), and

minimum annual flow — 1.4 x 10^6 m^3 (1180 acre-ft) per year, or 0.4 m^3/sec (1.6 cfs).

Upper Indian Creek near the mine site has intermittent flow.

2.4.2.3 Water use

Presently utilization of Indian and Marshall creeks mainly consists of recreation (moderate trout fishing) during the summer months. Downstream from the mine area, Marshall Creek is also used for livestock watering. The flow of these creeks supports downstream irrigation rights on Tomichi Creek and Gunnison River.

2.4.2.4 Water quality

Presently, the water quality and habitat characteristics of Marshall and Indian creeks are such that they both support naturally reproducing populations of trout (ER, Sect. 2.8.2.3).

Suspended solids

Suspended sediments in both Marshall and Indian creeks were sampled during the 1976 snowmelt period. Total suspended solid (TSS) concentrations were already relatively high by the time sampling began on these creeks. High concentrations ranged between 19 and 70 mg/liter TSS at lower Marshall Creek, 16 and 61 mg/liter TSS at upper Marshall Creek, and 16 to 33 mg/liter TSS of Indian Creek at the confluence with Marshall Creek (ER, Table 2.6-7). By the end of the sampling period (June 14 and 27, 1976), TSS concentrations ranged between 4 and 8 mg/liter and more than likely continued to be low except during a spate, where TSS concentrations would increase temporarily. The relatively high slopes of streams allow the rapid transport of sediments from the systems and provide clean, adequate gravel-rubble bottom substrate for fish spawning.

Chemical and radiological constituents

Chemical characteristics of Indian and Marshall creeks and the intermittent stream in Hale Gulch have been summarized in Table 2.7 from water quality data in the ER, Appendix E, Tables E-7, E-9, and E-12. These data indicate that Indian and Marshall creeks are well-buffered, cold-water mountain streams with relatively high hardness resulting from the presence of the divalent calcium and magnesium ions. Although a minimum concentration of 5.4 mg/liter of dissolved oxygen (DO) has been reported to have occurred in December with water temperatures near freezing, the staff considers this DO concentration an anomaly and concludes that DO seems to be adequate to support trout populations. In plant nutrients, the streams contain adequate silica (3.1 to 18 mg/liter); however, available phosphorus and nitrogen may, at times, be in short supply for primary production.

Baseline concentration of selected trace elements was determined in water for Indian and Marshall creeks and for the intermittent stream of Hale Gulch. These trace element concentrations are summarized in Table 2.8. From these data, it appears that the concentrations are low enough not to be toxic to aquatic life[3] and render the streams classified as A-1 by the water quality standards of the State of Colorado (ER, Sect. 2.6.3.3.3 and Appendix E).

The old mine area and the discharge from the closed Pinnacle Mine appear to contribute a significant amount of alpha and beta radioactivity to Indian Creek. At SW-4, immediately upstream of the confluence of Indian Creek with Marshall Creek, alpha and beta values drop to about one-half that observed below the mine, probably caused by dilution from Little Indian Creek (Fig. 2.9). The mine discharge is estimated to contribute 16 to 45% of the gross alpha and 23 to 65% of the gross beta. Uranium, radium-226, magnesium, calcium, and bicarbonate

Table 2.7. Radiological and chemical characteristics of Indian and Marshall creeks and Hale Gulch

Range and means of eight observations measured between 17 November 1975 and 28 June 1976

Chemical characteristics	Indian Creek[a] (SW-4)	Marshall Creek[b] (SW-9)	Hale Gulch (SW-2)
	(milligrams per liter)		
pH	7.1–8.8/8.2	6.7–8.6/8.0	7.2–7.8/7.6
Dissolved oxygen	8.3–9.8/9.2	5.4–10.2/8.8	6.3–8.8/7.7
Temperature in °C	0.5–8.5	0.5–11.5	3.13
Total suspended solids	2.8–33/13.3	2.4–155[c]	1.1–8.0
Total dissolved solids	170–260/215	76–190/109	130–240/192
Total hardness	160–200/189	36–185/77	56–155/107
Total alkalinity	150–195/176	45–165/75	60–155/100
CL^-	<1.0–8.2/3.1	<1.0–5.7/2.6	<1.0–2.8/2.2
NO_3^-	<0.1–6.9/1.2	<0.1–3.0/0.6	<0.1–2.5/1.1
PO_4^{3-}	<0.1[c]	<0.1–0.6[c]	<0.2[c]
Si	3.1–9.9/4.6	3.9–18/11.4	18–26/22
SO_4^{2-}	<4.0–1.5/6.9	<4.0–10/5.5	<4.0–20/11.3
U	0.1–0.22/0.13	<0.002–0.003/0.002	<0.002–0.003
	(picocuries per liter)		
Gross alpha	46–83/60	0–3.8/1.0	0.1–0.6/0.4
Gross beta	0–93/38	0–6/1	0
Ra-226	0.1–1.5/0.7	0–0.8/0.2	0–0.2/0.1
Th-230	0–0.3/0.1	0–2.4/0.3	0.1–0.3/0.2
Pb-210	0–0.2/0.1	0–0.1/0.04	0–0.2/0.1

[a] Indian Creek at the confluence with Marshall Creek.
[b] Marshall Creek at the confluence with Indian Creek.
[c] Measurements were not taken frequently enough to warrant expression of means.
Source: ER Suppl., Appendix E, Tables E-7, E-9, and E-12.

Table 2.8. Trace elements of Indian and Marshall creeks and Hale Gulch

Ranges and means (in milligrams per liter) of eight observations measured between 17 November 1975 and 28 June 1976.

Elements	Indian Creek[a]	Marshall Creek[b]	Hale Gulch
Iron	<0.5–0.10/0.06	0.07–0.6/0.4	0.05–0.4/0.2
Manganese	<0.05–0.06/0.05	<0.05–0.07/0.05	<0.05
Beryllium	<0.01[c]	<0.01[c]	
Argon	<0.01[c]	<0.01[c]	<0.01[c]
Barium	<1.0[c]	<1.0[c]	<1.0[c]
Boron	<0.1[c]	<0.1[c]	0.2[c]
Cadmium	<0.01[c]	<0.01–0.01[c]	<0.01[c]
Chromium	<0.01[c]	<0.01–0.01[c]	<0.01[c]
Copper	<0.1[c]	<0.1[c]	<0.1[c]
Lead	<0.01–0.02[c]	<0.01[c]	<0.01[c]
Mercury	<0.001[c]	<0.001[c]	<0.001[c]
Molybdenum	<0.01[c]	0.01[c]	
Nickel	<0.01–0.02[c]	0.01[c]	<0.01[c]
Selenium	<0.01[c]	<0.01[c]	<0.0[c]
Vanadium	<0.01[c]	<0.01[c]	
Zinc	<0.01[c]	<0.1[c]	<0.1[c]
Silver	<0.01[c]	<0.01[c]	<0.01[c]

[a] Indian Creek at the confluence with Marshall Creek.
[b] Marshall Creek at the confluence with Indian Creek.
[c] Measurements were not taken frequently enough to warrant expression of means.
Source: ER , Tables E-7, E-9, and E-12.

concentrations in Indian Creek are also considerably higher downstream of the mine discharge than upstream, which further underscores the effect of the discharge on Indian Creek water quality (ER Suppl., Table 2.6-12; ER, Fig. 2.6-11).

2.5 GEOLOGY, MINERAL RESOURCES, AND SEISMICITY

2.5.1 General geology

The Homestake Mining Company Pitch Project is on the southern flank of the Sawatch Range and is located within the Marshall Pass mining district. This area is part of an exposed remnant of gently folded sedimentary rocks of Paleozoic age approximately 5 km (3 miles) in diameter. A circular patch of sedimentary rocks, it is bounded by Precambrian rocks on the north and east and is covered by Tertiary age volcanic rocks to the west and south. The eastern Precambrian-Paleozoic contact is a high-angle reverse fault (the Chester Fault), which formed during the Laramide Orogeny and was subsequently mineralized; the surrounding rocks were altered by hydrothermal solutions that emplaced uranium throughout the fault zone.

2.5.1.1 Regional geology

The project area is in the Southern Rocky Mountain physiographic province. Aside from the San Juan Mountains, this province is composed of a series of north-south trending ranges, having an anticlinal structure, with cores of igneous and/or metamorphic rocks that are flanked by steeply dipping sedimentary units. The ranges fall into two main north-south belts separated by a series of intermontane basins and parks. The Southern Rocky Mountain province is the result of erosion and glaciation subsequent to the Laramide Orogeny that uplifted the ranges 70 million years ago.

The project area is on the very southern flank of the Sawatch Range (Fig. 2.3). This range contains some of the highest peaks in Colorado, including the highest, Mount Elbert. The project area is near the junction of the Sawatch Range and the Sangre de Cristo Range [which starts at Poncha Pass, 19 km (12 miles), to the east], the San Luis Valley, and the Cochetopa Hills (a northeastern protuberance of the San Juan Mountains) that "die out" in the southern part of the area around the Homestake site.

The Continental Divide, which follows the crest of the Sawatch Range and then swings westward into the Cochetopa Hills, is only 4 km (2.5 miles) to the east of the proposed open pit at its closest approach. On the eastern and southeastern side of the divide, major areal drainage is by the Arkansas River and the closed, internal drainage of the northern part of the San Luis Valley. The western side of the divide is drained by Tomichi Creek and its tributaries, including Marshall, Indian, and Agate creeks in the immediate vicinity. Tomichi Creek flows into the Gunnison River, which in turn eventually empties into the Colorado River.

In the southern part of the Sawatch Range, faulting and subsequent erosion have reduced the flanking sedimentary rocks to a series of isolated remnants. Three such remnants, ranging in area from less than 2.6 km^2 (1 sq mile) to approximately 26 km^2 (10 sq miles), are in the Marshall Pass district. (Other sedimentary remnants may be concealed by the overlapping volcanic rocks.) The project area includes the largest of these.

2.5.1.2 Site geology

Landforms within the project area are related directly to rock type. In the southern portion of the area, which is underlain by volcanic rocks, the terrain is relatively smooth and undulating. To the east of the Chester Fault, relief is high in areas underlain by Precambrian rocks, but ridges are still relatively smooth, and slopes seldom exceed 20°. West of the fault, relief is even higher, angularity of the land-forms is more pronounced, and streams have cut steep-walled valleys into the sedimentary rocks.

There are more than 762 m (2500 ft) of relief within the area of the project. Elevations range from 2682 m (8800 ft) at the confluence of Indian and Marshall creeks to 3475 m (11,400 ft) along the top of Lime Ridge.

The Homestake site is within the Tomichi Creek drainage basin. Lime Ridge forms an east-west divide through the area. Agate Creek and its tributaries drain the northern part and flow in a westerly loop to Tomichi Creek. The area south of the ridge is drained by Marshall Creek and its tributaries, the largest of which is Indian Creek. Indian Creek is narrow and contains very little alluvium, while Marshall Creek is in a very broad, flat-floored, underfit valley. The latter formation is more than likely the result of glacial cutting and/or subsequent erosion when large quantities of glacial meltwater flowed through the valley. The valley, subsequently, was refilled partially by alluvium.

Three general rock types occur within the site: (1) Precambrian metasedimentary, metaigneous, and igneous; (2) Paleozoic sedimentary; and (3) Tertiary volcanic rocks. The Paleozoic sedimentary rocks are the result of a wide variety of depositional environments. A rather complete section is well exposed along Indian Creek. The only sedimentary unit significant to the proposed mining operation, however, is the Belden Formation.

The Belden Formation is a variable sequence of sandstone, quartzite, siltstone, mudstone, limestone, dolomite, shale, and carbonaceous shale. The more brittle units, particularly the limestone and dolomites, were the primary host rocks to ore-bearing solutions migrating along the Chester Fault and were important sources of ore during previous mining.

Volcanic rocks of Tertiary age cover the southern portion of the project area. Two deep test holes have been drilled by Homestake Mining Company in this area. The borings encountered Paleozoic-age carbonate rocks (actual formation undetermined) at depths of approximately 122 m (400 ft), drilling through a variable sequence of tuffs. The difference in elevations at which the sedimentary rocks were encountered, as found by the applicant's consultants, suggests that the bedrock surface upon which the volcanic rocks were deposited sloped down to Marshall Creek. The volcanic units have no relationship to the ore deposits but are significant to the project in that the proposed tailings dam and mill sites will be located on them.

The Rawley andesite mantles several of the higher ridges in the southern portion of the Homestake site. Individual flows are 9 to 61 m (30 to 200 ft) thick. Their aggregate thickness is estimated at 305 to 610 m (1000 to 2000 ft).[4] The andesite both overlies and is overlain by layers of variable and waterlaid tuff with interbedded siltstones and sandstones, ash fall, and alluvial channels. These channels are filled with gravel that consists mainly of andesite, reworked tuff, and Precambrian rock fragments. Some of the tuff layers, particularly the welded tuffs, appear to be very jointed and blocky.

The dominant structures of the project area are faults. However, without subsurface exploration and mining, few of the faults would have been recognized because of heavy tree cover (precluding aerial photographic interpretation) and the sparsity of good outcrops.

The most significant structure within the Homestake site is the Chester Fault, a high-angle reverse fault along which Precambrian rocks from the east have been pushed up over sedimentary units of Upper Paleozoic age. The surface trace of the fault is quite undulatory but strikes generally in a north-south direction. It can be traced almost continuously from Marshall Creek, just east of the abandoned railroad stop of Chester to Lime Ridge north of the mine, a distance of about 7 km (4.5 miles). The dip on the fault toward the east varies from 40° to practically vertical.[5] At least 427 m (1400 ft) of displacement are believed to have occurred along the fault,[6] with possibly as much as 610 m (2000 ft).[7] Several other faults in the immediate vicinity have similar orientations and are probably associated with the Chester Fault.

The sedimentary rocks in the fault zone have been highly deformed. The "crush zone" is 91 to 122 m (300 to 400 ft) wide. Within the fault zone, the more brittle limestones and dolomites have been brecciated, whereas the more plastic units of the Belden Formation have been squeezed, contorted, and sheared. The applicant's ER provides more detailed geologic descriptions of the fault zone and associated ore deposits (ER, Sect. 2.4.2.2) as well as geotechnical descriptions of the rock material in the proposed open-pit mine area (ER, Appendix B).

In addition to the high-angle reverse faults, there are also several normal faults in the area. The largest of these is the Erie Fault, which trends about N60°E through the approximate center of the proposed open pit. The fault dips very steeply to the south and appears to have 122 to 152 m (400 to 500 ft) of displacement (downthrown on the south side). Movement along the Erie Fault has offset the Chester Fault approximately 122 m (400 ft) to the east.[7]

Two prominent sets of vertical joints have been mapped in the general area. One set strikes N20° to 40°W and the other N40° to 60°E.[8] During the first phase of the geotechnical investigation for the pit slope design, oriented cores were taken from the fault zone. Unfortunately, core recoveries were low, making the core orientation relatively unsuccessful. Nevertheless, the few oriented cores that were obtained indicate that discontinuities (e.g., joints, fractures, and bedding planes) within the rock mass on the east side of the proposed open pit dip to the east, while those on the west side dip to the west. This condition is favorable with respect to slope stability and is discussed in more detail in Appendix B of the ER.

2.5.2 Mineral deposits

2.5.2.1 Uranium

Uranium mineralization was first discovered in the Marshall Pass district by local Gunnison prospectors in 1955 when some minor mineralization in the Belden Formation at the confluence of Marshall and Indian creeks was detected. This discovery led to further exploration and discovery of the Harding mineralization in the western part of the district. In all, five prospects in varying geologic settings were found in the district. It was thought at first that the deposits in the quartzite might represent "Colorado Plateau-type" deposits and might be the most extensive. Earlier exploration efforts operated under that assumption.[9] Although some development of the Harding quartzite was done [6168 metric tons (6800 tons) of ore averaging 0.5% U_3O_8 were taken from the formation in the Little Indian No. 36 Mine], attention soon focused on the Chester Fault because the main deposits of the district were associated with the fault zone.

Several interpretations of the method of ore emplacement and depositional or localization controls have been developed throughout the history of exploration and mining in the district. The current hypothesis of Homestake Mining Company is based on their interpretation of previously collected data as well as the results of their own extensive exploration program.

Brecciation and fracturing that took place during the formation of and subsequent movement along the Chester Fault, especially within the more brittle carbonate units of the Belden Formation, provided a host to solutions migrating along the fault. Later faulting resulted in offset of the original ore body and scattering of ore pods. Early attempts at mining were likened to "picking plums out of a pudding."[9]

The fault zone is approximately 122 m (400 ft) wide. The Chester Fault forms the eastern boundary. In some places, the western boundary is marked by a distinct high-angle reverse fault with a maximum displacement of 46 to 55 m (150 to 180 ft) known as the West Fault. Within the fault zone, more or less parallel, sympathetic (with respect to the Chester Fault) faults have created a series of wedges or slices having a "horst and graben" configuration with some associated drag folding. Various sections prepared by Homestake Mining Company over the length of the proposed mine show 6 to 61 m (20 to 200 ft) of displacement on these faults.

Mineralized zones have been detected by radiometric logging of drill holes. Limestone had been the prime "target" during the earlier underground mining operations, but the mineralization is not by any means confined to the carbonate rocks. This distribution points out one of the more obvious necessities for open-pit mining in such a dispersed ore body.

During previous underground mining, individual ore "pods" were found to range from 1 to 14 m (3 to 45 ft) in width, and most ore bodies tended to have a vertical elongation. Ore mined during the period 1959 to 1962 was of variable grade but averaged 0.4 to 0.5% U_3O_8,[9] with some localized areas yielding ore as high as 10 to 15%.[10]

Uraninite is the most common uranium mineral present in the Marshall Pass mining district. Although nominally composed of UO_2, it is almost always partially oxidized, and its actual composition lies somewhere between UO_2 and U_3O_8. Analyses of samples taken during the various periods of exploration and mining in the district also indicate the presence of several secondary or alteration minerals, most of which occur in the weathered zone or in pegmatites.[5-7,11]

2.5.2.2 Other mineral resources

No other mineral resources with potential for economic development are known to exist within the project area. The Marshall Pass district was prospected about 50 to 60 years ago for iron ore, but only very low-grade hematite (Fe_2O_3) was found.

Analyses of samples collected during the early exploration of the Marshall Pass district showed trace occurrences of molybdenum, bismuth, niobium, cobalt, lead, zirconium, tungsten, yttrium, chromium, silver, and copper.[7] Other than the previously mentioned hematite, the only other mineral to occur commonly is pyrite (FeS_2) (less than 3% associated with the uranium ore). Pyrite is disseminated and in small veins throughout the fault zone but is not in sufficient quantity to have commercial value. Other metallic minerals that have been recognized in small amounts in the area (particularly in veins of Precambrian rock) are chalcocite (Cu_2S), covelite (CuS), galena (PbS), bornite (Cu_5FeS_4), and sphalerite (ZnS).

2.5.2.3 Geologic hazards

The San Juan region (which includes the volcanic rocks in the southern portion of the project location) is well known for landslides. The volcanic rocks, particularly in places where they have been steepened by glaciation or stream erosion, are susceptible to sliding and slumping. Landslides also frequently occur where the volcanic veneer over sedimentary rocks is very thin. The proposed mill site and tailings dam and reservoir will not involve any active landslide areas or slopes that are considered to be potentially unstable.

The open pit will be excavated into unstable, altered rock. "Flowing ground" and extreme pressures in the altered Precambrian rock along the fault zone presented serious problems to previous underground mining.[5] The open-pit method, however, will avoid the problems associated with support of underground openings, and the pit walls are designed to minimize the chances of slope failures.

Ground motion resulting from earthquakes should not be a geologic hazard to the proposed operation (Sect. 2.5.3).

2.5.3 Seismicity

Colorado and parts of adjacent states are considered to be in a region of low seismic risk.[12] Of the more than 200 recorded earthquakes within a 320-km (200-mile) radius of the project area, all have had an intensity* of less than VIII (Fig. 2.10). Earthquake intensities are based on subjective observations that are then assigned numerals ranging from I (barely perceptible) to XII (total destruction). In general, the intensity of an earthquake diminishes with increasing distance from the epicenter.

The nearest recorded earthquake to the project area occurred in 1901 near Buena Vista, approximately 45 km (28 miles) northeast of the site. At Buena Vista, the earthquake, which had an intensity of VI, broke windows and dislodged boulders; however, it would probably have been only slightly perceptible by people in the project area.

The majority of destructive earthquakes occurs along active or recently active faults. Witkind[13] has compiled a preliminary map showing all known and suspected active faults in Colorado. The fault nearest the Homestake area considered to have a high potential for future earthquakes is about 35 km (22 miles) southeast of the area and marks the boundary between the Sangre de Cristo Range and the San Luis Basin (Fig. 2.10). At present, geologists cannot predict when, or if, an earthquake may occur along this fault.

The epicenters plotted on Fig. 2.10 show a seemingly random distribution. Based on the seismic record of this region, it has been assumed that earthquakes having intensities of IV or less will continue to occur with the same frequency and that a rare earthquake of intensity VI or VII is possible.[14] Moreover, there is a possible, but unlikely, probability of an earthquake of Intensity VIII.[15]

*Modified Mercalli Scale of Earthquake Intensity.

ES-4425

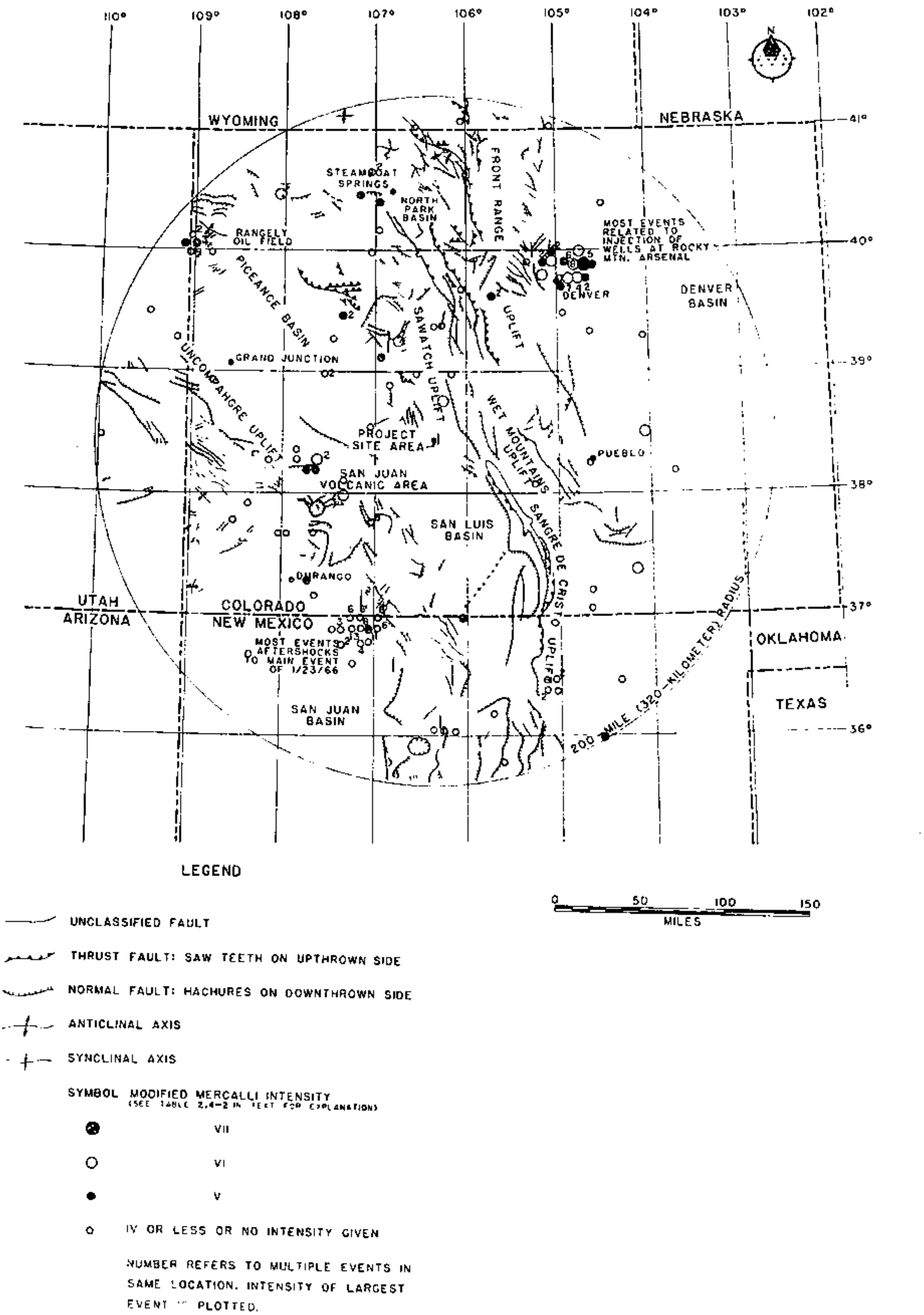

Fig. 2.10. Regional tectonic map showing historic earthquake epicenters within 200-mile radius of the project area. Source: ER, Plate 2.5-1, p. 2-120.

2.6 SOILS

The following information on soils is derived from detailed reconnaissance soil surveys conducted on the project area in 1976 by the applicant's consultant and by the Soil Conservation Service. The surveys were conducted using the soil association concept of the National Cooperative Soil Surveys. A soil association is a group of defined and named soil series occurring together in an individual and characteristic pattern over a geographic area. The soil series have been classified according to the criteria of the National Cooperative Soil Surveys.

Figure 2.11 shows the distribution of soil units within the project area. The relative suitability of the existing soils as media for plant growth is indicated, and the suitability ratings are summarized in Table 2.9.

2.6.1 Physical characteristics of onsite soils

Soil mapping unit descriptions indicating the general characteristics of soil in the Homestake Mining area are presented in Table 2.10.

2.6.2 Chemical properties of onsite soils

The known key chemical properties are shown in Table 2.11. Sodium adsorption ratio (SAR) values and electrical conductivity of the soil extract readings were low on all soils tested, indicating low salt levels. Potassium values on all the soils tested, except the Scout gravelly loam (10), ranged from 60 to 80 ppm, a medium to high reading. Zinc levels were low. Levels of iron, copper, manganese, and gypsum were all sufficient to support plant growth.

2.7 VEGETATION

The vegetation in the vicinity of the project is a mosaic of several communities reflecting a multitude of environmental factors affecting plant distribution. The five major community types are willow, big sagebrush, aspen, lodgepole pine, and spruce-fir.

2.7.1 Willow

Willow communities are located along Marshall and Indian creeks and in several seasonally moist drainages where water is sufficient for willow growth. These communities are mainly associated with beaver ponds and lie at about 2682 m (8800 ft) on 1% slopes with a west aspect. Grasses and forbs dominate the understory. Analysis indicates that vegetative cover varies from 16 to 44%, litter from 31 to 66%, and bare soil 1 to 7%. Vegetative production ranged from 1746 to 1976 kg/ha (1559 to 1764 lb/acre), depending on location. This estimate includes shrubs (willow).

2.7.2 Sagebrush

Sagebrush communities in the area occupy the lower elevations [2743 m (9000 ft) or lower] on southeast and southwest aspects with 10 to 25% slopes. This community (dominated by big sagebrush) is composed of numerous grass and forb species and is readily accessible for grazing by cattle. During the spring and fall, this community is utilized by elk as they move from winter and summer ranges. Analysis indicates that vegetative cover varies from 11 to 18%, litter 43 to 47%, and bare soil 7 to 8%. Vegetative production ranged from 961 to 1272 kg/ha (858 to 1136 lb/acre) for all vegetation but only 670 to 824 kg/ha (598 to 736 lb/acre) for grasses and forbs.

2.7.3 Aspen

Aspen communities in the area occur at mid-elevation [2743 to 3048 m (9000 to 10,000 ft)] on deeper, gently sloping soils (10 to 19%) with southwest aspects. The understory is composed

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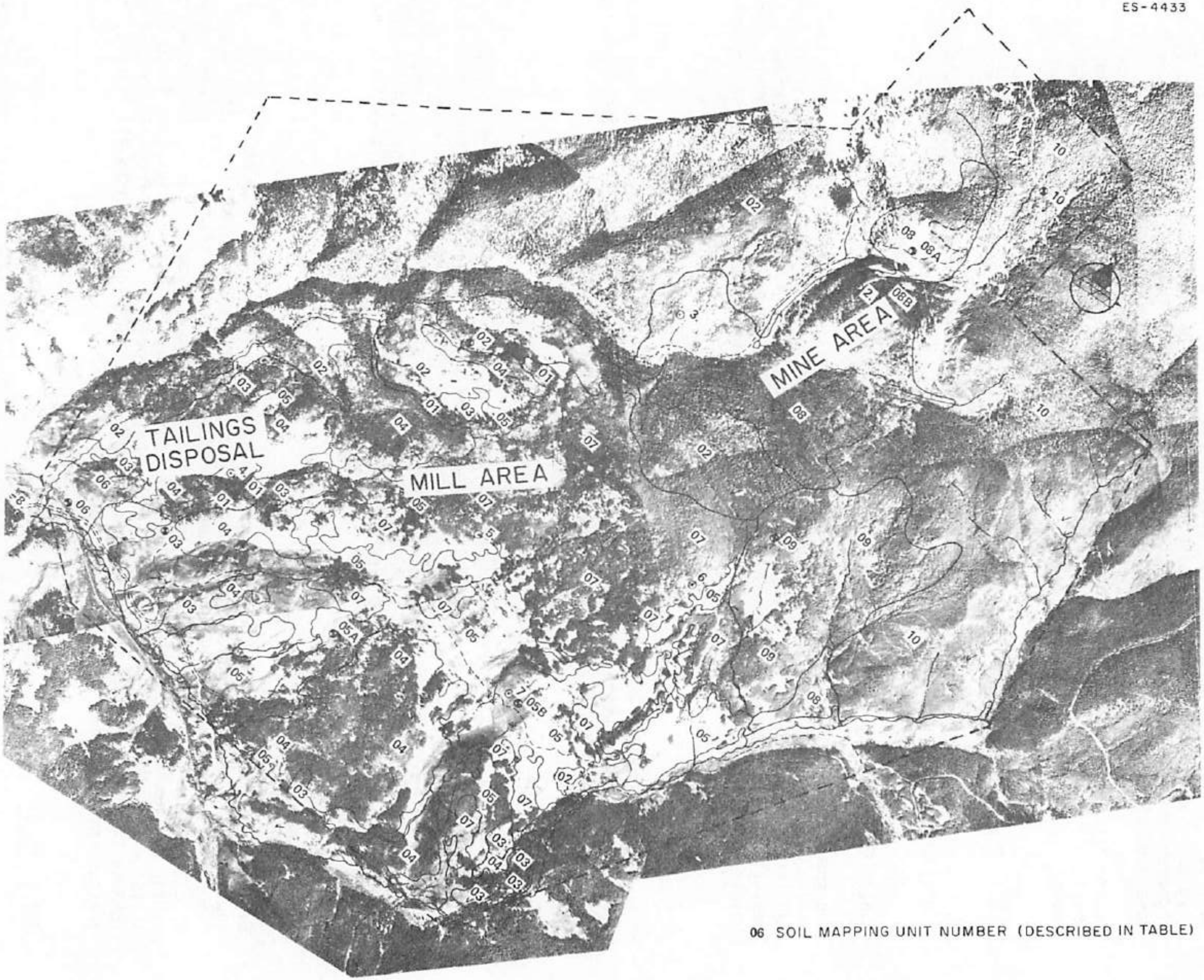

Fig. 2.11. Soil map of the project area. Source: ER, Plate 2.10-1, p. 2-229.

Table 2.9. Summary of major soil properties[a]

No.	Soil type	Soil classification: Family	Soil classification: Subgroup	Parent material	Dominant vegetation	Horizon: Classification	Horizon: Depth (in.)	Texture: Classification	Texture: % >2 mm	pH (1:1)	Organic matter (%)	Conductivity (mmhos/cm)	SAR[b]	CEC[c] (meq/100 g)
01A	Typic Cryaquolls	Fine montmorillonitic	Typic Cryaquolls	Alluvial sediments	Grasses	A	0–16	C	45	6.8	4.5	0.3	1.5	40.7
						B21g	16–26	C	49	7.0	0.4	0.3	2.1	27.7
						Cg	42–66	CL	35	7.0	0.4	0.2	2.1	28.8
02	Unnamed cobbly loam	Clayey-skeletal, mixed	Lithic Cryoboralf	Limestone bedrock	Mixed timber	B2t	2–8	C	42	8.2	2.6	0.2	0.2	27.6
						R	13–60	CL	56	8.5	2.3	0.2	0.2	17.9
03	Yence cobbly loam	Loamy-skeletal, mixed	Argic Cryoboroll	Fine-grained igneous	Sagebrush and mixed grasses	A1	0–7	CL	24	7.4	3.5	0.1	0.2	22.3
						B2t	7–20	CL	37	7.7	0.5	0.3	1.3	25.2
						Cr	56–72	CL/L	75	6.9	0.3	0.4	1.8	25.9
04	Seitz gravelly loam	Clayey-skeletal, montmorillonitic	Typic Cryoboralf	Fine-grained igneous	Mixed grass and timber	A2	0–11	L	46	7.1	1.4	0.1	0.5	13.3
						B2t	15–25	CL	52	6.8	0.7	0.1	1.0	22.4
						C	40–60	L	34	7.1	0.4	0.1	1.0	17.7
05A	Cimarron Channery loam	Fine, montmorillonitic	Argic vertic Cryoboroll	Fine-grained igneous	Sagebrush and mixed grasses	A11	0–8	CL/L	25	6.8	5.5	0.1	0.4	28.5
						B2t	8–34	C	39	6.6	1.0	0.3	1.0	38.9
						Cr	38–60	SCL	29	6.4	0.2	0.1	1.0	24.2
06	Chedsey clay loam	Fine, montmorillonitic	Mollic Cryoboralf	Shale, limestone, and sandstone	Sagebrush and mixed grasses	A1	0–7	CL	20	8.0	6.0	0.3	0.4	37.4
						B21t	7–14	C	52	8.0	1.5	0.2	0.6	24.9
						Cr	36–42	C	47	8.2	0.7	0.2	1.0	39.2
07	Cowdrey loam	Fine, montmorillonitic	Typic Cryoboralf	Fine-grained igneous	Mixed timber	A2	0–10	L	41	6.3	1.8	0.2	0.2	13.9
						B2t	20–28	C	36	5.4	0.6	0.2	1.4	30.5
						C	46–60	C	32	5.3	0.2	0.3	1.3	36.2
08A	Jenkins loam	Loamy-skeletal over fragmental, mixed	Typic Cryocrept	Sandstone	Mixed timber	A2	0–10	L	41	6.2	1.3	0.2	0.6	9.7
						B2	10–18	SCL	42	6.4	0.5	0.1	0.8	6.5
						C	18–60	SL	53	6.3	0.4	0.1	0.7	6.4
09B	Bucklon shaly clay loam	Clayey-skeletal montmorillonitic	Typic Cryoboralf	Mixed shale and limestone	Mixed timber	A2	0–9	CL	48	6.9	0.8	0.2	0.2	11.1
						B2t	9–28	C	50	7.2	1.5	0.8	0.6	21.0
						Cr	20–40	C	60	7.9	1.2	0.6	0.5	17.0
						IIC	40–60	C	50	8.3	0.4	0.3	0.7	15.0
09	Tolver gravelly sandy clay loam	Loamy-skeletal, mixed	Typic Cryoboralf	Decomposed granite	Mixed timber	A2	0–6	SCL	28	6.6	0.9	0.3	0.2	10.1
						B2t	12–22	SCL	42	7.0	0.5	0.2	0.4	17.3
						C	36–60	SCL	56	8.3	0.4	0.3	0.6	13.4
10	Scout gravelly loam	Loamy-skeletal	Typic Cryocrept	Decomposed granite	Mixed timber	A&B	0–9	L	42	5.9	0.7	0.1	1.0	10.4
						B	9–34	SL	54	6.0	0.4	0.1	0.7	10.7
						C	34–60	SL	52	6.3	0.1	0.1	0.5	7.2

[a] Data provided by the applicant.
[b] Sodium adsorption ratio.
[c] Cation exchange capacity.

Table 2.10. Soil identification legend[a]

Unit number	Name	Slope range	Percent of area	Soil description
01	Typic Cryaquolls	0–4%	0.4	Deep, clayey, grassland soils formed on wet alluvial areas
01A	(about 50% of area)			
01B	(about 25% of area)			
01C	(about 10% of area)			
02	Unnamed cobbly loam	20–70%	16.9	Shallow, clayey, forested soils formed on limestone bedrock
03	Yence cobbly loam	10–40%	11.5	Deep grassland soil formed on fine-grained igneous materials overlaying welded waterlaid tuffs
04	Seitz loam	10–50%	7.5	Deep forested soil formed on fine-grained igneous materials
05	Cimarron-Bucklon loam complex	5–40%	13.9	Complex of hilly grassland soils formed on igneous materials
05A	Cimarron Channery loam (75% of area)			Deep grassland soil formed on fine-grained igneous materials overlaying welded and waterlaid tuffs
05B	Bucklon loam (15% of area)			Very shallow grassland soil overlaying welded and waterlaid tuffs
06	Chedsey clay loam	10–40%	1.3	Moderately deep grassland soil formed on interbedded shales and limestones
07	Cowdrey loam	5–40%	14.9	Deep, forested, clayey soil formed on fine-grained igneous materials
08	Jenkins-Bucklon-unnamed loams complex	20–60%	10.0	Complex of forested shallow soils formed on sandstones, shales, and limestones
08A	Jenkins loam (45% of area)			Formed on sandstones
08B	Bucklon loam (15% of area)			Formed on mixed shales and limestones
08C	Unnamed cobbly loam (25% of area)			Formed on limestones
09	Tolvar gravelly sandy clay loam	10–50%	5.7	Deep forested soil formed on fractured granite bedrock
10	Scout gravelly sandy loam	20–70%	17.9	Moderately deep, forested soil with minimal development formed on granites, gneiss, and shists

[a]Data provided by applicant.

primarily of grasses and forbs that vary in production depending upon edaphic conditions. Drier sites seem to produce less growth than do the wetter sites. Vegetative cover varies 19 to 41%, litter 27 to 46%, and bare soil 0%. Vegetative production averages about 645 kg/ha (576 lb/acre).

2.7.4 Lodgepole pine

The lodgepole pine community is the most widespread of the communities in the project area. It occurs at mid-elevations [2743 to 3048 m (9000 to 10,000 ft)] on steeper (25+%) slopes and shallower soils, with northeast and northwest aspects. Density of trees varies from the "doghair" condition to relatively open stands. Stand age varies, depending on site characteristics and the time interval since the most recent fire. Lodgepole pine understory varies,

Table 2.11. Other physical and chemical properties of site soil[a]

No.	Depth (in.)	Textural analysis			Water holding capacity		Plant nutrients			Zinc		Iron		Copper		Manganese		Gypsum (meq/100 g)
		Sand	Silt	Clay	1/3 Bar	15 Bar	Total N (%)	P (ppm)	K (ppm)	DPTA[b] (ppm)	Total (ppm)	DPTA (ppm)	Total (ppm)	DPTA (ppm)	Total (ppm)	DPTA (ppm)	Total (ppm)	
01A	0–16	33	23	44	45.7	29.5	0.223	53	1330	1.0	72	230.7	33,000	1.35	24	20.3	3,170	<1
	16–26	37	19	44	45.2	29.3	0.023	11	1580	0.3	72	31.6	32,000	0.62	13	4.6	830	<1
	42–66	35	27	38	40.2	25.6	0.018	11	2200	0.6	49	38.4	21,000	2.66	16	8.9	235	<1
02	2–8	23	36	41	26.4	16.3	0.130	5	160	0.5	113	40.2	37,000	0.53	17	17.2	785	<1
	13–60	24	45	31	23.7	11.8	0.130	2	48	0.2	70	9.9	21,000	1.30	23	3.7	350	<1
03	0–7	37	33	30	23.4	14.8	0.200	27	730	1.0	86	18.1	40,000	0.82	27	16.8	900	<1
	7–20	35	23	42	32.0	21.1	0.035	7	350	0.2	77	5.6	45,000	0.30	25	5.1	730	<1
	56–72	44	29	27	36.1	23.8	0.013	6	398	0.5	99	10.1	46,000	1.58	51	2.1	250	<1
04	0–11	36	42	22	22.0	9.3	0.073	38	188	0.8	83	69.4	38,000	0.30	16	3.3	775	<1
	15–25	36	27	37	27.0	15.4	0.033	15	200	0.1	79	21.5	52,000	0.21	32	2.7	410	<1
	40–60	44	30	26	20.8	11.0	0.026	7	183	0.1	70	18.7	55,000	0.40	24	10.3	695	<1
05A	0–8	36	37	27	30.2	18.0	0.316	16	950	9.9	142	49.8	27,000	0.61	23	66.4	2,115	<1
	8–34	36	16	48	46.1	32.2	0.055	4	1480	0.1	70	23.3	31,000	0.28	13	2.1	180	<1
	38–60	59	14	27	25.4	17.3	0.014	11	950	0.1	55	12.5	22,000	0.19	8	2.5	160	<1
06	0–7	33	29	38	31.4	20.4	0.386	34	700	1.5	82	12.1	34,000	1.53	30	6.7	835	<1
	7–14	34	19	47	24.0	16.4	0.093	2	278	0.1	63	5.6	41,000	1.03	30	4.9	350	<1
	36–42	18	16	66	49.9	34.8	0.036	1	120	0.1	72	11.8	34,000	0.49	12	1.1	245	<1
07	0–10	48	32	20	23.0	12.4	0.093	12	1000	0.9	80	65.7	17,000	0.16	11	15.5	820	<1
	20–28	34	10	56	50.2	33.6	0.029	7	1400	0.1	65	45.3	22,000	0.17	8	2.4	120	<1
	46–60	38	16	46	42.6	28.6	0.016	22	1830	0.2	51	39.3	17,000	0.16	6	37.8	775	<1
08A	0–10	42	37	21	18.8	9.4	0.039	5	95	0.2	43	40.2	38,000	0.24	20	8.9	285	<1
	10–18	54	25	21	12.8	7.5	0.021	3	70	0.1	41	30.4	39,000	0.40	27	6.9	215	<1
	18–60	57	24	19	13.5	7.3	0.021	1	40	0.1	38	26.1	47,000	0.40	38	4.2	260	<1
08B	0–9	44	28	28	16.5	9.0	0.040	5	63	0.1	69	41.2	41,000	0.40	19	13.1	760	<1
	9–28	20	22	58	30.3	20.4	0.077	3	105	0.1	118	20.1	57,000	1.77	36	21.4	465	<1
	28–40	25	22	53	22.5	11.5	0.054	1	95	0.5	113	9.4	54,000	0.89	24	10.4	425	<1
	40–60	17	29	54	22.4	12.8	0.027	2	70	0.4	109	5.7	53,000	0.44	38	2.4	210	<1
09	0–6	56	21	23	15.4	8.1	0.051	21	100	0.1	64	69.4	40,000	0.16	16	4.9	405	<1
	12–22	55	15	30	18.0	10.8	0.029	7	105	0.1	91	24.4	56,000		20	11.7	760	<1
	36–60	60	17	23	14.4	7.5	0.025	4	58	0.1	81	7.2	30,000		19	6.3	670	<1
10	0–9	48	29	23	20.4	9.2	0.033	26	64	0.2	80	58.0	29,000	0.23	14	2.1	470	<1
	9–34	61	20	19	15.6	8.3	0.020	25	30	0.1	62	43.5	32,000	0.10	16	0.2	450	<1
	34–60	64	21	15	13.7	6.7	0.011	10	30	0.1	71	12.4	30,000	0.10	21	1.0	795	<1

[a] Data provided by applicant.
[b] Diphenylamine tetraacetate.

but generally it is minimal and not particularly useful to livestock. Vegetative cover varies from 6 to 15%, litter 68 to 73%, and bare ground 2 to 6%. Vegetative production varies from 96 to 158 kg/ha (86 to 141 lb/acre).

2.7.5 Spruce-fir

Spruce-fir communities in the area are dominated by associations of either Engelmann spruce (*Picea engelmanni*) and alpine fir (*Abies lasiocarpa*) or blue spruce (*Picea pungens*) and white fir (*Abies concolor*). The Engelmann spruce—alpine fir association occurs at the upper elevations [above 2743 m (9000 ft)], reaching its maximum development on Lime Ridge adjacent to the project area. Blue spruce—white fir association occurs along the moist drainages of Indian Creek adjacent to willow communities [below 3048 m (10,000 ft)] as it flows through the area. Understory vegetation production in both associations is typically minimal.

Vegetative analysis indicates that grass and forb cover varies from 2 to 4%, shrub cover from 13 to 37%, litter from 57 to 71%, and bare soil from 1 to 2%. Vegetative production ranges from 78 to 184 kg/ha (70 to 164 lb/acre).

2.7.6 Minor community types

The minor community types occur in only a few locations throughout the area. The silver sagebrush community type occurs at low elevations [between 2743 and 2896 m MSL (9000 and 9500 ft MSL)] in seasonally moist drainage bottoms. The dominant shrub is silver sagebrush; however, shrubby cinquefoil (*Potentilla fruticosa*), serviceberry (*Alamanchier* sp.), and rock spirea (*Holodiscus dumosus*) are locally important. Numerous grasses and forbs are present in the shrub understory. Production within the community is variable, depending upon the amount of "runon" moisture. Generally, production would be between the production values for big sagebrush communities and willow communities.

The ponderosa pine community occurs primarily as a stand of small, scrubby trees scattered through the big sagebrush community on a west-facing slope visible from the junction of Indian and Marshall creek roads. This group of trees is probably a relic population of trees that at one time was more prominent in the area. Most of the trees in this stand showed extensive porcupine damage. A much larger, and presumably older, tree occurs upslope from the population and may have been the seed tree for the population. Individual ponderosa pines occur scattered on rocky soils throughout the lower elevations. These trees are probably old, mature seed trees — although no seedlings were evident in their vicinity.

Disturbance communities occur in a variety of locations throughout the area wherever the surface soil has been disturbed. These communities are dominated by pioneer species that are adapted to exist in these newly opened habitats. Normally, weedy or annual species capitalize upon such environments. Such communities exist along the roadsides of Indian and Marshall creeks, on the sawdust piles near the old sawmill in Indian Creek, and the old exploration pits, spoil piles, and roads around the old Pinnacle Mine. While most of these areas have been naturally reseeded, others have been planted with a mixture of bromegrass and bluegrasses to retard erosion.

2.8 WILDLIFE AND FISH

2.8.1 Terrestrial wildlife

The following description of wildlife at the Homestake Mining Company Pitch Project is summarized from detailed information contained in Sect. 2.8.1 and Appendix C of the ER, with additional sources as referenced in the text. Terrestrial vertebrate species in the study area include at least 28 mammals, 66 birds, 3 amphibians, and 2 reptiles. For the sake of this review, these 99 species are subdivided between economic (game and fur bearers) and noneconomic wildlife.

2.8.1.1 Game and fur-bearing wildlife species

Twenty-three game and fur-bearing species were observed on the project area. Except for three game birds [common snipe (*Capella gallinago*), American widgeon (*Anus americana*), and northern shoveler (*Anus clypeata*)], all probably breed in the study area or its vicinity (ER, Suppl., p. 2-166).

Elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*) are two big-game species that occur in the project area. Indirect observational evidence indicates that both breed at the Pitch Project (ER Suppl., pp. 2-166 and 2-167) although elk utilize the area primarily for winter range, while mule deer utilize it for summer range. Probably 200 to 250 elk reside on the project grounds in winter, with about 80 individuals present throughout the year. About 200 to 250 mule deer inhabit the same area in spring and summer, while very few deer remain through the winter (responses to comments, Homestake Mining Company, 1 December 1977, p. 36). During field studies, pine marten were sighted, and black bear scats were found. No evidence of mountain lions was present.

Hares and rabbits [snowshoe hare (*Lepus americanus*), white-tailed jackrabbit (*Lepus townsendii*), Nuttall's cottontail rabbit (*Sylvilagus nuttalli*)], were observed too infrequently to estimate population densities, while red squirrel (*Tamiasciurus hudsonicus*) counts varied between 27 and 74 per 100 ha (14 to 30 per 100 acres) of mixed conifer forest land. Observations of the other game animals were too few to allow conclusions to be drawn regarding their numbers or activities. Mountain lion, black bear, and pine marten may utilize the site.

Furbearers recorded included those restricted to streamside communities [beaver (*Castor canadensis*) and muskrat (*Ondatra zibethica*)] and those present in a wide variety of upland habitats [yellow-bellied marmot (*Marmota flaviventris*), long-tailed weasel (*Mustela frenata*), badger (*Taxidea taxus*), and coyote (*Canis latrans*)]. Game birds included several waterfowl species [mallard (*Anus platyrhynchos*), blue-winged teal (*Anus discors*), green-winged teal (*Anus crecca*), and shoveler)] as well as snipe and blue grouse (*Dendragapus obscurus*). The waterfowl apparently breed along the local streams, while the blue grouse was restricted to either mixed conifer forest or sagebrush communities above about 2900 m (9600 ft).

2.8.1.2 Other wildlife species

Mammals

Fourteen species of mammals were observed, exclusive of the wildlife species discussed above. Rodents outnumbered all other mammal species and individuals. Among the 12 rodent species observed (ER Suppl., Appendix C, Table C-2), the least chipmunk, *Eutamias minimus* (<1-5 animals per hectare) and the deermouse, *Peromyscus maniculatus* (<1-7 animals per hectare) were the most abundant (50% and 45%, respectively, of the 189 small mammal captures). Neither species was absent from habitats sampled, although the least chipmunk was more abundant in sagebrush than in mixed conifer communities (ER Suppl., p. 2-152). The masked shrew (*Sorex cinereus*), mountain vole (*Microtus montanus*), long-tailed vole (*M. longicaudus*), northern pocket gopher (*Thomomys talpoides*), golden-mantled squirrel (*Spermophilus lateralis*), jumping mouse (*Zapus princips*), and little brown myotis (*Myotis lucifugens*) were also trapped — but in numbers too few to characterize population abundance or behavior.

Birds

Fifty-nine bird species were observed, exclusive of the game species. Migrants and breeding species (summer residents) were more abundant and compositionally diverse than year-round residents. Observed bird density reached a maximum in June (128 to 166 birds per square kilometer in mixed conifer forest and 22 to 25 birds per square kilometers in sagebrush). Diversity of breeding birds was greatest in mixed conifer forests (6.5 to 8.9 species per square kilometer). Diversity was much lower in riparian and sagebrush communities (e.g., two species per square kilometer in sagebrush) and apparently lower still in pure lodgepole pine stands (ER Suppl., p. 2-161).

Reptiles and amphibians

The three amphibian species [Tiger salamander (*Ambystoma tigrinum*), chorus frog (*Pseudacris triseriata*), and leopard frog (*Rana pipens*)] and the two reptile species [western terrestrial garter snake (*Thamnophis elegans*) and gopher snake (*Pituophis melanoleucus*)] observed on the Pitch Project are all common species throughout their respective ranges.

2.8.2 Aquatic biota

The construction and routine operation of the uranium mine and mill can potentially affect Indian and Marshall creeks. Potamologically, both streams represent mountain trout streams with associated biota. Characteristically, trout streams are fast-flowing, cold, clear-water habitats with adequate gravel bottom for reproduction. Their water quality must be of the degree to maintain dissolved oxygen (DO) at not less than 4 to 5 mg/liter and free of toxic contaminants because species of trout and their associated benthic fauna are intolerant of low DO and toxic contaminants. The cold-water nature of the stream usually limits the development of a diverse fish population; therefore, species of fish other than trout are limited to other cold-water species, such as sculpins (*Cottidae*). On the other hand, cold-water stream habitats usually develop a diverse benthic fauna of aquatic invertebrates (especially immature life stages of insects). The bioenergetics of these types of streams are usually driven by heterogenous sources of autochthonous and allochthonous inputs. Some organic matter is imported from the terrestrial system (allochthonous input) in such forms as tree leaves and terrestrial insects; however, a primary production of organic matter is in the form of benthic diatoms, aquatic mosses (*Fontinalis* spp.), liverworts, or higher vascular aquatic macrophytes (autochthonous sources).

To characterize the biological communities of Indian and Marshall creeks, the applicant had sampled the periphyton, benthos, and fish communities of these streams. The sampling schedule was conducted over a 12-month period in 1975-1976. The sampling stations of this program are shown in Fig. 2.9. Stations 1 and 2 were on upper and lower Indian Creek, respectively. Stations 3, 4, and 5 were located on Marshall Creek. Station 3 was upstream of the project area, Station 4 was located at the confluence of Indian Creek, and Station 5 was approximately 4 km (2.5 miles) downstream of Station 4.

Periphyton

The periphyton communities of Indian and Marshall creeks were dominated by diatom species. The genera *Navicula, Nitzschia, Synedra,* and *Gomphonema* were most abundant in the collection. Species diversity was uniform in Marshall Creek. Species diversity was lower in Indian Creek than in Marshall Creek; however, an increase was observed from upstream to downstream in Indian Creek. On the site visit that occurred in mid-October 1977, the abundant presence of a fully submerged thallous liverwort covering an estimated 20 to 25% of the bottom substrates in the lower reaches of Indian Creek was observed. The thalli of these liverworts were vivid green, measuring approximately 15 x 20 mm (0.6 to 0.8 in.). Active reproductive structures were visible on the thallus. These plants were not observed in Marshall Creek. It is suggested that the biomass of these liverworts was far more than that of periphitic diatoms. The liverworts, then, may dominate the macrophyte community in Indian Creek.

Benthos

Benthic macroinvertebrates were sampled in the spring, summer, and fall of 1976. The benthic habitats differed considerably between Indian Creek and Marshall Creek. The substrate particle size distribution in Indian Creek consisted of finer particles (17 to 30% sand, silt, and clay) and higher organic content (8.6 to 10.8%) than in Marshall Creek (7.7% sand, silt, and clay and 0.8 to 2.3% organic content), as shown in Table 2.12. The benthic fauna of Indian Creek was also different from that of Marshall Creek. Station 1, at the upper section of Indian Creek, shows the dominant benthic organisms to be planarians and beetle larvae (*Elmidae*). In the lower section at Station 2, the benthos composition shifted to caddisflies of the families Limnephilidae and Rhyacophilidae. Mayflies and midges were also present (Table 2.13). The dominance of planarians and the poor diversity of other invertebrates at Station 1 may be the result of limited growth of periphyton, which inhibits the presence of grazing organisms. The high organic content (8.6 to 10.8%) and fine nature of the sediments may also enhance the presence and growth of planarians.[16]

Table 2.12. Substrate particle size and percent organic composition of Indian and Marshall creeks

Description	Particle size (mm)	Organic composition (%) for stations 1–5				
		1	2	3	4	5
Rubble	64–256	0	17.0	15.1	52.8	40.1
Coarse gravel	32–64	14.3	30.6	23.0	18.9	23.8
Medium gravel	8–32	31.9	24.1	17.2	12.4	21.3
Fine gravel	2–8	23.8	10.6	10.4	8.0	7.2
Subtotal		70.0	82.30	05.30	92.0	92.4
Coarse sand	0.5–2	17.1	9.4	6.4	4.5	4.3
Medium sand	0.25–0.5	5.7	4.1	3.0	1.4	1.6
Fine sand	0.125–0.25	2.9	1.7	7.2	0.8	0.9
Very fine sand	0.063–0.125	1.2	0.9	6.9	0.4	0.3
Silt and clay	<0.063	3.1	1.6	10.8	0.8	0.5
Subtotal		30.0	17.70	34.3	7.9	7.6
Organic loss (percent weight) of sample dried at 110°C, on ignition at 700°C		10.8	8.6	2.3	1.9	0.8

Source: ER Suppl., Table 2.8-32, p. 2-189.

The primary productivity by periphyton may be limited by the lack of adequate light and nutrient regime and/or by excessive concentrations of trace elements, such as copper, zinc, and cadmium. It may be possible that particular trace elements, at times, reach concentrations or accumulate in the sediments in concentrations high enough to limit algal as well as benthic production in the upper reaches of Indian Creek. The limiting and toxic aspects of trace elements will be discussed in Sect. 4.7.1.2.

Reflecting the low diversity and numerical density of benthos at Station 1, the standing crop biomass (dry weight) was also low, ranging from 90 to 2942 mg/m². At Station 2, in the lower section of Indian Creek, standing crop biomass was consecutively higher, ranging from 846 to 1759 mg/m². The diversity index ($\overline{D}$), calculated on family taxa, also indicated a stressed community of benthic invertebrates. At Stations 1 and 2 the mean $\overline{D}$ was 1.91 and 1.93, respectively (Table 2.13). For comparison, a value of $\overline{D}$ of 3.00 or above indicates an undisturbed environment, below that a disturbed or stressed environment.[17,18]

At Stations 3 through 5 of Marshall Creek, the benthos was dominated by immature forms of mayflies, caddisflies, midges, and beetles. On certain occasions, stoneflies also contributed a considerable amount of the biomass, although their numerical density was not very high. The standing crop biomass in these three stations ranged from 312 to 4354 mg/m², and it was consecutively higher than in Indian Creek. Biomass appeared to increase from Station 3 to Station 5. The mean $\overline{D}$ values were also higher in Marshall Creek. At Stations 3 through 5, they were 2.99, 3.25, and 2.83, respectively, indicating relatively undisturbed environments.[17,18] It appeared that the benthic community in Marshall Creek enjoyed little or no environmental stress. The contributing environmental factors toward this diversity may have included adequate water supply throughout the year, adequate substrate composition (Table 2.12), and the availability of periphytic growth that supplemented their diet over the available allochthonous material present in the stream.

2.8.3 Endangered species

2.8.3.1 Aquatic species

The U.S. Department of the Interior, Fish and Wildlife Service,[19] and the Colorado Division of Wildlife (personal communication, Colorado Division of Wildlife, Fish Management Section, 6 March 1977) list two species of fish as endangered in Colorado:

Humpback chub — *Gila cypha*[20]
Colorado River squawfish — *Ptychocheilus lucius*[20]

The Department of the Interior, Fish and Wildlife Service, has proposed to determine the bonytail chub (*Gila elegans*) to be endangered and the humpback sucker (*Xyrauchen texanus*) to be threatened (*Fed. Regist.*, vol. 43, no. 79, April 24, 1978). The Colorado Division of Wildlife identifies the bonytail chub, humpback sucker, and Colorado River cutthroat as endangered. All of the above species occur in the Colorado River drainage. However, none of them are known to occur in streams in the project area, apparently because adequate critical habitat is lacking.

2.8.3.2 Terrestrial species

The applicant's local and outside consulting biologists observed no evidence (individuals or sign of individuals) of endangered or threatened wildlife species, including all species recognized as threatened or endangered by Federal, State, or local groups (ER, Suppl., p. 2-172). Colorado terrestrial wildlife species, listed by U.S. Fish and Wildlife Services as endangered or threatened[21] through 31 December 1977,[22] included the black-footed ferret, the whooping crane, and the American and arctic peregrine falcons. Presence in Colorado of the grizzly bear and the grey wolf is probable but unverified.[23] The classification of the northern bald eagle provides it with endangered status in Colorado and in 42 other states.[24] In the ER Suppl. Appendix C, Table C-2, the bald eagle is listed as a possible site resident, but none were observed.

There are no recognized threatened or endangered plant species in Colorado, although 51 Colorado species are proposed by Federal agencies.[25,26] Among the 51 species proposed, *Trollius laxus* was the only species found at the site. The applicant's consulting biologists checked with Dr. R. Dephillips, Coordinator of the Endangered Flora project of the Smithsonian Institution, who indicated that only the northeastern U.S. variant of the species is proposed as endangered (applicant's responses to staff questions, 1 December 1977, p. 22). Populations of the species are common throughout the Rocky Mountains and the Pacific Northwest.[27,28]

The applicant also identified *Carex microptera* on the site, without subspecies or variety determination. *Carex microptera* var. *crassinerva* is proposed as threatened.[25] A literature search by the staff revealed no information of its habitat requirements beyond the need for wetlands, a need shared with most other members of the genus. Its presence has been verified only in Ouray County, Colorado,[29] where some of the same vegetation formations that occur at the Pitch site (SW spruce-fir and alpine meadows)[30] are found. Because the variety was found elsewhere only in Natrona County, Wyoming, which is dominated by bluestem prairie,[30] the staff concludes that the variety is not necessarily limited to specific regional vegetation formations. The species without variety designation is apparently common in the Rocky Mountains further north[31] and is listed for Larimer County, Colorado.[32] Although the Pitch Project specimen is probably the more common species, the possibility that the specimen is the variety to be protected cannot be ruled out.

2.9 NATURAL RADIATION ENVIRONMENT

Radiation exposure in the natural environment is due to cosmic radiation, terrestrial radiation, and the inhalation of radon and its daughters. Doses attributable to background environmental radioactivity were determined by the applicant, using TLDs at six sampling locations.[33] The calculated average dose was 212 millirems/year to the total body. Approximately 110 millirems/year reflect terrestrial radiation, and the 102 millirems/year were due to fallout and cosmic radiation levels. The cosmogenic and fallout radiation dose are each about 1 millirem/year, mainly from carbon-14. The dose from ingested radionuclides is estimated to result in a dose of 18 millirems/year to the total body.[34] The dose to the total body from all sources of environmental radioactivity is about 230 millirems/year at the project site due to the relatively high elevation and the radioactivity in the soil.

The natural concentration of radon in the Homestake Mining Company Pitch Project area is in the range of 500 to 1000 pCi/m^3, based on the concentration of radium-226 in the local soil.[34,35] Exposure to this concentration on a continuous basis would result in a dose of 500 to 1000 millirems/year[36] to the segmented bronchi. In unventilated enclosures, the lung dose could reach 2000 millirems/year.

The medical total body dose for Colorado is about 75 millirems/year per person.[37] The total dose in the Pitch Project area from both natural background (230 millirems/year) and medical exposure is estimated to be about 305 millirems/year.

2.10 SOCIAL PROFILE

2.10.1 Regional demography

The area surrounding the Homestake Mining Company Pitch Project site is sparsely populated. There are no permanent residents within an 8-km (5-mile) radius of the site. The only dwelling within this radius is a summer dwelling used intermittently by two persons in Section 22, T48N, R5E (ER, p. 2-26). The community of Sargents, with 15 permanent residents, is approximately 8 km (5 miles) from the center of the proposed site. The nearest population centers are Gunnison, about 56 km (35 miles) northwest, and Salida, about 56 km (35 miles) northeast, of the proposed project area.

2.10.2 Community characteristics

There are three counties (Saguache, Chaffee, and Gunnison) and two communities (Salida and Gunnison) likely to be impacted by the Homestake Mining Company Pitch Project. Although the proposed project is located in Saguache County, it is expected that because of commuting distance and the availability of services most of the population increase would occur in and around Salida and Gunnison.

2.10.2.1 Population

Saguache County

Saguache County had a 1975 population of 4100. Over 1700 people live in Center, and about 700 live in Saguache. Fewer than 150 individuals live west of the continental divide. This figure represents a 3.2% increase over the 1970 population, which in turn showed a 14% decrease during the period 1960-1970. County population is expected to increase some 1.26% during the period 1975-1980. Thus, the population is expected to remain essentially constant.

Saguache County contains no cities with over 2500 in population; therefore, the whole county is classified as rural. The population density is 1.3 persons per square mile. The national average population density is 57.2 persons per square mile, and the Colorado average is 24.

Chaffee County

The 1975 population of Chaffee County was approximately 12,000, an 18% increase over the 1970 figure of 10,162. Population in the county increased 22.5% during the period 1960-1970. In 1970 Chaffee County was classified as approximately 42.7% urban (living in cities over the population of 2500 or more), with a population density of 10.8 persons per square mile.

Gunnison County

Gunnison County had an estimated 1975 population of from 8600 to 8800 up 14% from the 1970 figure of 7578. Migration into Gunnison County caused a 19.9% increase in population between 1960 and 1970. The population of Gunnison County was 63.5% urban, and the average population density was 2.7 persons per square mile.

Tables 2.15 and 2.16 summarize population data for the three counties.

Table 2.15. Historical population trends

	1940	1950	1960	1970
Saguache County	6,173	5,664	4,473	3,827
Gunnison County	6,192	5,716	5,477	7,578
Chaffee County	8,109	7,168	8,298	10,162
State of Colorado	1,123,296	1,325,089	1,753,947	2,207,259

Source: ER, Table 2.2-1, p. 2-10.

Table 2.16. Five-year population projections, 1975 to 2000

	1975		1980		1985		1990		1995		2000	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
Saguache County	4,197	4,119	4,250	4,095	4,517	4,223	4,869	4,393	5,267	4,530	5,622	4,566
Gunnison County	8,788	8,605	9,757	9,353	10,721	9,934	11,936	10,600	13,086	10,974	14,307	11,134
Chaffee County	12,198	11,966	13,200	12,714	14,251	13,298	15,689	14,096	17,281	14,775	19,106	15,328
State of Colorado	2,636,906	2,564,992	2,812,433	2,661,344	3,056,123	2,760,222	3,389,516	2,890,572	3,782,590	3,001,675	4,243,491	3,028,310

Source: ER, Table 2.2-2, p. 2-11.

Gunnison

The city of Gunnison is estimated by the mayor to have a population of 5700 (for 1976). Of this, 3100 are students at Western State College, and of this number approximately 2100 leave Gunnison during the summer months. During the period 1970–1976, population increased an average of 3.5 to 5.0% annually and is expected to continue increasing at a rate of 1.5% per year.

Salida

Population in Salida has remained fairly constant over the past three decades, ranging from a low of 4355 in 1970 to a high of 4969 in 1940. The 1976 population of Salida is estimated at 4900.

2.10.2.2 Employment

Saguache County

The major sector for employment within Saguache County is agriculture, where a total of 595, or 37% of the county work force is employed. Following in importance are the wholesale and retail trade sector, employing 16%, and the governmental sector, employing 13%.

Unemployment in Saguache County has ranged from 4.7 to 6.5% since 1970. Table 2.17 gives a complete breakdown by sector of the employment for the three counties impacted by the project.

Chaffee County

Chaffee County's unemployment rates have ranged from 3.8 to 5.9% during the period 1970 to the beginning of 1976. Of those employed, 26% work in the service area, 19% in wholesale and retail trade, and 16% in government.

Table 2.17. 1974 Sectorial employment data[a]

	Saguache County	Gunnison County	Chaffee County	State of Colorado
Total number employed[b]	1,596	3,244	4,263	1,095,954
Agriculture				
Number employed	596	388	173	50,081
Percent of total	37	10	4	5
Mining				
Number employed	27	80	663	10,214
Percent of total	2	2	16	1
Construction				
Number employed	50	134	126	65,181
Percent of total	3	4	3	6
Manufacturing				
Number employed	43	67	144	144,581
Percent of total	3	2	3	13
Transportation, communication, and public utilities				
Number employed	49	67	313	60,630
Percent of total	3	2	7	6
Wholesale and retail trade				
Number employed	254	494	793	228,399
Percent of total	16	15	19	21
Finance, insurance, and real estate				
Number employed	3	102	90	58,711
Percent of total	0.18	3	2	5
Service				
Number employed	49	565	1,116	182,229
Percent ot total	3	17	26	17
Government				
Number employed	206	377	671	253,456
Percent of total	13	12	16	23

[a]Estimated from 1970 census figures (U.S. Bureau of the Census, *U.S. Census Population*, 1970, vol., I, *Characteristics of the Population, Part 7, Colorado*, U.S. Government Printing Office, Washington, D.C., 1973) and 1974 sectorial employment estimates for regions (Colorado Division of Employment, Research and Analysis, *Resident Labor Force Estimates*, Internal Report, 1975). For a description of methodology employed, see ER, Sect. 2.2.1.5.

[b]Percentages do not total to 100 because of the absence of data on self-employed persons. This absence results in a downward bias of sectors, such as services and agriculture, that normally contain a substantial number of self-employed people (ER, Sect. 2.2.1.5.).

Source: ER, Table 2.2-8, p. 2-29.

Gunnison County

Gunnison County has 17% of its work force employed in the service sector, 15% in wholesale and retail trade, 12% in government, and 10% in agriculture, showing a slightly greater variety in employment than either Chaffee or Saguache counties. Unemployment for the county has a range from 3.4 to 5.7% during the period 1970-1976.

2.10.2.3 Income

Saguache County

Saguache County had an average per capita income of $3655 in 1973, representing 74% of the State average. Table 2.18 gives the historical trend for incomes within each of the counties discussed.

Table 2.18. Per capita income

County	1969	1972	1974	Percent change 1969–1974	County as percentage of State total		
					1969	1972	1974
Saguache	1678	2599	3726	122.1	54	64	76
Gunnison	2559	3127	3773	47.4	82	77	77
Chaffee	2392	3147	3820	59.7	77	77	78
State of Colorado	3106	4065	4884	57.2	100	100	100

Source: U.S. Bureau of the Census, 1977.

Chaffee County

Chaffee County showed an average per capita income of $3932 for 1973. This figure is 79% of the State average for that year.

Gunnison County

The per capita income in Gunnison County for 1973 was $3214, or 65% of the State average. Gunnison is the lowest of the three counties in per capita income, a fact that probably reflects the presence of nonwage earning students within the county.

2.10.3 Social and cultural characteristics

2.10.3.1 Saguache County

Saguache County is overwhelmingly rural and predominately agricultural. The county is somewhat depressed socioeconomically; it is one of the seven Colorado counties with a welfare caseload of over 20% of the population.

2.10.3.2 Chaffee County: Salida

Salida began as a railroad and mining town during the 19th century. Although railroad activities have been cut back, mining continues to occupy a substantial portion of the community and county, with over 240 Salida residents commuting to the Climax Mine 145 km (90 miles) away.

In addition to being a mining town, Salida also attracts adequate tourist trade to support 25 motels. According to the Chamber of Commerce, Salida is a close-knit community where the residents show a high degree of community spirit and participation in local clubs and activities.

2.10.3.3 Gunnison County: Gunnison

Gunnison, begun as a support center for miners in the area, is now a town that directs its attentions toward education, tourism, and ranching (ER, p. 2-72). As such, the town is quite heterogenous. The school age population at Western State gives Gunnison a college town environment with a disproportionate number of young people, while the tourist trade community and the college population ensure that the community remains a relatively open one, that is, receptive to new members.

2.10.4 Housing

The housing market in Chaffee and Gunnison counties is relatively tight. Most housing activity is centered in the cities of Gunnison (Gunnison County) and Salida (Chaffee County). The costs and difficulties of meeting State requirements for water and sewer services presently slow the development of new housing units in unincorporated areas.

Salida

Salida presently has a restricted housing market. Until the imposition of State restrictions on septic tank and well construction, the growth rate outside the city limits averaged about 4% annually. Currently, most new construction is occurring within the city limits. However, fewer than 200 new housing units have been completed within the city in the past five years. Also, future growth will be constrained by a shortage of building lots within the city. United Construction, Salida's largest builder, estimated that as of May 1976 there were, at most, 100 lots available within the city. Annexation of surrounding areas could alleviate this shortage.

In recent years about 40 new single family dwellings have been constructed annually. In addition, approximately 100 older homes are put up for sale each year. The rental market is very tight; new apartment units usually are filled before construction is completed. Total mobile home capacity in the Salida area is 125 to 135 units. The vacancy rate is currently running at about 7%. County regulations limit further mobile home development. Two such developments proposed in 1975 were denied permits by the county. Because of such restraints, the construction and mobile homes sectors would respond slowly to a sudden increase in housing demand.

Gunnison

Housing within Gunnison city limits is expensive and difficult to obtain. In the five-year period from 1970 to 1974, for example, 52 single-family and 72 multi-family units were built, or an average of 10.4 and 14.4 units, respectively, per year (Gunnison City Engineer, unpublished, 1976). Rental units, in particular, are in short supply. The situation is aggravated by the high demand of college students for rental units during only nine months out of the year, which means that a high percentage of units is unoccupied during the summer months. This problem decreases the profitability and attractiveness for those developers interested in investing in rental units. The few multi-family dwellings that are currently being constructed are to be sold as expensive condominiums.

Although available land within the Gunnison city limits is scarce, there is room for limited expansion. Development in areas outside the city is expensive because the cost of providing water, sewage, and other services is high. However, construction of a sewage treatment facility is opening the way for additional development in the county area south of the city. Furthermore, the county is studying ways to provide sewer service for the area north of Gunnison.

Mobile home parks in Gunnison are presently filled to 97% capacity. In May 1976, for example, a survey of the ten major mobile home parks in the area revealed a total of approximately 350 spaces, with no more than 12 vacancies. However, the supply of spaces is expected to increase. The Antelope Creek development (proposed for completion in 1977) included 117 mobile home spaces, in addition to 19 residential lots. Also, two of the existing mobile home parks were planning to add a total of 70 new spaces in 1976, with plans for construction of 20 additional units in 1977. Although these plans exhaust the list of planned construction of units, there is land available in existing mobile home parks that could increase capacity by 160 spaces, should demand for mobile homes increase sufficiently (ER, p. 2-76).

2.10.5 Government, public service, and public finance

The primary impact area of the Homestake Mining Company Pitch Project includes three counties, two cities, two school districts, and two special districts — the Upper Gunnison Water Conservancy District and the Colorado River Water Conservation District.

2.10.5.1 Adequacy of planning: zoning

In Gunnison County, there are both a County Planning Office and a City Planning Office for the town of Gunnison. Because there are no county zoning laws, technical review groups have been established to review new projects that are proposed for the area. These review groups are composed of various members of each of the planning offices. In the City of Gunnison, a building moratorium is currently in effect until March 1978, at which time limited building — duplexes and single-family homes — will be permitted (private communication, city manager, Gunnison, 22 February 1978). The City Manager is presently revising the Master Plans originally adopted in 1964 and will incorporate a land-use concept where new building will be reviewed by a commission on a project-by-project basis.

In Chaffee County, planning is also performed at both the county and city levels. County planning is through the County Commissioner's office, although the County Board of Adjustment meets to make the final decisions on zoning regulations. The county is following a Master Plan developed by the local Council of Governments. Planning for the City of Salida follows a 1990 Policy and Plan adopted in 1968. The Planning Commission deals mainly with new annexations.

Saguache County has a County Planning Commission, and the zoning ordinances apply only to hazardous and mineral resource areas. The county is developing a Master Plan for land use planning. The Saguache County Land Use Administrator believes that the Pitch Project will not conflict with this Master Plan (private communication, Mark Daly, 24 February 1978).

2.10.5.2 County profiles

The following discussion considers Gunnison and Chaffee counties. Saguache County is not considered because the workers will more than likely reside in the towns of Gunnison or Salida. Tax benefits accruing to Saguache County are considered in Sect. 4 of the ER.

Chaffee County

Chaffee County had a 1975 assessed valuation of $29,418,120, which increased to $32,586,170 in 1976 (County Assessor, 1975). Total county expenditures budgeted for 1976 were $2,102,394 with general fund allocations amounting to $729,486 of the total $2,100,000 (Chaffee County Budget, 1975). The total county budget includes the general fund as well as special funds for roads and bridges, public welfare, and retirement. Table 2.19 shows that general fund expenditures increased $115,458, or 18.8%, from 1975 to 1976.

Health service staffing by Chaffee County to the Salida area includes two part-time public health nurses working with the Salida community and school systems and a county health officer who inspects sewage and septic tank facilities in the city. The county subsidizes a reduced-fare taxi service to health care centers for the elderly. Also, building space is donated by the county for a State-supported drug and alcohol abuse center and a legal aid center, both located in Salida. All county roads are maintained by the county. The sheriff's department operates on a direct cooperative basis with the Police Department of Salida,

Table 2.19. Chaffee County general fund budget summary, 1975–1976

1975 estimated expenditures	
General government	$361,038
Judicial (District Attorney)	49,658
Public safety	131,054
Health and hospitals	41,563
Auxiliary services	30,715
Capital outlay	
Debt service	
Transfers to other County funds	
Total	$614,028
1976 budgeted expenditures	
General government	$420,935
Judicial (District Attorney)	52,099
Public safety	169,755
Health and hospitals	45,445
Auxiliary services	41,253
Capital outlay	
Debt service	
Transfers to other County funds	
Total	$729,487

Source: ER, Table 2.2-23, p. 2-59.

sharing central records, radio, telephone, and communications equipment. The State Patrol for the area operates from the same facility and employs eight men. The sheriff's department has five vehicles and the State Patrol, six (private communication, Chaffee County Sheriff's Department, 17 May 1976).

Gunnison County

Gunnison County has a 1976 assessed valuation of $25,798,215. Total expenditures budgeted for 1976 amount to $2,411,167, an increase of 15% over estimated 1975 expenditures of $2,099,127. The 1976 county general fund expenditures budget is $627,504 and is summarized in Table 2.20.

Table 2.20. Gunnison County general fund expenditures, 1975 and 1976

Category	Estimated 1975 expenditure	Budgeted for 1976	Percent change
General government	$294,604	$325,870	11
Judicial (District Attorney)	29,800	49,275	40
Public safety	101,447	117,175	16
Health and hospitals	34,684	82,492	138
Auxiliary services	35,556	43,142	21
Capital outlay (land and building)	11,000	9,550	−13
Totals	$507,091	$627,504	24

Source: ER, Table 2.2-31.

Health services in the town of Gunnison are provided primarily by the county, which owns and operates the 24-bed Gunnison County Public Hospital located in Gunnison. Public health, home health care, and family planning services are provided by the Gunnison County Public Health office, staffed with two full-time Public Health nurses and one family planning worker. An office of the regional Mid-Western Mental Health Center, located in Gunnison, is staffed by a clinical psychologist and an alcoholism treatment coordinator. These therapists are available to a number of community organizations, including the hospital, for services and education (private communication, Bill Cavanaugh, Gunnison County Hospital, 10 May 1976).

The County Sheriff's Department is staffed by seven full-time employees in the main office in Gunnison. In addition, there are four officers employed at Crested Butte and three at Mount Crested Butte, all of whom are on call. The sheriff's department owns four county vehicles and has one personal car on lease. Communication equipment owned by the county includes seven radio sets.

Other services provided by the county include road maintenance, building inspection, and rural fire control. Over one-half of total county budget expenditures is devoted to road maintenance and snow removal on all county roads. The county also maintains the Gunnison airport, contributes to the community building in Gunnison, and provides a Social Services Department and senior citizens organization.

2.10.5.3 City profiles

Salida

The city government of Salida, a mayor—council form of government, provides police and fire protection as well as water and sewage treatment for the city. Assessed valuation for Salida in 1975 was $8,696,210. Total expenditures for 1976 were budgeted at $750,851, a 22.6% increase over 1975 expenditures estimated at $612,384. The 1976 budget figure does not include $450,000, which was included as capital outlay in the budget, but was not available due to the failure of a swimming pool bond issue. General fund expenditures were budgeted at $411,847 (not including $450,000 in capital improvements) for 1976, an increase of 11.5% over 1975 estimated expenditures of $369,663. Table 2.21 presents a summary of general fund expenditures.

The water supply of Salida has a total capacity of 2.6×10^4 to 2.8×10^4 m^3/day (7 to 7.5 million gpd), supplied primarily by the Little Arkansas River and treated by one water treatment plant. There are 1800 hookups to the water supply system, 1500 of which are residential and 300 of which are industrial and commercial users. Average daily use amounts to 5.7×10^3 m^3/day (1.5 million gpd) in the winter and 2.2×10^4 m^3/day (6 million gpd) in the

Table 2.21. City of Salida general fund expenditures, 1975 and 1976

Category	Estimated 1975 expenditures	Budgeted for 1976	Percent change
General	26,282	27,800	6
Police	50,800		−24
Fire	49,980	56,100	12
Highways	128,100	107,000	−16
Health	2,000	2,000	0
Recreation	16,800	16,300	−3
Parks	11,800	13,500	14
Hot springs	11,500	7,500	−35
Airport	2,800	3,000	7
Miscellaneous	69,601	63,747	−8
Capital outlay		76,300	
Totals	369,663	411,847	11

Source: ER, Table 2.2-24, p. 2-61.

summer. There are no constraints to reasonable expansion of the water supply because more water is available to the city than is actually treated. In addition to its current 2.7 x 10^4 m^3/day (7 x 10^6 gal) daily capacity, the city has access to approximately 3.8 x 10^3 to 7.6 x 10^3 m^3/day (1 to 2 million gpd), which could be purchased from local owners of water rights.

The city operates one sewage treatment plant, utilizing a trickling filter system with a peak capacity of 3.8 x 10^3 m^3/day (1 million gpd). Current daily usage averages 2850 to 3040 m^3 (750,000 to 800,000 gal). Because Salida has added the 300 to 400 residents of Poncha Springs to its sewage system, the city has been approaching full-capacity use of its sewage treatment facilities. An in-depth study of the sewage system by Wright McLaughlin Engineers is currently under way, with the aim of increasing capacity. According to the Salida mayor, the elimination of underground water infiltration into sewage lines should create additional capacity that would allow for expansion of services. This hypothesis has yet to be substantiated by the study, which should have been completed in 1978 (private communication, Ed Touber, Salida Mayor, 2 May 1976).

Electricity is currently provided by the Public Service Company of Colorado to Salida and an 8-km (5-mile) radius, including Poncha Springs. There are 3400 residential meters and 650 commercial and industrial meters (private communication, Public Service Company, local office, May 1976). Because one home may have more than one electric meter, the number of meters in the area should not be interpreted as an indication of the number of households served (private communication, Public Service Company, Salida Office, 2 May 1976). Salida Gas Service Company provides natural gas service to approximately 2000 customers in Salida, Poncha Springs, and Chalk Creek areas. There are approximately 450 propane users in the area. Salida Gas Service is no longer accepting additional gas customers because of a moratorium imposed by the Colorado Public Utilities Commission. However, propane is available to new customers at the present time. Although there is presently no constraint on the amount of propane available, the cost can be twice as much as for natural gas (private communication, Salida Gas Service Company, May 1976).

The city has no formal recreation department but sponsors several programs, including a summer softball and baseball program, occupying one municipal baseball field east of town and one field at the high school. The 1976 recreation budget included a capital outlay of $23,000, mainly for lights for the ball parks. The city also contributes to maintenance of a nine-hole golf course and an ice pond, both of which are open to the public. Municipal parks include Riverside and Alpine parks and a small park near the courthouse. Frazer Park, a Colorado State Park, is located west of town. Salida Hot Springs, an indoor swimming pool, operates from June until September of each year. Current employment for recreation services includes four part-time seasonal workers, three swimming teachers, and one manager for the softball program. When Salida Hot Springs pool is in use, the swimming program employs between 15 and 20 people (private communication, Ed Touber, Salida Mayor, 2 May 1976).

The Salida Police Department currently employs ten officers, including one working chief. There is a police-population ratio of 1:490, which is less than the national average, and there are two patrol cars. Fire protection is provided by five paid employees and 10 to 12 volunteers. The city owns eight working fire vehicles (private communication, Ed Touber, Salida Mayor, 2 May 1976).

Health services are provided to the city by two part-time county public health nurses, and one-fourth of the health services costs are paid by the State. There is one hospital in Salida operating at about 80% of its 60-bed capacity. There are six local doctors, including one ophthalmologist and one anesthesiologist. Approximately 40 to 45 registered nurses work in Chaffee County, 25 of whom are located in Salida. One nursing home operates at full, 60-bed capacity in Salida. There are currently no plans for expansion of the nursing home nor is any expansion felt necessary for the overall health care program (private communication, Judy Spencer, Public Health Nurse, 3 May 1976).

Gunnison (city)

The town of Gunnison had a 1975 valuation of $6,916,870. Total expenditures for 1976 are budgeted at $1,896,910, including general fund expenditures of $609,015, a 6% increase over 1975 estimated general fund expenditures. A summary of 1975 and 1976 budget expenditures is presented in Table 2.22.

Table 2.22. Summary of general fund expenditures 1975 and 1976, town of Gunnison

Account	1975 budget	1976 budget	Percent change
City Council	$ 4,994	$ 4,994	0
Judicial	4,873	6,088	24
City Manager	21,421	23,060	8
Elections	1,000	1,000	0
Finance Department	12,820	16,736	31
Law Department	13,588	13,588	0
Planning Department	3,000		
Engineering Department	29,106	41,505	43
General government and shop buildings	17,754		
Police Department	142,445	181,810	28
Fire Department	17,435	29,460	69
Public Works supervision	35,069	38,731	10
Garbage and refuse collection	55,568	57,279	3
Garbage and refuse disposal	11,405	16,848	48
Weed control	1,504	929	−38
Ditch construction	3,872	4,222	9
Ditch maintenance	6,009	5,372	−11
Public health	650	650	0
Animal control	11,166		
Mosquito control	8,928	9,026	1
Recreation Department	39,015	41,179	6
Cranor Ski Hill	5,000		
Webster Hall	12,750	10,556	−17
Parks Department	8,922	9,547	7
Advalorem tax – principal	9,000	10,000	11
Advalorem tax – interest	1,435	1,120	−22
General government			
Clearing account	50,516	47,968	−5
Audit	5,000	5,000	0
Insurance and bonds	15,000	15,000	0
Publishing	500	750	50
Workmen's compensation	6,500	6,500	0
Contingency Fund	16,797	10,097	−40
Totals	$573,042	$609,015	6

Source: ER, Table 2.2-32, p. 2-81.

Municipal services provided by Gunnison include police and fire protection, water, electricity, and sewage and solid waste disposal. The Police Department employs a total of 18 persons, including eleven police officers, six dispatchers, and one part-time secretary. The police population ratio is 1:540, slightly less than the national average. Equipment used by the department includes four patrol cars, one parking control three-wheeler, four two-way radios, a C.B. radio channel, and four telephone lines (private communication, Floyd F. Johnson, Gunnison Police Chief, 10 May 1976). The Volunteer Fire Department is staffed by 38 to 40 volunteers, including an unpaid chief and two assistant chiefs. The fire department houses four city fire trucks and three vehicles owned by the county rural fire district (private communication, fire dispatcher, 15 May 1976).

The city maintains an integrated system of domestic water pipes that services the area within the city limits. Water is supplied to 1217 residential and industrial customers. The main source of water consists of seven wells located in the western part of the city. Maximum capacity of the water treatment system is not known because water is taken and distributed from seven different wells to the water treatment plant (United Banks of Colorado, Inc., 1974). Current average daily consumption is 3895 m^3 (1,025,000 gal), and peak consumption has been as high as 8181 m^3 (2,153,000 gal). Gunnison is currently (1976) in the process of adding two wells that are projected to increase the water supply by 2.3 to 3.0 m^3/min (600 to 800 gpm). Also, the city is adding underground service lines and a 3800-m^3 (1-million-gal) storage reservoir that will provide a total of 7600 m^3 (2,000,000 gal) of storage for backup pressure and fire protection (private communication, Rial Lake, 1976, and United Banks of Colorado, 1974).

The sewage treatment system for Gunnison currently has a peak capacity of 6080 m^3/day (1,600,000 gpd). Average daily use is 2090 m^3 (550,000 gal). However, efficiency is significantly decreased by groundwater infiltration during the summer months, which results in a less thorough treatment of all water that is processed by the plant. Groundwater infiltration can account for as many as 17,670 m^3/day (4,650,000 gpd) (private communication, Rial Lake, 10 May 1976). In 1975, the city initiated a sewer-sealing program to reduce groundwater infiltration that should solve 75 to 80% of the infiltration problem within four to five years. In 1975 and 1976 the sewage treatment plant was upgraded to meet Federal Environmental Protection Agency (EPA) and State Board of Health requirements. At the present time there are no constraints to additional hookups within city limits. However, the county is presently conducting an engineering study to resolve sewage problems in areas adjacent to the city. Until its completion, a sewer moratorium had been imposed for areas outside the town (private communication, Rial Lake, Gunnison Mayor, 10 May 1976, and United Banks of Colorado, 1974).

Electric power is distributed by the city to residents within a 3.2-km (2-mile) radius and obtained primarily from the U.S. Bureau of Reclamation. Secondary power is obtained from the Gunnison County Electric Association. Demand has been increasing at a rate of 8% annually. Although no changes in rates have been initiated in the past ten years, the city is planning to establish a new rate structure because of increasing prices of electricity supplied by the Gunnison County Electric Association (private communication, Rial Lake, 10 May 1976).

Gas service to Gunnison and a 1.6- to 3.2-km (1- to 2-mile) radius around the city limits is supplied through Peoples Natural Gas Company. Currently there are 1750 residential, commercial, and industrial customers. Peoples Natural Gas has been under a moratorium for two years due to the shortage of natural gas on the western slope and has not been able to extend service to new customers. The company is considering lifting the moratorium this year, but the backlog of demand will not be removed entirely (private communication, Gunnison City Manager, 24 February 1978). However, propane is available and is presently not limited in supply, although it is significantly more expensive than natural gas (private communication, Peoples Natural Gas, May 1976).

The Gunnison County Hospital has a current capacity of 24 beds, the present occupancy rate of which is approximately 50%. Six medical doctors and one osteopath practice in the city. Also, one anesthesiologist works at the hospital, and one radiologist, one orthopedist, and one urologist perform services and hold clinics periodically each month. There are currently ten registered nurses on the hospital staff. In addition to the hospital staff, three dentists, one orthodontist, and one oral surgeon practice in Gunnison. Because a new addition to the hospital was completed in 1970, no plans are currently being made for expansion of public health facilities.

Public parks within Gunnison city limits include City Park, covering an area of two blocks on the eastern edge of the city, and Char-Mar Park in the northwest, which covers approximately one city block. Both parks have lighted tennis courts, grass playing areas, and barbecue facilities. West of the city is Lion's Park, with 2 ha (5 acres). The city also owns and services Taylor River Park, located in a national forest service area, 21.7 km (13.5 miles) north of the town. Sixteen kilometers (10 miles) west of town is the Blue Mesa Reservoir, a national recreation area popular for boating. The reservoir contributes significantly to the tourist trade in Gunnison. In 1975, for example, 852,260 persons visited Blue Mesa (private communication, U.S. National Park Service, May 1976).

Municipal recreation facilities in Gunnison include the 21-acre East Side Multipurpose Recreation area, which has four softball fields, an outdoor archery range, basketball court, and the city's outdoor iceskating rink. Also, Webster Hall Community Building is open seven days a week and houses an auditorium and stage, lounge, archery and pistol shooting ranges, tumbling equipment, and a Senior Citizen Center. The city also runs and operates Cranor Ski Hill, 5.6 km (3.5 miles) north of the town, and helps to operate Dos Rios Golf Club and a golf course at Spring Creek Resort. Recreational facilities in the town are in great demand, particularly due to heavy use by college students and tourists, in addition to Gunnison residents. However, budget limitations in recent years have stifled expansion of facilities. In particular, construction of a multipurpose recreation complex and three additional tennis courts has remained in the planning stages because of limited funds (private communication, Gunnison Recreation Department, May 1976).

2.10.5.4 School district profiles

Salida School District

The Salida School District had an assessed valuation of $19,089,000 for 1976. The school district budget was equal to $1,700,000 for that year and had been increasing by approximately $250,000 per year. Annual operating cost per pupil averaged $1025 in 1975. School enrollment (1551) has remained steady over recent years with a total difference of 40 students (approximately 2.5%) from 1966 to 1976 (Table 2.23). The school system is presently operating at 85% capacity. The overall student-teacher ratio is 20:1. In addition to 79 teachers, the school system also employs four specialists, including a psychologist, speech therapist, and two public health nurses. Average daily attendance in the district is 93%. In addition to three public schools, there are two pre-schools in Salida and St. Joseph Catholic School, with an enrollment of 112 pupils and a capacity for 137 (private communication, St. Joseph Principal, 21 May 1976).

Table 2.23. 1976 enrollment and capacity of the Salida schools

School	Grades	1976 enrollment	Maximum capacity	Number of teachers	Student-teacher ratio
Public					
Longfellow Elementary	K–6	726	865	30	24:1
Kesner Jr. High	7–8	275	310	17	16:1
Salida High	9–12	550	650	32	17:1
Total		1551	1825	79	20:1
Private					
St. Joseph School	K–6	112	137	9	15:1

Source: ER, Table 2.2-25, p. 2-65.

The school district plans to expand facilities in the future and has acquired land for new buildings. However, actual construction has been delayed by the recent failure of a school bond issue. A temporary alternative to new building construction is the addition of two classrooms to the elementary school and a four-classroom addition to the junior high school. Plans have not been finalized for either alternative (private communication, Salida School Superintendent, 3 May 1976).

Gunnison School District

The Gunnison School District encompasses four elementary schools, one junior high, and one high school. The school district enrollment has experienced a 7% decline in the past 18 months and is presently (1976) operating at 78% capacity. Full-time equivalent teachers numbered 90.8 in 1976 and were reduced to 87.8 in 1977. (Full-time equivalent is used to express the number of teachers, including part-time employees. For example, two part-time teachers, each working 20 hr per week, would equal one full-time equivalent.) There are no present plans for expansion of educational facilities. Operating costs per pupil currently average $1705, and the budget for 1976 is $2,159,728 (private communication, Gunnison School Superintendent, 6 May 1976). A summary of enrollment, faculty, and capacity in each school is presented in Table 2.24.

Table 2.24. Enrollment and capacity in Gunnison Re-1J school district

School[a]	Grades	Enrollment	Maximum capacity	Number of teachers full-time equivalent	Student-teacher ratio
O'Leary Elementary	K–2	159	210		
Blackstone elementary schools	3–6	238	330	31	19:1 for Gunnison Elementary
Lake Elementary	K–6	183	220		
Crested Butte Elementary	K–8	120	200	8	15:1
Ruland Jr. High	7–8	220	280	12.3	16:1
Gunnison High	9–12	472	550	27 (plus 4 Jr. and Sr. High teachers)	16:1
Total		1394	1790	90.8	15:1 15:1

[a]School district attendance rate: 96%.
Source: ER, Table 2.2-33, p. 2-87.

2.11 RECREATIONAL ACTIVITIES

National Forest System land surrounding the project area consists of multiple-use areas serving as recreational areas in addition to many other uses. Fishing, camping, hiking, and hunting are just a few of the recreational activities occurring on adjacent National Forest System lands.

Recreational usage at the Homestake site is considered light, with the exception of elk hunting season in the fall. The 1976 total number of hunters recorded by the Division of Wildlife in Game Management Unit 551 (which includes the project area) was 2184 persons for a total of 10,518 recreation days (one person per 12 hr). The project area would probably account for 10% of the use.

Next in popularity in the vicinity is fishing. An estimated five persons per day fish Marshall Creek from mid-May until mid-September each year. Other recreation uses in the area include camping, hiking, backpacking, snowmobiling, cross-country skiing, and sightseeing. Total annual use for these activities in the Marshall and Agate creek drainages is about 1500 visitor days, which is considered to be light.

Gunnison and Salida provide a variety of developed recreational opportunities such as baseball, golf, swimming, tennis, basketball, and grass-playing areas. In addition, there is the Blue Mesa National Recreation Area west of Gunnison that offers boating, fishing, and camping, and north of Gunnison is Crested Butte, offering spectacular summer recreation and winter skiing.

The potential for intensive development of recreational uses in the project area is low. No unique scenic or natural features are present, nor are there any existing developed recreational facilities.

2.12 AESTHETIC CONSIDERATIONS

The landscape is characterized by gently rolling hills with some steep slopes. The vegetation varies from open parks of grass and sagebrush (subdued grays, browns, and greens) to dense stands of coniferous trees (dark green) with occasional patches of aspen (bright green, yellow, and gray). The dominant visual element of the landscape in the area is the variation between open spaces and dense timber. Due to these characteristics, man-made facilities such as fences, roads, and buildings will be relatively inconspicuous in the local landscape. The project area is similar visually and aesthetically to other parts of the National Forest where similar multiple-land uses are occurring. There are no unique features within the area.

The Chipeta (Area Code 2358) roadless and undeveloped area lies immediately to the northwest and north of the site. This area (which includes the former Agate Roadless Area) is being evaluated by the FS for its wilderness and nonwilderness potential in the current Roadless Area Review and Evaluation (RARE II). The Final Environmental Statement (FES) for RARE II was issued in January 1979.

2.13 ARCHAEOLOGICAL AND HISTORICAL VALUES

Gunnison and Chaffee counties reflect the historic development of ranching and mining, while Saguache County reflects agricultural development. Historic sites in these counties capture these influences. The National Registry of Natural Landmarks and the National Register of Historic Places have indicated no sites within a 16-km (10-mile) radius of the project area (6 December 1977 lists). Consultation with the State Historical Preservation Officer has revealed that there are no pending nominations within this area.

An archaeological survey was conducted by Grieser and Grieser in 1976 in which 31 sites were identified as being of potential archaeological interest. The area surveyed was that which might be affected by surface disturbance from construction, mining, and milling activities. This survey revealed that construction of the access road could affect sites that have archaeological significance. The sites are being inspected and evaluated for archaeological significance. The mill site access road has had three potential sites inspected, and nothing significant has been found. The Forest Service has received a "no effect" stipulation from the Office of the State Archaeologist and State Historic Preservation Office for this portion of the project.

The Homestake Mining Company is expected to evaluate all identified sites for which National Register significance has not been determined in advance of impact on those sites. This evaluation will allow the FS to request concurrence in the determination from the State Historic Preservation Officer. If the site is determined significant, mitigative measures will be proposed (Sect. 4.1.2).

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3. APPLICANT'S PROPOSED MINING AND MILLING OPERATION

3.1 MINE

3.1.1 The proposed action

The location of the open pit uranium mine and mill proposed by Homestake Mining Company is shown in Fig. 2.9. Known reserves with an ore grade above 0.05% U_3O_8 are estimated to be 1.7 million tons; known reserves with an ore grade between 0.020 and 0.049% U_3O_8 are estimated to be 0.4 million tons. The applicant estimates the overall average ore grade to be approximately 0.17% U_3O_8 on a diluted basis. For assessment of environmental effects, a value of 0.2% has been used in this Statement. At the anticipated mining rate of 544 metric tons (600 tons) of ore per day, reserves should last for 11 years. At this production rate, approximately 181,400 metric tons (200,000 tons) of ore per year will be processed at Homestake's proposed mill, located 2.4 km (1.5 miles) southwest of the open pit. Additional ore will be extracted from small adit mines driven into the walls and floor of the open pit. To extend the 11-year operational life of the project, Homestake is exploring other areas within economic hauling distance of the mill; ore that may be found in these areas is ultimately expected to be mined and trucked to the mill, extending the project lifetime. Each new mining operation will require a new set of reviews and approvals. The mill site is consistent with known ore reserves and operating economics. Several existing mills are of similar size.

The proposed open pit mine will be at an elevation of 3078 to 3292 m (10,100 to 10,800 ft) above sea level. The anticipated maximum dimensions of the pit are approximately 1463 m (4800 ft) long, 366 to 549 m (1200 to 1800 ft) wide, and up to 213 m (700 ft) deep, over an area of about 62 ha (152 acres) (Figs. 3.1 and 3.2). Approximately 34 x 10^6 m^3 of intact rock (44 x 10^6 bank yd^3) will be removed during the 11-year operational life of the mine. Of the total rock removed, more than 97%, or 33 x 10^6 m^3 (43 x 10^6 bank yd^3), will be hauled by trucks to nearby dumps. The dumps will cover an area of approximately 87 ha (216 acres) (Fig. 3.2). The overall overburden removal ratio for the open pit is estimated to be 15.8 m^3 (20.7 bank yd^3; 44 tons) per ton of ore.

3.1.2 Mining procedures

3.1.2.1 General

Uranium ore at the proposed open pit mine occurs in a zone approximately 1219 m (4000 ft) long and up to 122 m (400 ft) wide. Abundant faults and widespread brecciation have tended to separate the ore into pods that are distributed randomly throughout the mine site. Vertical depth to the ore bodies varies from the surface to over 213 m (475 ft) deep. Because the ore is widespread, randomly concentrated, and may be hundreds of feet below the surface, Homestake estimates that 44 tons of waste overburden must be excavated for each ton of ore. Due to the random occurrence of the ore, open pit mining is considered the only efficient and economical method of developing these reserves.

Overburden at the proposed open pit mine will be loosened by ripping and blasting and then hauled by eight trucks of 35-ton capacity to nearby waste dumps. Once the ore is exposed, it will be loaded onto trucks and hauled to Homestake's proposed mill approximately 2.4 km (1.5 miles) southwest of the mine.

3.1.2.2 Mining sequence

Figures 3.2 through 3.8 show the 25-year mining and reclamation sequence as currently planned by the Homestake Mining Company. Because this part of Colorado usually has a severe winter,

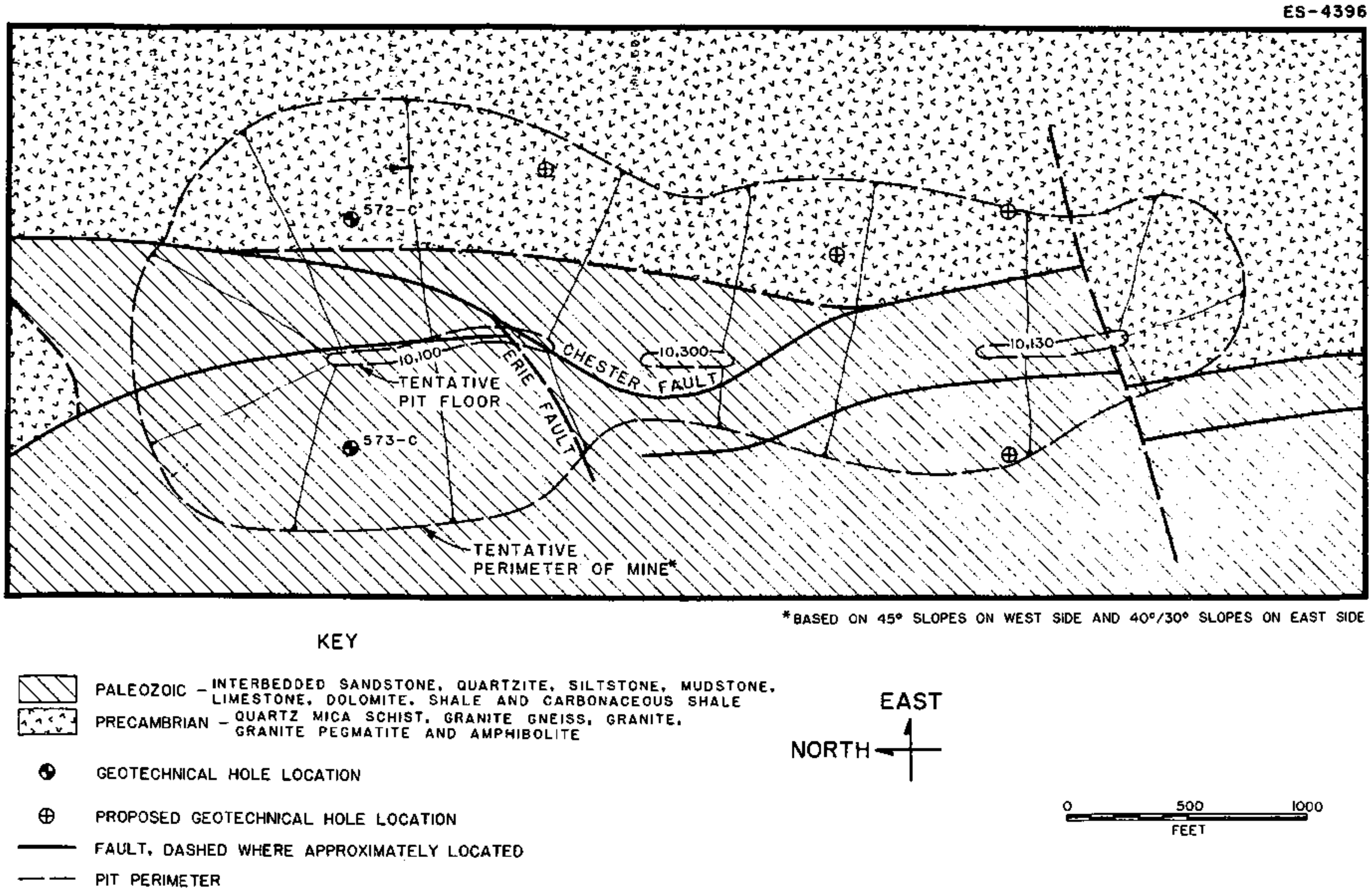

Fig. 3.1. Mine plan and geologic map. Source: Homestake Mining Company, "Geologic Map--Pitch Project," Feb. 19, 1974.

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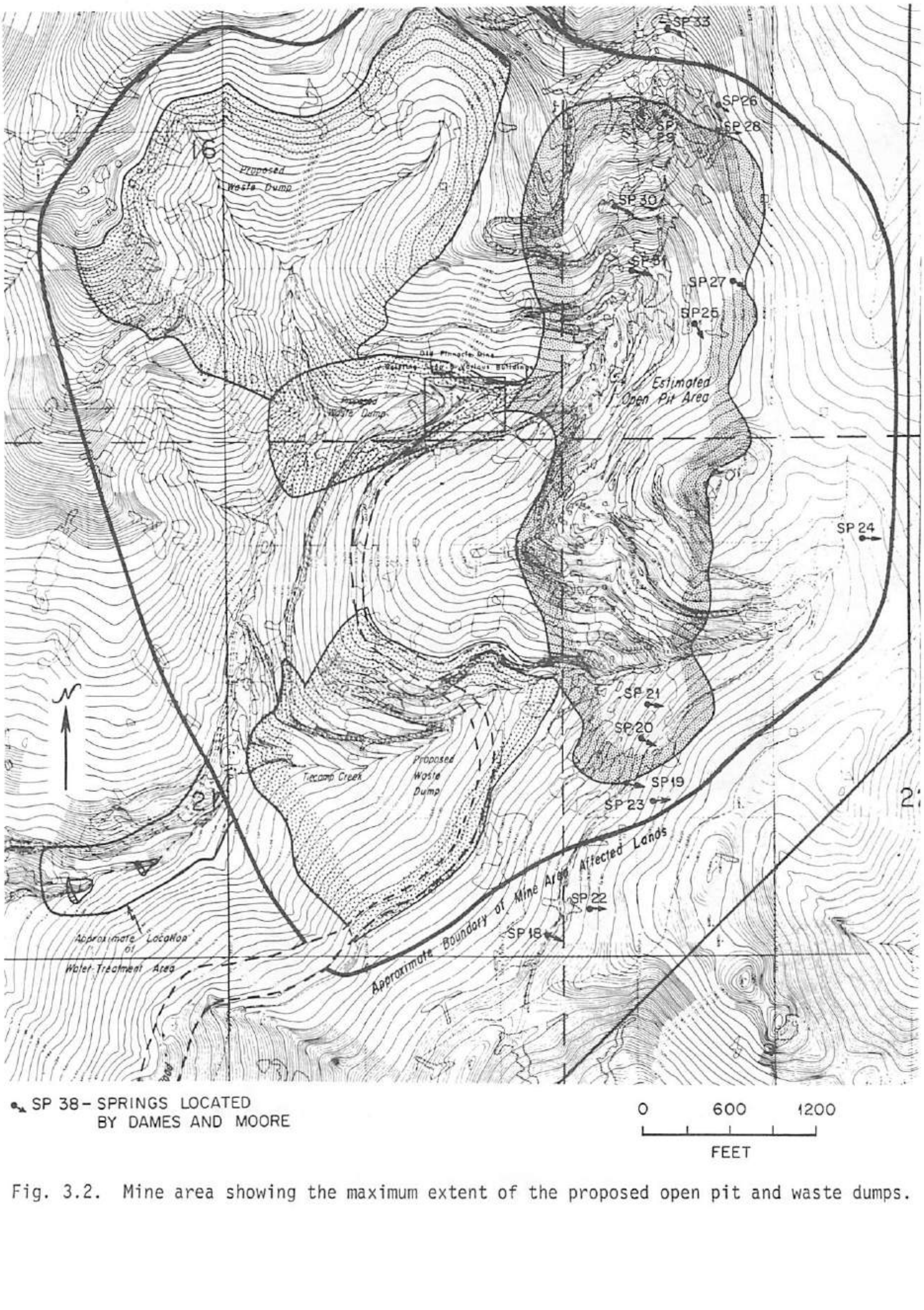

Fig. 3.2. Mine area showing the maximum extent of the proposed open pit and waste dumps.

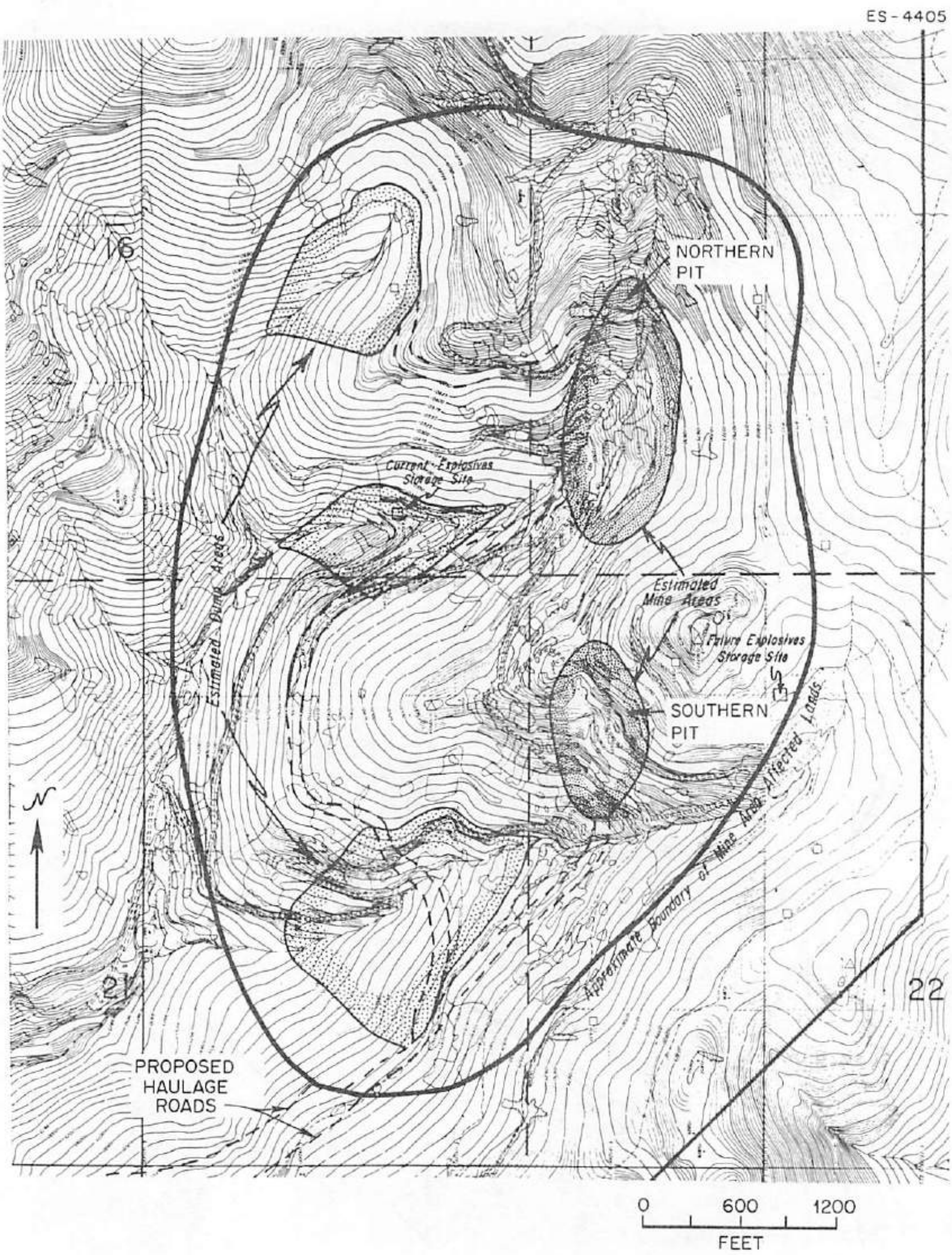

Fig. 3.3. Mine area during the initial 1.5- to 2-year construction period.

ES-4406

Fig. 3.4. Mine area, operational years 1 through 5.

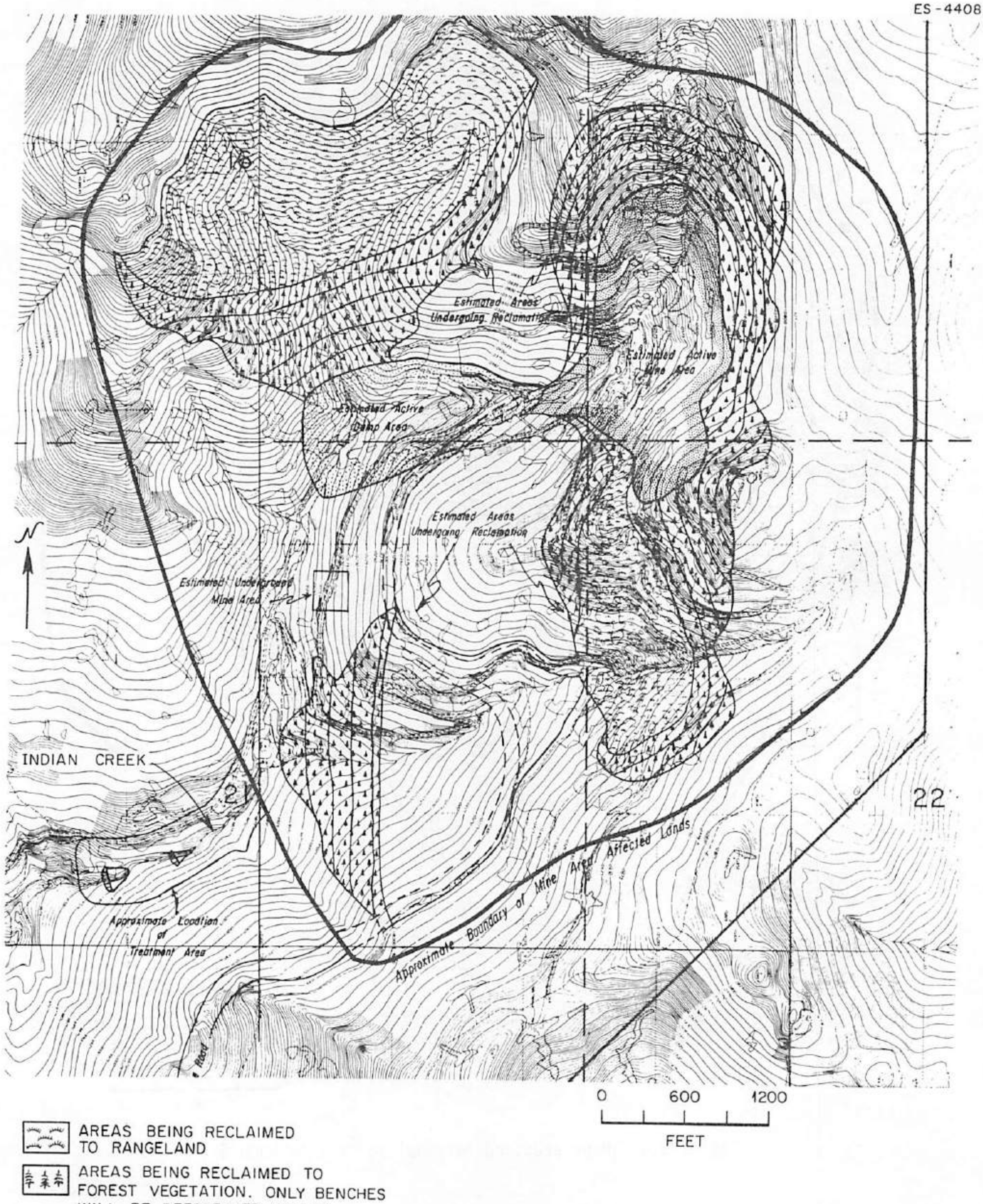

Fig. 3.5. Mine area, operational years 6 through 20.

ES-4418

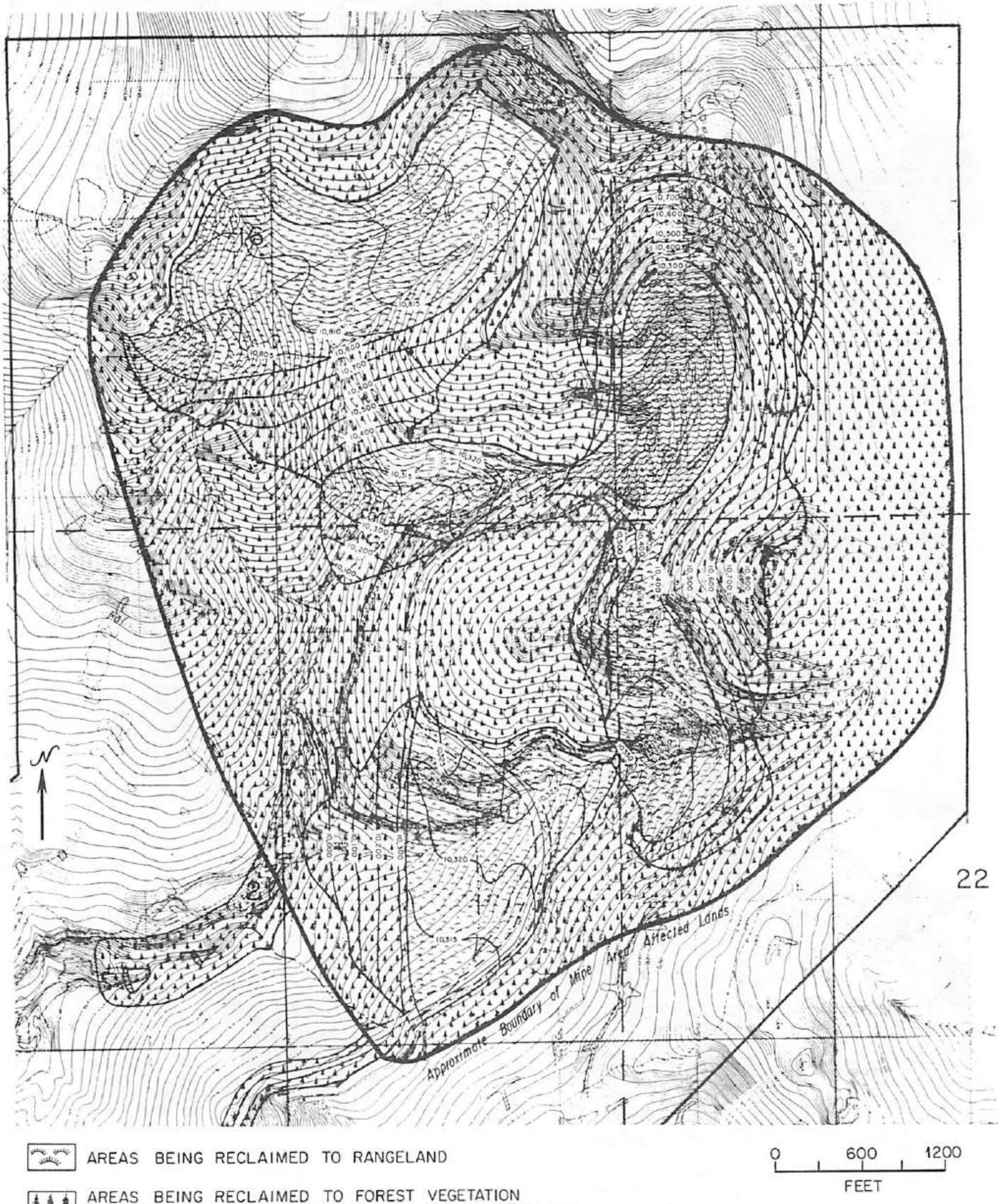

Fig. 3.6. Mine area, operational years 21 through 25.

ES-4404

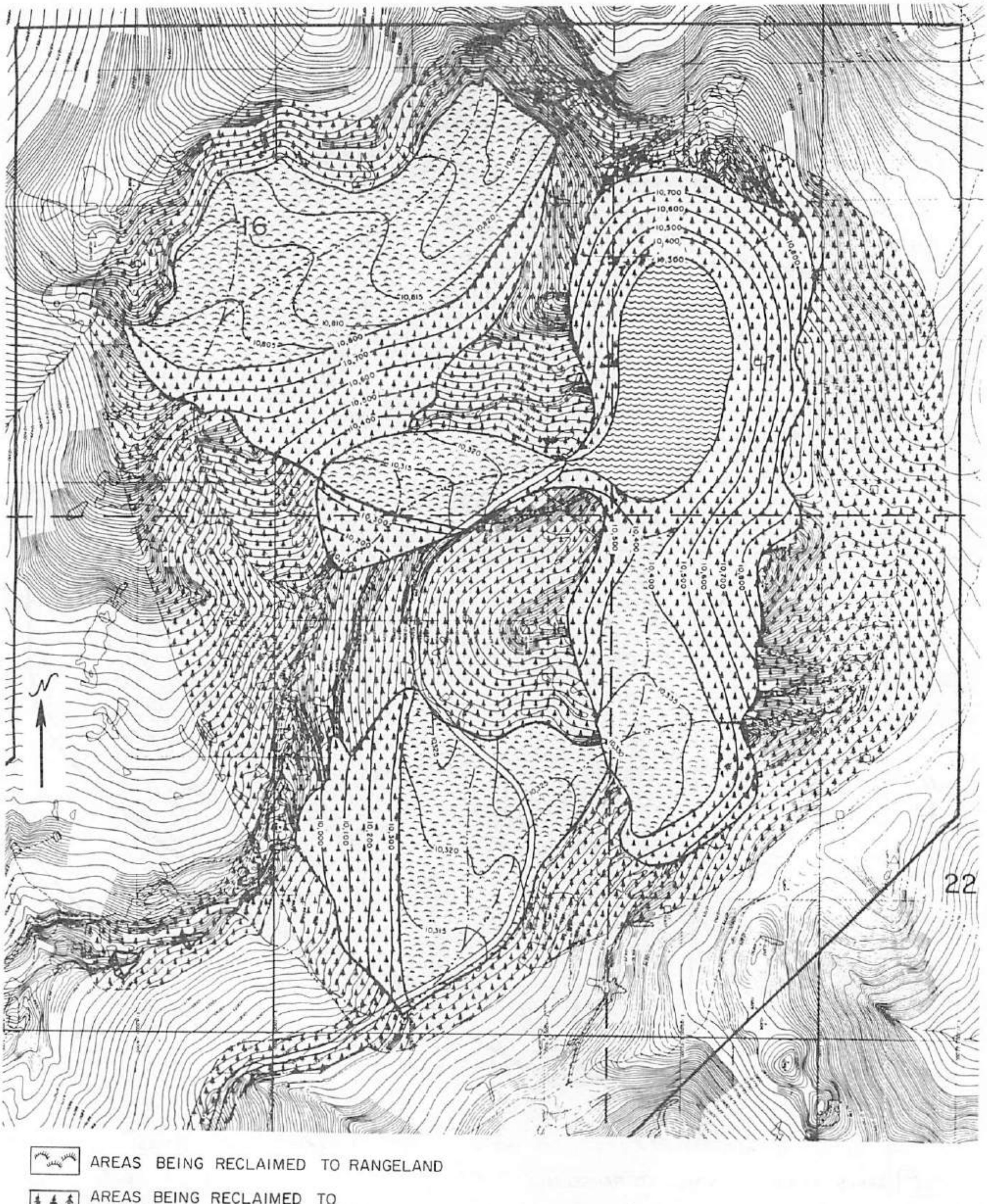

Fig. 3.7. Reclamation plan No. 1, showing ultimate contours of land surface.

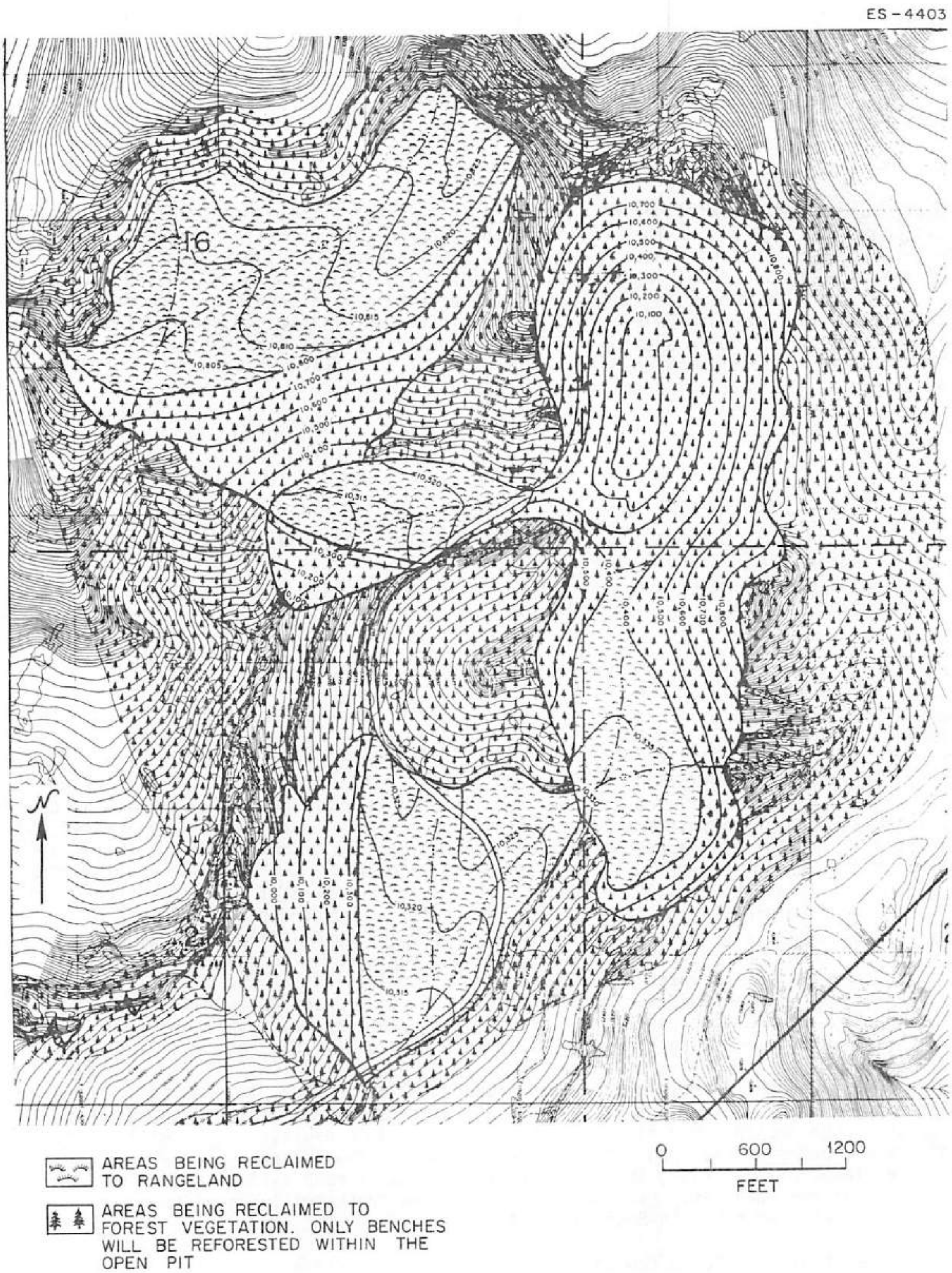

Fig. 3.8. Reclamation plan No. 1, showing ultimate con..urs of the land surface without a lake in the open pit.

Homestake plans to mine from mid-May through November only. However, if practical, Homestake may continue mining operations during the winter months.

Before the mill is constructed, Homestake will mine and stockpile approximately 136,000 metric tons (150,000 tons) of ore. Some of this ore will be shipped for processing elsewhere, and the remainder will be used for ore-grade blending when milling begins. Blending of different ore grades and lithology is necessary because the mill will operate most efficiently when processing ore with a predetermined average grade and composition.

Premilling overburden removal will begin in the vicinity of the northern and southern ends of the proposed open pit (Fig. 3.3). The ore in the northern pit is generally a higher grade than the ore in the southern pit, and mining the two pits simultaneously should simplify ore blending when milling commences. As mining progresses (Fig. 3.4), the northern and southern pits will merge. Ore bodies in the walls and floor of the pit that are accessible by short pit-wall adits will be mined out. The ore below the ultimate pit bottom will be removed by underground mining methods using an adit or a shaft. If the northern part of the open pit is still being mined after the southern part is mined-out, overburden will be backfilled into the southern pit rather than dumped at the waste disposal sites (Figs. 3.5 and 3.6).

3.1.2.3 Overburden removal

Soil

Homestake considers that, in general, the topsoil at the mine and at waste dump sites is too thin to justify segregation. However, whenever encountered in recoverable thickness on workable slopes, topsoil will be segregated and used for reclamation purposes; otherwise it will be disposed of with overburden at the waste dumps.

Rock

Overburden will be stripped with hydraulic shovels and off-highway haulage trucks. Operating widths for open pit cuts will average 61 m (200 ft). The cuts will begin at the natural surface and progress downward in 6- to 12-m (20- to 40-ft) benches (vertically) to the vicinity of the ore zone. Crawler-mounted dozers will develop ramp systems to new benches as the size of the open pit increases. The ramps will be widened until large rotary drills can be positioned over solid rock to drill blast hole patterns for overburden shooting. The holes will be drilled to a depth of about 14 m (45 ft) at approximately 9-m (28-ft) centers. The drills use 10-in.-diam tricone bits. Multiple-row patterns will be used to obtain a shovel working width on the mine bench below. All dry blast holes will be loaded with a blasting agent of ammonium nitrate and fuel oil. The powder column will be detonated by cast boosters suspended on downlines of reinforced detonating cord and the blasting sequence controlled by millisecond delay connectors to minimize ground vibrations and flyrock. After men and equipment are cleared to a safe distance, the blast will be initiated by detonating an electric blasting cap taped to a trunk line of blasting cord. Large boulders from the blast will require secondary blasting with an air-track drill and portable compressor. The short, small-diameter holes will be loaded with cartridge water-gel slurry blasting agents and detonated from a safe distance away.

Two electric shovels and one large, rubber-tired loader will be required to meet the production requirements of 3.4×10^6 m^3 (4.5×10^6 bank yd^3) per year. Small excavation equipment will also be used when needed. Six-tired, off-highway, rear-dump haulage trucks will be used to transport overburden from the open pit to the waste dumps. The loaded haulage trucks will leave the shovel face, proceed along the mine benches to a major ramp system, and then be driven to the rim of the open pit. From the pit's edge, the trucks will travel to one of three waste dump sites, described in Sect. 3.1.2.4.

Homestake estimates that 8 to 20 ha (20 to 50 acres) will be cleared at the mine site during the 18-month to two-year construction phase (Fig. 3.3) and 4 to 6 ha (10 to 15 acres) cleared each year thereafter until the entire mine site is cleared.

As indicated in Fig. 3.1, the eastern wall of the open pit will have a 30 to 40° slope, and the western wall will have a 45° slope (Figs. 3.7 and 3.8). Preliminary slope stability studies conducted for the applicant (ER, Appendix B) indicate that these slopes will be satisfactory. The slope will be lessened, however, if geotechnical monitoring indicates a stability problem.

A pit wall stability program will be instituted and maintained during the operation of the open pits. This program will consist of keeping permanent records, including survey controls to monitor excessive hydrostatic pressures, and any other factors that may endanger mine personnel.

3.1.2.4 Overburden disposal

The proposed waste dump sites will cover an area of 87 ha (216 acres) west of the open pit mine (Fig. 3.2). Over the estimated 11-year pit life, disposal of 33 x 10^6 m^3 (43 x 10^6 bank yd^3) of intact overburden and ore-zone associated rock will be required. Should a 35% volume increase result from excavation, the material will occupy 45 x 10^6 m^3 (59 x 10^6 loose yd^3) of dump space.

Three dumps will be established by clearing timber at an elevation of about 3146 m (10,320 ft) west of the open pit mine. The sites will include truck probe towers and parking areas for cars and equipment.

Roads will be constructed to the northernmost dump in 2- or 3-bench intervals. The dumps will be constructed in lifts of 24 to 73 m (80 to 240 ft), with the top of each lift coinciding with a road from the mine. Each lift will be started at the point closest to the mine, and the top of the lift will progress outward with an upgrade slope of about 0.5 to 1%. The final contours of the northern dump will have 6- to 15-m (20- to 50-ft) terraces (Fig. 3.7). Trucks coming from the mine will travel to the edge of the dump, turn, and deposit their loads down the slope. Crawler and rubber-tired dozers will maintain the dumping area to provide turning room for trucks and to reduce truck tire cuts. The material in the dump will tend to segregate according to size as it falls down the side of the dump slope. Coarser particles will tumble to the bottom and form underdrains in the natural drainages.

The other two dumps will be constructed in a single lift, with dumping beginning at the point nearest the mine. The top of the dump will extend outward with an upward slope of about 0.5 to 1%. As in the northern dump, coarse particles will tend to fill the natural drainage and form underdrains.

Any overburden containing toxic inorganic materials in concentrations considered harmful to plants (such as pyrite) used for reclamation will be buried at least 6 m (20 ft) below the surface of the dump and away from the underdrains. Much of this material, however, will be mixed with other overburden and disposed of without special burial.

A part of the overburden will be used as construction material for (1) the tailings dam, (2) water storage dam, (3) ore haulage road, (4) the access ramps connecting the various pit levels, and (5) stabilization cover for the tailings. Approximately 0.7 x 10^6 m^3 (0.9 x 10^6 yd^3) will be required to fill the 2316 m (7600 ft) roadway connecting the mine area with the proposed mill site, assuming an average width of 30 m (100 ft), plus a utility corridor paralleling the haulage road. A safety berm will separate the road from the utility corridor. In addition, approximately 0.3 x 10^6 m^3 (0.4 x 10^6 yd^3) of fill will be required for the initial 4- to 6-year dam.

During construction of the dumps, 8 to 20 ha (20 to 50 acres) will be cleared (Fig. 3.3), with 4 to 10 ha (10 to 25 acres) cleared each year thereafter until the dumps reach the anticipated size of 87 ha (216 acres) (Fig. 3.2).

3.1.2.5 Ore zone mining, loading, and transport

Most of the ore will be ripped with a crawler-mounted tractor prior to excavation. Each pass of the tractor will rip to a depth of about 0.6 m (2 ft) with an average spacing of approximately 0.6 m (2 ft). The ore will then be loaded by front-end loaders and transported to the mill in off-highway haulage trucks. Backhoes will be used for specialized excavation, such as steeply dipping deposits below grade and excavating in-pit ditches to control groundwater that is entering the lower open pit.

The air-track drill and portable compressor used for secondary blasting will be used to drill ore probe holes in a closely spaced grid. Hole depths will vary from 12 to 15 m (40 to 50 ft) with a diameter of 6.3 to 7.6 cm (2.5 to 3 in.) to allow the passage of a probe for a scintillometer gamma count. Approximately 2000 holes will be required annually. Spot chemical analyses will determine the chemical equilibrium of the uranium.

Because most rock at the mine site is abundantly jointed, it will probably be rippable by either single direction or cross-ripping; however, some light blasting may be required for intact sandstone and limestone. Probe men will walk through the ripper troughs and radiometrically probe for uranium content. Ore zones identified by the probe men will be flagged for excavation.

A rubber-tired front-end loader and a hydraulic-powered backhoe will be used in ore zone excavation. These machines, in tandem with the ripping dozers, will enable mining in highly selective cuts approximately 0.6 m (2 ft) deep. A fleet of six trucks of 35-ton capacity will be used for ore and in-pit waste haulage.

Trucks loaded with ore zone material will stop at a truck scanning station adjacent to the pit exit. The tower may be equipped with several heads, each probing the gamma radiation from the material in the haulage trucks. An accumulative 30-sec reading would be counted automatically to determine the uranium content. The operator of the probe tower will then convert the count into percent uranium, record the data, and direct the trucks to one of several destinations by turning on the appropriate signal light. (Alternative methods may be used.)

Truckloads with less than 0.02% uranium will be dispatched to the overburden dumps. Trucks carrying low-grade ore, between 0.020 and 0.049% uranium, will be directed to one of several surface stockpiles near the mill for later blending. All other trucks (those carrying ore greater than 0.05% uranium) will be directed to one of several ore stockpiles adjacent to the mill. Stockpiles with various ranges of uranium content will be maintained at the mill so that ore grade control can be achieved during mill production.

Underground mining

Although detailed underground mining plans have not been finalized by the applicant because of a lack of deep drilling, tentative plans are presented, based on drilling to date and past experience from underground mining operations in this area.

Several ore deposits that can be mined by underground methods occur adjacent to the expected ultimate pit walls and below the ultimate pit floor. The ore bodies vary in size and shape and are within nearly flat-lying to steeply dipping rock. Because of these characteristics, trackless mining methods are tentatively planned.

Access to the ore deposits in the pit walls will be through small drifts driven into the walls at a slight uphill grade for water drainage. Access to the ore deposits below the pit floor will be through a decline drift beginning west of the pit or through a small shaft in the bottom of the pit. Various stoping methods are envisioned, depending on the dip, size, and shape of the ore body.

Flat-lying ore bodies will be mined by room-and-pillar methods. As the dip increases, stoping will start by driving drifts at an oblique angle to the strike of the rock to control the operating grades within the capabilities of small load-haul-dump units and underground haulage trucks to operate. Once these development headings have reached the maximum extent of the stoping area, the pillars will be recovered according to the roof conditions. Based on previous underground mining operations in this area, substantial roof supports will be needed to prevent collapsing. The mining will continue, on a retreating basis, from the maximum extremities of the stope towards the main haulage opening. The mines will use air legs and compressors for drilling and blasting prior to excavation.

The more steeply dipping deposits may be mined by square set or cut-and-fill stoping methods. The major difference between this method and adit mining is the way the ore will be transported out of the mine. After breaking, the ore will be slushed to chutes for transfer to the haulage drift of gravity. A sill pillar, which will be left between the haulage level and the bottom level of the stope to maintain stability in the haulage drift throughout the stope life, will permit maximum extraction of ore.

Underground mines will be ventilated with fans installed on ventilation shafts, raises, and bore holes. Active stopes and the farthest underground workings will be ventilated with booster fans and ventilation tubing.

3.1.3 Reclamation procedures

A detailed reclamation plan has been submitted to the MLRB and will be amended over time. The following description of reclamation procedures covers the disturbed land areas for the Homestake Mining Company Pitch Project. The goal for reclamation of disturbed lands is to return the land to its present use, that is, livestock grazing and wildlife habitat. Short-term reclamation will center on the immediate reduction and prevention of the erosion of (1) overburden piles, (2) topsoil storage areas, (3) mill tailings, (4) road cuts, and (5) downstream dam faces. Also included will be reclaiming areas for staging, storage, and diversion channels. Long-term reclamation will be the reestablishment of approximately all of the existing natural vegetation mix (e.g., trees, shrubs, forbs, grass, etc.) on all disturbed areas. (See Appendices J and K.)

Slopes of waste dumps and benches within the open pit will be reforested. The flat areas of waste dumps will be revegetated to rangeland. A lake covering about 12 ha (29 acres) may form in the northern portion of the pit. (The southern section will be partially backfilled with overburden and waste from the north pit). If the lake does not form, then this area will be reforested as the rest of the pit.

Reclamation at the millsite will return this area to rangeland. The mill buildings will be removed, but the main access road and about one-half of the width of the haul road may remain to provide access to the area, as determined by the FS. Stabilization, reclamation, and control of the tailings area will be accomplished in accordance with regulations in effect at the time stabilization is implemented.

3.1.3.1 Grading

Disturbed land within the project area will be graded to blend with the surrounding topography. Overburden dumps will be compacted by heavy equipment during dump construction. Final slopes of the dump faces will be between one and one-half to one and two to one.

Overall slopes within the pit will remain at the angle used during operations. These will generally be about 1:1, except where rock conditions would justify steeper slopes.

The stabilized surface of the tailings disposal area will be contoured to receive runoff from Hale Gulch and to discharge it through a concrete saddle (on the southeast side of the facility) over a concrete spillway. The elevation of the tailings dam is higher than the stabilized tailings surface to prevent erosion of the dam that could be caused by runoff from major storms. The final slope of the stabilized surface will be about 1:500.

Final topography in other disturbed areas will not be significantly different from the original topography. In the water storage area, the dams will be flattened so that they will no longer collect water. The mill site will consist of a series of relatively level areas with steeper slopes between them. All areas will be graded to a slope where erosion will be controlled.

3.1.3.2 Soil cover

Studies sponsored by the applicant indicate that "soils" suitable as a plant growth medium are available onsite in areas other than the mine and waste dump sites. Topsoil or parent material, which will be removed and segregated for use in reclamation where practicable, will be placed over the mill site, road cuts, tailings, and other disturbed areas. Fertilizer will be applied where needed.

The information described in Sect. 2.6 will be used to identify suitable top dressings to be stockpiled for use in reclamation. Topsoil stockpiles will be seeded and/or mulched to reduce erosion.

Topsoil segregated in the mine area is not expected to contribute measurably to the reclamation effort. Dumps and benches within the pit will be covered with a mixture of overburden containing fines to promote root growth and sufficient coarse material to control erosion.

Overburden will be spread over the benches within the open pit. About 30 cm (12 in.) of broken overburden will be sufficient to sustain tree growth on the benches within the pit. Below this depth the tree roots will follow fractures in the rock.

The open pit mining operations will remove virtually all radioactive materials from the pit. At the conclusion of mining operations, any areas in the pit bottom that have significant quantities of radioactive matter will be covered with approximately 6 m (20 ft) of nonradioactive overburden. This cover will prevent water in the lake (if it forms) from contacting this material directly and leaching significant amounts of radionuclides. Final design of such cover will be approved by the FS and the State of Colorado at the time of reclamation.

The tailings disposal area, when graded to the final contours, will be covered with compacted clay. This clay cap will be approximately 0.6 m (2 ft) thick over the sand portion of the tailings (47% of the surface area) and approximately 1 m (4 ft) thick over the slime portion (53% of the surface area). Approximately 346,000 yd^3 of clay will be required for this cap. The clay cap will be tied into the clay core of the dam and the clay lining the basin. The clay for this cap may come from a number of sources. There are several large deposits of clay located within the project area that Homestake hopes to use for stabilization and other purposes, but which have not been fully identified or evaluated. A considerable quantity of clay will also be available from the water storage reservoir sites for stabilization of the tailings. In addition, there are several commercial sources of clay near the project area, including one on Marshall Creek. Commercial sources of clay will be utilized to the extent necessary should the development of onsite clays be insufficient for project needs. The adequacy of this design and potential alternatives are discussed in Sect. 10.

When the clay cap is complete over the pile, it will be buried under 2 m (5 ft) of mine overburden. Approximately 560,000 yd^3 of overburden will be required for this layer. The overburden cover material will be stockpiled at one of the dumps in the mine area until needed. Care will be taken to ensure that this overburden contains no radioactive, low-pH, or other material toxic to plant growth. Approximately 23 cm (9 in.) of topsoil from the site will be placed over the overburden layer.

3.1.3.3 Revegetation

Generally, a forest cover will be established on sloping disturbed areas and grass cover on more level disturbed areas. Research will be conducted during the life of the project to ensure that revegetation efforts will produce the desired results.

Disturbed areas south of the mill site and the tops of dumps in the mine area will be revegetated to grass. These areas, with the exception of the area covered by tailings, will be seeded with the following mixture: orchard grass, 25%; timothy, 25%; mountain brome, 20%; intermediate wheatgrass, 20%; and white clover, 10%. This mixture will be broadcast by hand at the rate of 13 to 17 kg/ha (12 to 15 lb/acre). Areas subject to excessive drying will be mulched with straw, woodchips, or chemical mulches to hold moisture. Fertilizer will be added where it is necessary to achieve lasting plant growth. Fertilizer application will alternate between 336 kg/ha (300 lb/acre) annually, containing 12%, respectively, of nitrogen and phosphorous, and 202 kg/ha (180 lb/acre) annually, containing 33.3% nitrogen. (This procedure will be used in general on disturbed areas, for example, road cuts and staging areas.)

The area covered by tailings will be revegetated with grasses and forbs that are shallow rooted and have a low uptake of heavy metals. One combination will consist of winter wheatgrass, 18%; Kentucky bluegrass, 18%; perennial rye, 18%; brome, 18%; orchardgrass, 18%; and alsike clover, 10%. Once planted, this area will receive the same fertilizer and mulch treatment as discussed for other revegetated areas.

Revegetation in the mine area and haulage road corridor will be designed to reestablish forest vegetation. Lodgepole pine will be the primary species planted, interspersed with some Engelmann spruce in shady areas. The grass mixture proposed for the mine area and haulage road corridor will be seeded in areas between the trees to control erosion and to provide ground cover until the forest becomes established. Trees will be planted by hand, at the rate of about 283 per ha (700 per acre). Potted or balled seedlings will be utilized, and these areas will be fertilized and mulched as discussed above. Seedlings will be watered by a watering truck during the dry seasons of the year.

An ongoing program for vegetation maintenance will monitor success of revegetation efforts. Areas where seedlings do not grow, or are only thinly established, will be replanted.

Revegetated areas will be monitored closely for soil erosion. Where erosion occurs, steps, such as mulching, replacement of topsoil, and reseeding, will be taken to prevent or stop soil movement. Monitoring will continue until vegetation is clearly established.

3.1.3.4 Reclamation schedule

A reclamation schedule for disturbed land by mining time period is presented in Table 3.1.

Table 3.1. Estimated surface area disturbed and reclaimed during Homestake Mining Company Pitch Project operations by mining period and activity

Activity	Area per specified mining period											
	1–2 years		1–5 years		6–10 years		11–15 years		16–20 years		21–25 years	
	ha	acres	ha	acres	ha	acres	ha	acres	ha	acres	ha	acres
Access road	34	83	34	83	9	21	9	21	9	21	9	21
Tailings area[a]	55	137	58	143	60	149	70	163	70	174	70	174
Water storage	13	33	13	33	12	30	12	30	12	30	12	30
Mill and mine buildings	15	37	15	37	15	37	15	37	15	37	15	37
Haulage roads	16	40	16	40	9	22	9	22	9	22		
Mine	187	461	303	748	303	748	303	748	303	748		
Settling ponds	6	16	6	16	6	16	6	16	6	16		
Gross disturbed	327	807	445	1100	414	1023	420	1037	424	1048	106	262
Reclaimed			38	94					318	786	106	262

[a]The tailings impoundment covers 28 ha (69 acres) that will not be available for productive use after reclamation under existing regulations.

3.1.4 Deleterious overburden and control measures

Chemical analyses of overburden from the proposed open pit have shown only minor problems to exist relative to using this overburden as a subsoil at the dump (Supplemental Report to the ER, April 1977). Inorganic constituents detrimental to vegetation will be identified during core drilling analysis. When mined, the material will either be buried at least 6 m (20 ft) below the dump surface or be mixed with other overburden and disposed of without special buri The disposal method used must meet the requirements of the Mined Land Reclamation Board's Development and Extraction Mining Permit.

3.1.5 Surface-water drainage control

Diversion ditches will be constructed to divert surface runoff around the pit during the early stages of mining. The ultimate pit, however, will not have ditches surrounding it because the mine site is so close to the drainage divide that little runoff could be intercepted.

The volume of water stored in the vicinity of the mine is not known but is believed to be small. Based on limited investigations of the groundwater regime at the mine site, the applicant estimates that 0.72 to 1.9 m^3/min (190 to 500 gpm) may enter the open pit. According to present plans, this water will be collected in ponds and then used in the mill circuit, or it may be treated, if necessary, and used for dust control and/or reclamation or released under NPDES permit requirements.

At the waste dumps, coarse overburden will segregate to fill the natural drainages and form underdrains at the base of the dumps. Otherwise, runoff will not be diverted around the dumps except where needed during the initial stages of construction.

A treatment pond will be constructed in the drainage below the waste dumps (Fig. 3.2). The pond is designed to contain runoff from a 25-year, 24-hr precipitation event.

The pond is designed to provide 7.7 x 10^4 m^3 (62.4 acre-ft) retention volume, including flood containment for a 25-year, 24-hr precipitation event [4.8 x 10^4 m^3 (39 acre-ft)], 2.1 x 10^4 m^3 (18.8 acre-ft) sediment storage, and 8.1 x 10^3 m^3 (6.6 acre-ft) to provide sediment settling time.

3.1.6 Roads

The haulage road from the mine to the mill has not yet been surveyed but is expected to follow the route shown in Fig. 3.3. Sixteen hectares (40 acres), the equivalent of a corridor 91 m (300 ft) wide by 1707 m (5600 ft) long, have been designated by the applicant as the affected area. The haulage road will be partially constructed with mine overburden and designed with reasonable grades and cut and fill slopes to minimize erosion. Ditches will be constructed where the road follows cut banks and culverts installed to prevent large quantities of water from collecting. Discharge points from culverts will be riprapped to reduce erosion, while cut banks and fill banks will be revegetated as soon as construction is complete. Road design and construction practices must be approved by the FS.

Haulage roads in and between the open pit and the waste dumps (Fig. 3.3) will be constructed with mine overburden. To reduce dust and wind erosion, all haulage roads will be sprinkled with water periodically. The source of this water may be from the mine dewatering system.

3.1.7 Personnel

A maximum of 136 people will be required for the entire mining operation, if one assumes that 35-ton-capacity trucks are used for ore haulage. Manpower requirements include the following: (1) mine equipment operators, (2) shop maintenance personnel, (3) pit supervisors, and (4) professional staff to plan and supervise all open pit mining operations. Administrative positions related to payroll, accounting, personnel, and/or purchasing will probably be filled by the administrative staff at the mill.

Year-round ore zone mining will be attempted; however, if severe weather makes this impractical, ore zone mining crews will work at ore mining during the milder weather from about mid-May through November, possibly on a three-shift-per-day, five- or six-day-per-week schedule. During the winter, idled ore zone miners will be used for overburden removal on a three-shift-per-day, seven-day-per-week schedule. Any extra manpower during the winter months will be used for snow removal and/or in the mine shop on an "as-required" basis. No seasonal layoffs are expected.

3.1.8 Support facilities

3.1.8.1 Maintenance

A shop will be constructed to repair, service, and maintain the mobile equipment. The shop will have offices for pit and shop supervisors. It will also include repair bays for servicing large mobile equipment. Very large pit equipment that cannot be transported easily to the shop will be repaired in the open pit by field repair crews.

Related shops, such as welding, electrical, component rebuilding, and machining, will also be housed in the shop building. Warehousing space will also be a part of the shop to store repair parts and to house some of the operating supplies for the open pit mine.

3.1.8.2 Water supply

Drinking water and other potable water will be available at the mine office site, the maintenance shop, and the assembly area for open pit personnel. The water will be supplied by the freshwater system from the mill site and delivered through a small-diameter pipe to a holding tank. Additional water cans for the mine employees will be distributed throughout the active mine areas. This water will meet all State and Federal standards.

Industrial water required in the open pit mining operation will probably be supplied by the dewatering system for the mining area. A standpipe will be constructed to fill the water truck [30-m^3 (8000-gal capacity)] that will sprinkle the haulage roads when necessary to reduce dust from pit traffic. Dust control will represent the largest single use of water by the pit department.

3.1.8.3 Electrical power supply

The maximum electrical power requirement at the mine will be the electric shovel and rotary drill. It is expected that power will be purchased from the Gunnison County Electric Association, Inc., and supplied to the project site from a new power company substation to be located on private land about 2.4 km (1.5 miles) NNE of Sargents. The power will be transmitted from the substation to the site by a 25-kV underground line following U.S. Highway 50 and the Marshall Creek Road. At the site, a 12-kV transmission line will be constructed along the main haulage roads from the mill to the mine. This transmission line will extend around the ultimate pit scarp, approximately 91 m (300 ft) from the pit's edge. Substations will be installed to step down voltage to 4160 volts. Several radial lines will be constructed into the active pit and terminate at 5.0-kV, oil-submerged switch boxes. From there, power will be delivered to the electric shovel and drill by all-weather, reinforced, three-conductor trailing cables. Portable lights will supplement the electrical system during nighttime work.

3.1.8.4 Diesel fuel storage

A bulk storage tank will be built for storing diesel fuel required for the open pit operation. Other large tanks will be constructed for bulk storage of engine oil, transmission oil, hydraulic fluid, and engine coolants. All storage tanks will be designed, constructed, maintained, and monitored in accordance with applicable regulations and will be contained within an earth embankment. The specific location of the storage tanks has not yet been determined.

3.1.8.5 Sanitary facilities

Permanent sanitary treatment facilities will be provided at the shop-warehouse complex. Portable chemical toilets will be provided for personnel at the mine site. The toilets will be periodically collected, emptied, and washed. The sewage will then be treated in the maintenance shop's septic tank and discharged to the tailings pond or to a leach field. These facilities must be approved by the Colorado Department of Health.

Solid waste such as trash, rags, and supply containers will be collected throughout the operating area and buried at the overburden waste dumps. The disposal site has been approved by Saguache County with the issuance of a Certificate of Designation dated September 1, 1977.

3.1.8.6 Powder magazines

Powder magazines will be stored in remote areas shielded by topographic highs. Most blasting will be with ammonium nitrate and fuel oil (ANFO), and two 60-ton storage bins will be used to feed the ANFO pumping truck. One powder magazine will be used to store all electrical blasting caps and millisecond delay connectors. Another powder magazine will store explosives, including cartridge dynamite or slurries, detonating cord, and cast boosters.

The sites selected will be in accordance with the *American Table of Distances*, as revised and approved by the Institute of Makers of Explosives. The chosen sites will be in areas that will minimize the potential danger to personnel in the event of an accidental explosion. A two-way access road will be constructed between the magazine sites and the open pit mine roads. Current plans locate the future powder magazine storage site due east of the open pit (Fig. 3.3).

3.1.9 Proposed mining equipment

Table 3.2 is a basic equipment list. Additional equipment may be required.

Table 3.2. Basic equipment for use at the Homestake open-pit mine

Unit	Capacity	Number required
	Stripping	
Blasthole drill		1
Front-end loader	7 yd	1
Water truck		1
Dozer	400 hp	2
Trucks	35 tons	3
Trucks	75 tons	7
Hydraulic shovel	6½ yd	1
Road grader		2
Front-end loader	12 yd	2
	Mining	
Loader	4 yd	1
Air track drill		2
Trucks	35 tons	3
Dozer	300 hp	1
Dozer	200 hp	1
Backhoe		2
	Service	
Boom truck		1
Forklift		1
Pickup truck		13
Fuel and lube truck		1

3.1.10 Protective measures and fencing

Areas that could be a potential threat to human safety will be designated with appropriate warning signs. In addition, fences will be constructed and maintained around the tailings disposal area. Fences, where needed, will also be constructed for safety purposes or to protect seeded reclamation areas. After operations cease, the stabilized and reclaimed tailings impoundment will be fenced and restricted in accordance with the regulations of the State of Colorado.

3.2 THE MILL

The Homestake Mining Company's proposed Pitch milling operations will consist of a series of unit processes. The ore will be crushed and ground and the resulting particles leached with carbonate to extract the uranium. Leach liquors are then clarified, followed by precipitation with caustic. The resulting sodium diuranate yellow cake slurry is filtered, dried, and packaged for shipment if sufficiently pure. In the event that the sodium content does not meet specifications, the sodium diuranate is redissolved in sulfuric acid and reprecipitated with ammonia as ammonium diuranate. This product is filtered, washed with ammonium sulfate to remove additional sodium, then dried and packaged for shipment.

3.2.1 External appearance of the mill

The building layout, plant perimeter, and security fence locations are shown in Fig. 3.9, and an artist's rendition of the facility is shown in Fig. 3.10. The layout of the plant has been determined by the limited area of suitable flat topography, consideration for efficient materials handling, and consideration for the overall aesthetics of the facility. The various buildings would be largely prefabricated, using colored external panels that will blend with the natural background. The proposed location of the mill has been selected so that it is at least partially screened from the view of the general public by trees and topography along the primary roads. The site is in an isolated location; the closest permanent residents are approximately 8 km (5 miles) away in Sargents.

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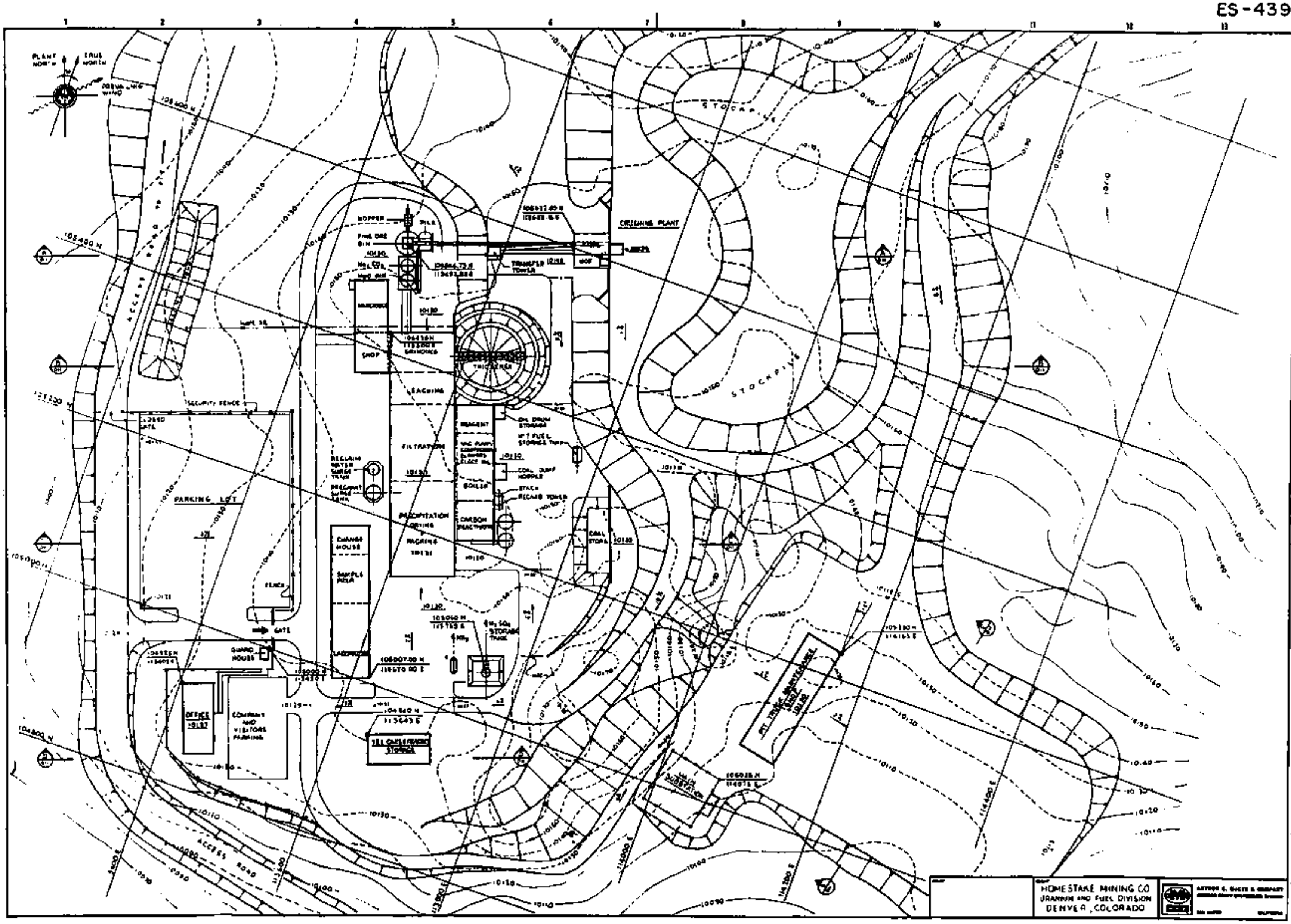

Fig. 3.9. Building layout of the proposed mill. Source: ER, Plate 3.1-1, p. 3-2.

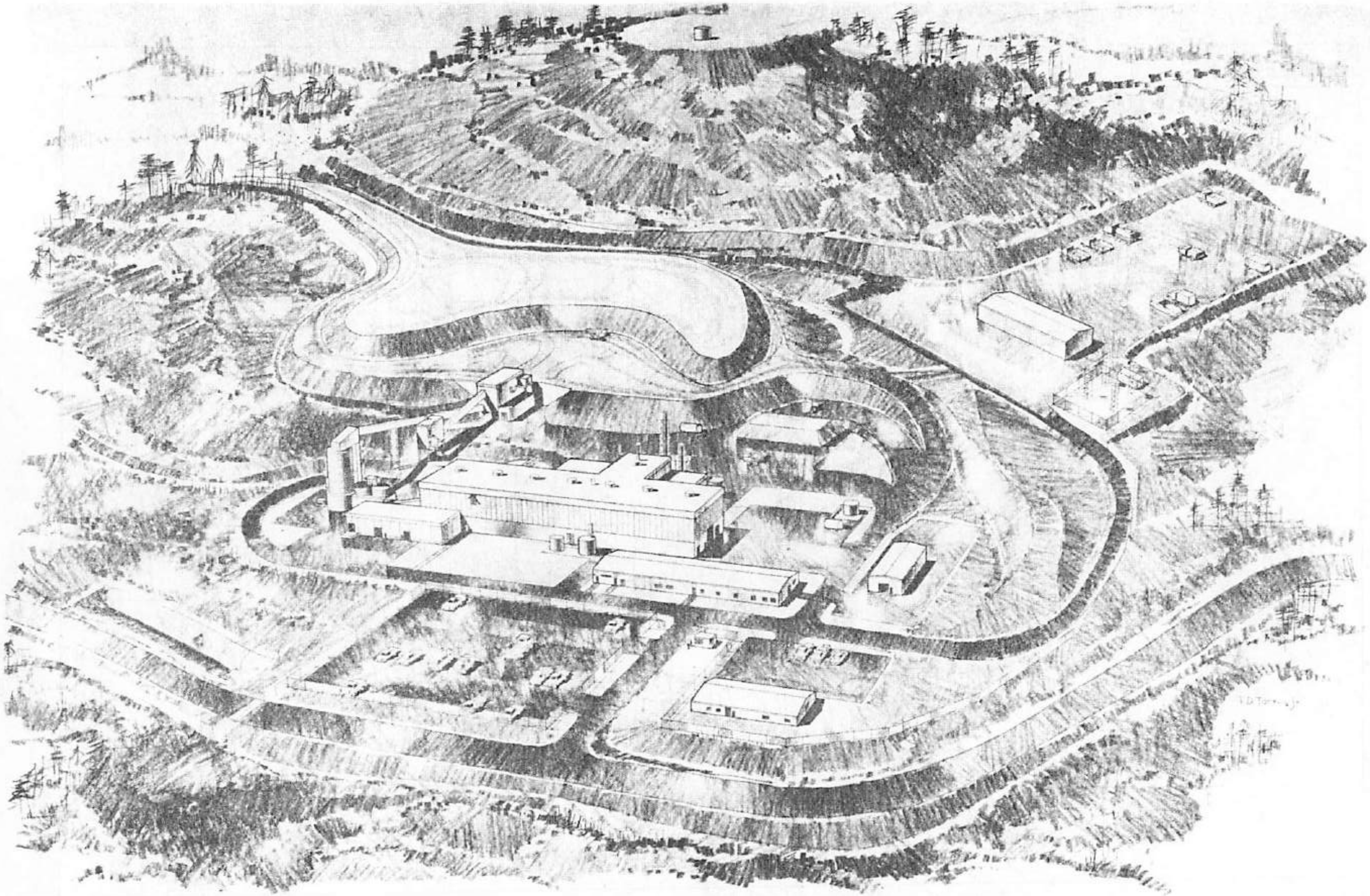

Fig. 3.10. Artist's rendition of the proposed mill. Source: ER, Plate 3.1-2, p. 3-3.

3.2.2 The mill circuit

Yellow cake production is accomplished by a series of hydrometallurgical processing and materials handling steps, including ore storage, crushing, grinding, thickening, carbonate leaching, filtration, clarification, caustic precipitation and purification, drying, and packaging of the yellow cake. Figure 3.11 is a general flow scheme of the proposed mill circuit. Figure 3.12 gives the estimated water balance for the entire project, including mill usage.

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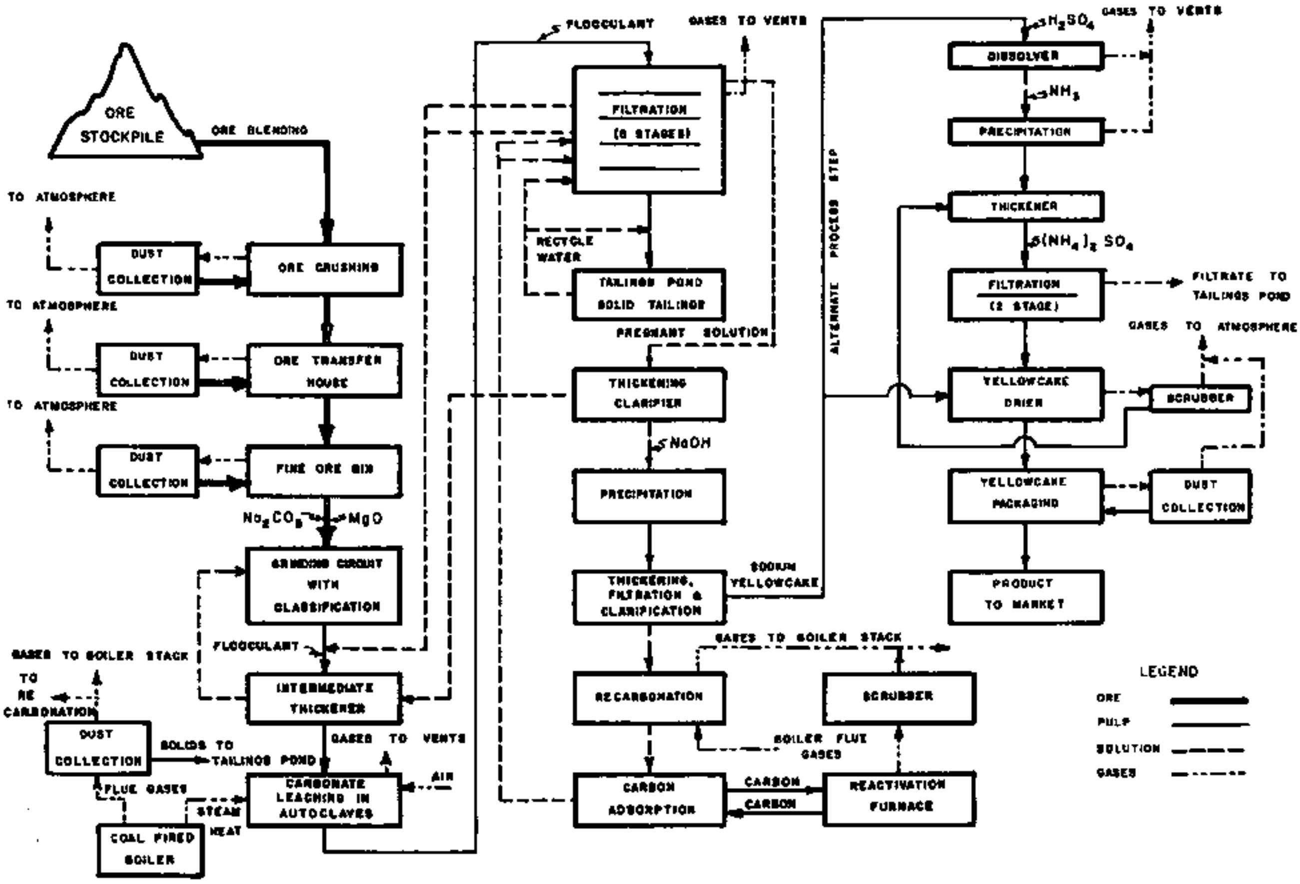

Fig. 3.11. Flow sheet of the proposed mill circuit.

The Pitch Mill will process about 544 metric tons (600 tons) of ore per day. The average U_3O_8 content of the ore is estimated to be about 1.8 kg (4 lb) per ton; thus, approximately 998 kg (2200 lb) of uranium concentrate will be produced daily. During the processing of the ore, sodium carbonate and sodium bicarbonate (Na_2CO_3 and $NaHCO_3$), 2037 m^3/day (536,000 gal/day) of water, and various quantities of polymeric flocculents, sodium hydroxide, sulfuric acid, ammonia, and ammonium sulfate will be used and largely recycled.

The ore from the open pit mining operation will be stored at the mine and mill sites, where it will be segregated according to uranium grade and lithologic characteristics. The uranium grade will be determined by a selective radiometric measuring system. Maximum extraction of uranium from the raw ore will require blending of the different grades of ore according to their metallurgical characteristics. Two-stage crushing will reduce the ore to below 19 mm (0.75 in.) in size. The two-stage wet grinding circuit will expose the uranium minerals in small-sized particles (nearly 100% to minus 48 mesh to the leach solutions). The ball mill will operate in a closed circuit with a classifier, using an aqueous grinding solution containing both sodium carbonate and sodium bicarbonate that have been recycled from the intermediate thickener. Additional sodium carbonate and magnesium oxide will also be added to the grinding

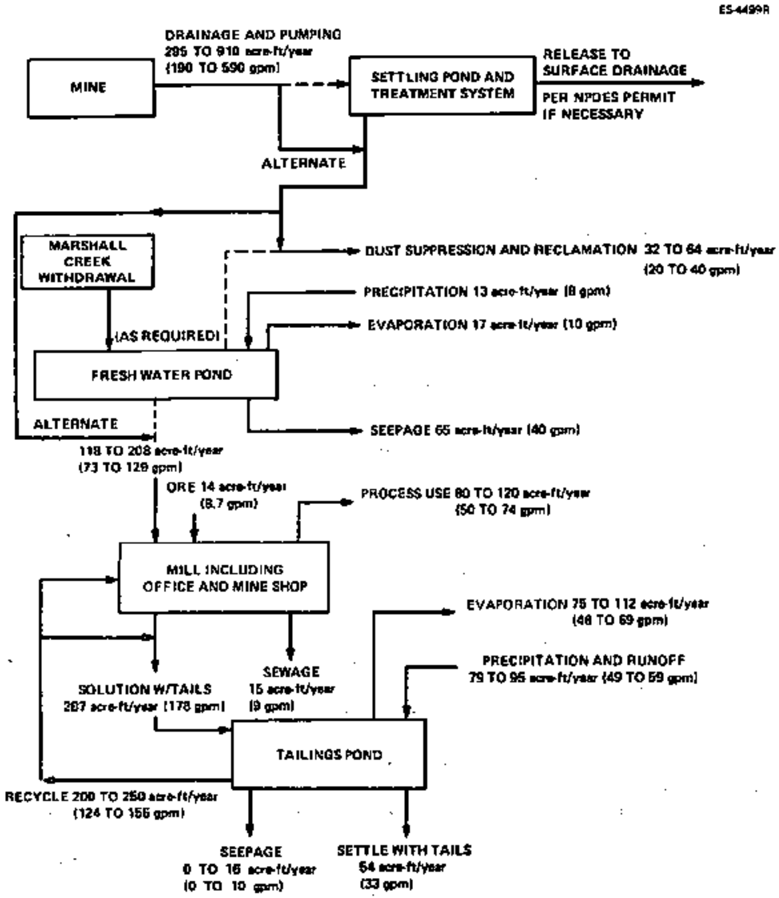

Fig. 3.12. Estimated water balance for Pitch Project.

circuit. Classifier oversize will remain in the grinding circuit until it is ground to the desired size. The thickener will provide a product of 50% solids for leaching in a series of ten agitated autoclave vessels that use heat and compressed air to aid the leaching process. The combination of heat [60 to 91°C (140 to 195°F) as required by different ore types], oxygen, and leaching solution (about 45 g of Na_2CO_3 per liter and 15 g of $NaHCO_3$ per liter) will dissolve most of the uranium in the ore.

Slurry from the leach circuit will be subjected to a five-stage vacuum filtration circuit to separate the barren waste solids from the pregnant (uranium-bearing) leaching solutions. Filtrate from the first stage will become pregnant solution and will go to the clarification and precipitation sections. Filtrate from the second and third stages will be recycled back to the intermediate thickener and reused in leaching. Recarbonated barren solution will be used for wash solution in the third and fourth stages. Recycle solution from the tailings pond will be used for wash and repulping solution on the last stage. The repulped filter cake will be barren tailings and will be piped to the tailings pond for disposal. The pregnant liquor from the first stage filtration will be clarified in a thickener and sand clarifier, with the thickener underflow pumped back into the intermediate thickener and the clarified pregnant solution going to storage and precipitation.

Precipitation of a relatively pure sodium diuranate yellow cake product will be accomplished by the addition of sodium hydroxide to the hot, pregnant solution. If the yellow cake purity is satisfactory after thickening, filtration, and clarification, the product will be sent directly to the drying and packaging section. However, if better product quality is required, the sodium diuranate will be sent to the purification section. The clarified barren solution from the sodium hydroxide precipitation stage will be recarbonated with stack gases from the coal-fired boiler. An activated carbon circuit will be utilized to remove small concentrations of solubilized organics from the recarbonated barren solution prior to returning it to the filtration circuit. The organics are adsorbed onto activated carbon as the solution passes through carbon-packed vessels. The carbon-treated barren solution is then recycled back to the third and fourth wash stages of the filtration circuit.

After the activated carbon becomes loaded with organic material, it will be thermally reactivated in a regeneration furnace where the adsorbed organics will be volatilized and oxidized and the activated carbon returned to a condition favorable for further organic adsorption. The reactivated carbon will be recycled back into the adsorption vessels, and the furnace gases will be treated in a wet scrubber and combined with the boiler stack gases.

If required, the impure yellow cake will be repulped and pumped to an agitated tank where sulfuric acid will be added to redissolve the uranium. Ammonia gas will then be added to the pregnant acid solution to precipitate ammonium diuranate. The reprecipitated yellow cake will be thickened and then filtered and washed with ammonium sulfate solution, resulting in additional sodium removal from the yellow cake. Purified uranium concentrate will be sent to the drying and packaging section, and filtrate from the $(NH_4)_2SO_4$ washing stage will be discharged to the tailings pond. The ammonium or sodium diuranate filter cake will be fed to an oil-fired, multiple-hearth furnace, where it will be dried at 371 to 593°C (700 to 1100°F). The dried cake (2% moisture) will be packaged in 55-gal steel drums for shipment. The entire drying, storage, and packaging operation will be in an isolated, enclosed area with negative air pressure to prevent fugitive dust emissions. The drier gases will be evacuated by a fan through a wet scrubber that will remove particles for return to the uranium yellow cake thickeners. The packaging area emissions will be evacuated by a fan through a fabric bag filter to recover all particulates possible.

3.2.3 Nonradioactive mill wastes and effluents

3.2.3.1 Gaseous effluents

Several nonradioactive vapors will be released to the atmosphere during the processing of the ore. The leaching process will release air, water vapor, and, possibly, a small amount of carbon dioxide. Gaseous effluents from filtration and clarification will be similar to those encountered over the leaching circuit. A small amount of water vapor and ammonia will be exhausted from the yellow cake precipitation and purification stages. The primary gaseous effluent from the tailings pond (water vapor) will be evaporated at a rate determined by pond area, wind velocity, relative humidity, ambient temperature, and the season of the year. Stack gases from the furnace drying operation will be the largest source of gaseous effluent from the precipitation, purification, and drying stages.

The dryer will consume 0.02 m^3/hr (4.0 gph) of No. 2 fuel oil (<1% sulfur), producing a gaseous effluent containing nitrogen, carbon dioxide, water vapor, sulfur oxides (SO_x), nitrogen oxides (NO_x) as well as ammonia from decomposition of yellow cake. The applicant estimates SO_x production for this same gaseous effluent at approximately 2 kg/hr (4.5 lb/hr), as indicated in the ER, p. 6-24. Based on 8.6 kg of NO_x per cubic meter of fuel oil burned (72 lb of NO_x per 1000 gal of fuel oil burned),[1] the NO_x production is estimated to be 0.13 kg/hr (0.29 lb/hr). The volume of the stack gas during the drying operation is estimated to be 17 m^3/min (600 cfm) (ER, p. 3-18).

The carbon reactivation furnace will consume 0.07 m^3/hr (18 gph) of fuel oil. Sulfur oxide and nitrous oxide production by this source is approximately 1.2 kg/hr (2.6 lb/hr) or less and 0.6 kg/hr (1.3 lb/hr), respectively. The off-gas will also contain nitrogen, carbon dioxide, water vapor, and organic compounds. This gas will be combined with the boiler exhaust gases.

The main process steam and building heat boiler will consume 22.7 metric tons (25 tons) per day of coal (≤0.5% sulfur) (ER Suppl., p. 3-37). The applicant estimates the SO_2 production to be less than 11.4 kg/hr (25 lb/hr) or 272 kg/day (600 lb/day). Based on 10 kg of NO_x per metric ton of coal burned (20 lb of NO_x per ton of coal burned),[1] the NO_x production is estimated to be 4.5 kg/hr (21 lb/hr) or 227 kg/day (500 lb/day). The volume of the stack gas from this operation is estimated to be 375 m^3/min (13,250 ft^3/min), given in the ER, p. 3-37.

A standby oil-fired boiler will be installed to provide process heat when maintenance is required on the coal-fired boiler. When in use, this boiler will consume 0.5 m^3 (125 gph) of No. 2 fuel oil and produce 359 m^3/min (12,670 ft^3/min) of combustion gases (ER, p. 3-38). The combustion gases would consist of nitrogen, carbon dioxide, water vapor, sulfur dioxide (8.2 kg/hr or 18 lb/hr), and nitrogen oxides (4.1 kg/hr or 9 lb/hr).

Each gaseous effluent source in the milling process will be controlled, as appropriate, to meet State and Federal emissions and air quality standards. Control measures are discussed in Sects. 3.2.4.1 and 3.2.5.

3.2.3.2 Liquid effluents

Nonradioactive liquid wastes from the milling process will be impounded in the mill tailings pond. Spills and natural runoff from the mill site and ore stockpiles will be collected by dikes and berms around the mill and diverted to the tailings pond. Sanitary liquid wastes will be released to either a sanitary leach field (Sect. 3.2.5) or the mill tailings pond. The estimated chemical composition of the tailings pond liquid is shown in Table 3.3.

Table 3.3. Expected chemical composition of tailings pond water

Component	Expected concentration
	(g/liter)
CO_3	15.2
HCO_3	0.5
SO_4	56.5
Chlorine	3.0
U_3O_8	0.05
Sodium	39.4
	(ppm)
Ammonia	60
Selenium	0.8
Molybdenum	65.0
Vanadium	40.0
Arsenic	3.2
Cadmium	0.2
Copper	1.0
Lead	1.0
pH	9.0

Source: Homestake Mining Company, *Environmental Report, Pitch Project, Saguache County, Colorado* (revised version of Sects. 3.0–3.5, November 1977), Project M-5, October 1976.

3.2.3.3 Solid effluents

Solid wastes will be generated in both particulate and bulk form. Coal boiler ash and ore dust are the main particulate wastes. Ore dust is largely comprised of inert materials (i.e., silicates, calcite, quartz, etc.), but it also contains low concentrations of naturally occurring radioactive elements (i.e., uranium, thorium, radium, etc.). Therefore, ore dust is considered a radioactive effluent and is discussed in Sect. 3.3. This ash consists of the inorganic mineral constituents of the coal. The applicant estimates the ash production rate to be under 2.3 metric tons (2.5 tons) per day (ER, p. 3-38). Both fly ash and bottom ash will be produced. The bottom ash and most of the fly ash will be impounded in the mill tailings pond. The portion of the fly ash that escapes the baghouse filter (Sect. 3.2.4) will be released to the atmosphere. The emissions from this source will be below the emission limits set by the State of Colorado.

Bulk wastes consist of industrial wastes produced by milling and maintenance operations. These wastes will be comprised of trash, wood, rags, and supply containers. Bulk waste disposal is discussed in Sect. 3.2.5.

3.2.4 Control of mill waste and effluent

3.2.4.1 Gaseous effluents

Several nonradioactive gaseous effluents must be controlled throughout the process. Any gaseous effluent from the ore-grinding section can be controlled by a simple roof vent over the grinding area. The leaching vessels will all be enclosed and vented to the atmosphere. Nontoxic gases from the filtration and clarification circuits and the precipitation and purification stages will be collected and vented to the atmosphere. Further, all tanks in the precipitation and purification stages will be enclosed with direct vents to the atmosphere.

The gaseous effluent from the carbon reactivation furnace and after-burner will consist of water vapor, carbon dioxide, and a small amount of sulfur dioxide. These gases are a result of the combustion products of 0.07 m^3/hr (18 gph) of oil, organic materials absorbed on the activated carbon, and a small amount of oxidized carbon. After wet scrubbing, these gases will be combined with the boiler flue gases for discharge.

The gaseous effluents from the yellow cake drying and packaging stages will consist of the combustion products from the 0.02 m^3/hr (4.0 gph) oil-fired furnace. These combustion products will be treated in the wet scrubber installed on the drier to collect the yellow cake dust losses.

Sulfur oxides control at the Pitch mill will be accomplished through the use of low-sulfur fuels. Calculations by the applicant show that the proposed mill will meet existing State and Federal standards for sulfur dioxide emissions and air quality (ER, p. 3-37). Sulfur dioxide removal by alkaline scrubbing in the recarbonation tower and scrubbers serving the yellow cake dryer and carbon reactivation furnace will result in reduced emissions from these sources.

3.2.4.2 Liquid effluents

Liquid effluents other than the tailings pond water include precipitation runoff from the ore stockpile area that will be collected with berms and ditches and diverted to the tailings pond. All liquid spillage and solid wastes from the ore grinding and leaching sections, along with the filtration and clarification circuits, will be collected and returned to the process. The precipitation and purification stages will produce no liquid effluents. Approximately 8 m^3/day (2200 gpd) of ammonium sulfate wash solution will be discharged to the tailings pond and join the tailings recycle solution. The tailings disposal pipeline and the water recycle return line are also designed so that any fluid loss will drain to the tailings impoundment.

The tailings disposal area will be monitored for emissions. A major part of the exposed tailings surface will be covered by a pond of recycled slurry water. Pond levels will fluctuate with evaporation and precipitation and will be controlled by regulating flows of return water and makeup water. The tailings disposal dam will be constructed with a clay core to minimize seepage through the dam structure. The design of the tailings pond (Sect. 3.3.7) will ensure that 4.5×10^6 metric tons (5×10^6 tons) of tailings can be retained in a clay-lined impoundment. This retention requires adequate dam structure stability, surface flooding protection, and overtopping protection. Final dam design must be approved by all cognizant agencies and construction methods will be inspected. Monitor wells will be located below the pond and will be sampled periodically to detect and control seepage. If seepage is detected in quantities sufficient to cause water quality degradation in Indian and Marshall creeks, provisions would be made to intercept the seepage and return it to the tailings pond. To intercept potential seepage, a trench across Hale Gulch downstream from the tailings embankment will be constructed. The trench will extend through the alluvium and at least 0.6 m (2 ft) into the underlying tuff. A perforated pipe, 15 cm (6 in.) in diameter, will be placed in the bottom of the trench. The trench will be backfilled with free-draining sand and gravel. At the low point of the trench, a sump will be constructed and a pump capable of pumping water to the tailings reservoir will be installed.

The water that collects in the sump will be sampled regularly. If the water quality deteriorates below an applicable standard, it will be pumped into the tailings reservoir. Water from the tailings reservoir will be pumped to the mill as required.

3.2.4.3 Solid effluents

Solid emission from the ore stockpile area should not be a severe problem. The moisture contained in the ore plus the natural precipitation in the area should help keep the surface of the ore pile moist and reduce the dusting problem. The operational monitoring program (Sect. 6.1) will determine whether additional measures such as periodic sprinkling of the ore pile surface will be necessary.

Hoods with fans will be provided in the crushing plant to collect dust. The discharge from the fans will go through a dry bag-type dust collector that should produce solid emissions of less than 0.12×10^{-3} kg per cubic meter of stack emission (0.73×10^{-5} lb per cubic foot).[2] Collected solids will be returned to the mill circuit.

Emission of fly ash from the coal-fired boiler will be controlled by a "bag house" fabric filter to satisfy State of Colorado air quality airborne particulate regulations. The collected fly ash and bottom ash will be slurried with water and impounded in the tailings pond.

3.2.5 Sanitary and other mill waste systems

Other nonradioactive wastes generated from mill operations will include (1) wastes from sanitary and laundry facilities, (2) ashes and emissions from combustion of coal, (3) industrial solid wastes, (4) laboratory wastes, and (5) vehicular emissions.

The mill, laboratory, and office buildings will all have toilet facilities. These facilities will all drain to a septic tank that will drain either into the tailings pond or to a leach field. All showers and washing sinks will discharge into the tailings pond.

Coveralls will be issued to all employees required to work in the yellow cake product areas or to perform maintenance on equipment from these areas. These coveralls will be laundered in facilities maintained at the mill. All liquid effluent from these laundry facilities will be returned to the mill process circuit to recover any uranium present.

The mill facilities will include an analytical laboratory in which samples of mined ore, process streams, and final products will be analyzed routinely to ensure adequate quality control and plant operating efficiency. The laboratory fume hood will collect air and mixed chemical fumes for dilution and discharge through a stack to the atmosphere. These gases will contain nonradioactive chemicals, including HCl, NO_2, and H_2O. The volume of gaseous fumes emitted from the laboratory operation will be quite small and, by appropriate dilution in the collection stack with air eductors, will be at concentrations low enough to meet Colorado air quality regulations.

Liquid wastes will include some analytical chemicals and wash water used in normal laboratory procedures. Solid effluents will consist of ore sample rejects and sample preparation dust collector products. All liquid wastes from the laboratory, including chemical sink drains, will be sent directly to the tailings pond. The dust collection hood and fan in the sample preparation area will divert the airborne particulate wastes through a bag-type filter. All solids collected in the filters and solid ore reject material will be routed back into the mill process circuit.

Industrial solid wastes such as trash, wood, rags, and supply containers will be collected in containers located throughout the mill and deposited and buried in a 0.4-ha (1-acre) landfill disposal site. This disposal site will be located in one of the mine waste dumps. The landfill site will meet public health requirements, and any necessary permits for the facility will be obtained.

Some gaseous emissions will occur from gasoline-powered vehicular units utilized around the mill yard. All pollution control equipment installed by the manufacturers will be maintained in good condition during the life of the vehicles. A diesel-powered standby generator will be utilized at the mill during electrical failures. These units will be inspected frequently and kept in good operating condition to ensure good fuel combustion. Periodically, a piece of mine equipment, such as a motor patrol or dozer, will be utilized at the mill site for cleanup, ore pile maintenance, snow removal, or road maintenance. Such vehicles will also be kept in good operating condition.

3.3 RADIOACTIVE EFFLUENTS

Mining and milling of natural uranium result in the release of some radioactivity to the environment. Uranium-238 and its radioactive daughter products in the ore are the most significant sources of radiation. The ore at the Homestake Mining Company Pitch Project will contain an average of approximately 0.2% uranium (measured as U_3O_8). Ore of this grade has an activity of about 515 μCi of uranium-238 per ton of ore. The total combined alpha and beta activity from the uranium and its daughters is about 7200 μCi/ton.[3] The activity from uranium-235 is only 1/20th that of uranium-238 and may be ignored.

Mining and milling processes offer several pathways for release of radioactive effluents to the environment (Fig. 3.13). The proposed mine and mill are designed to minimize the releases through these pathways. In the following sections each potential effluent source is discussed, and estimates of effluent releases based on operating data from other similar facilities[4-38] will be presented. The parameters used in preparing the following estimates are defined in Sect. 3.3.9.

3.3.1 Radioactive liquid waste

The proposed mill circuit will not discharge any radioactive liquid effluent to surface drainages. However, liquid wastes may seep from the tailings pond into the local groundwater system. This effect is discussed in Sect. 3.3.7.

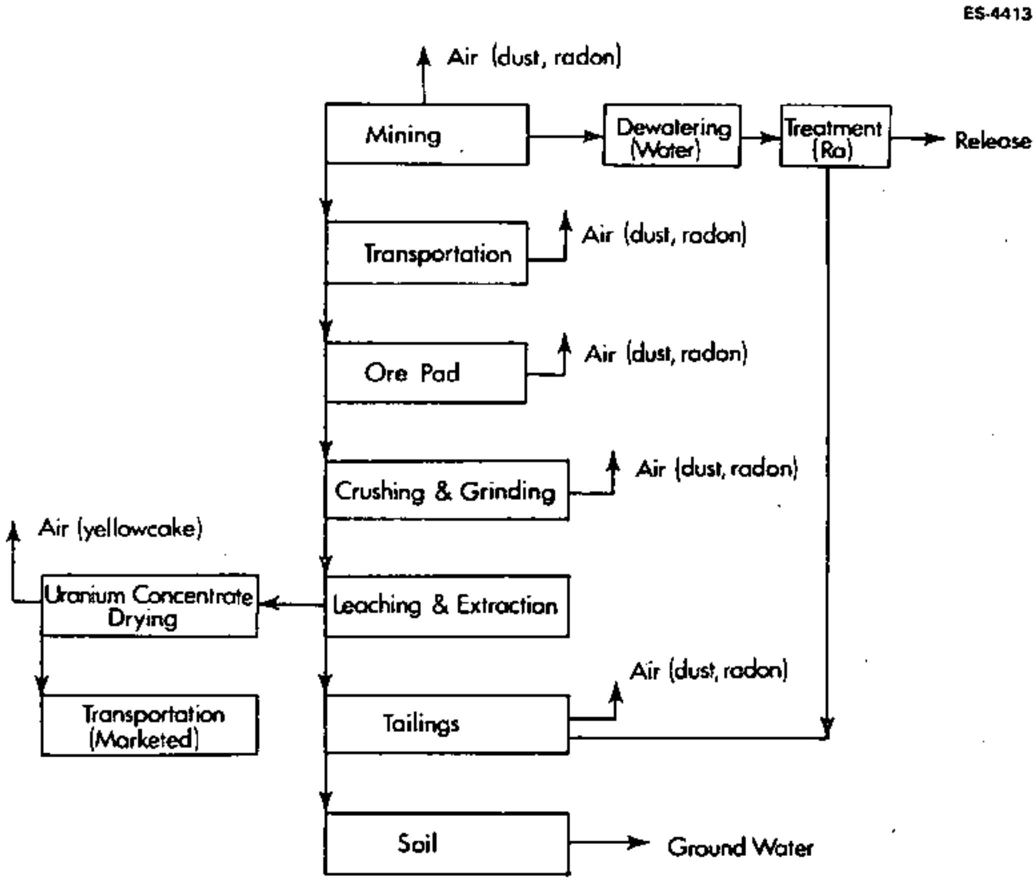

Fig. 3.13. Radionuclide dispersion via pathways relevant to Homestake Mining Pitch Project activities. Source: U.S. Nuclear Regulatory Commission, Draft Environmental Statement Related to Operation of Bear Creek Project, Docket No. 40-8452, January 1977, Fig. 3.16.

Liquids produced by mine dewatering during initial construction activities will be collected in holding ponds and, if necessary, discharged to the Indian Creek drainage under NPDES Permit CO-0022756 (Saguache County). Once mill operations begin, some mine water would be diverted to the mill for use in the milling process. This water would then be sent to the tailings area for disposal. In either case, the liquid waste volume due to mine dewatering will be small because the groundwater in the area of the mines is scarce.

Runoff from overburden piles may also contain quantities of radioactive materials in the form of uranium, thorium, and radium. Such runoff will be monitored pursuant to the terms of the applicant's NPDES permit. The drainage will be treated, if necessary, in holding ponds to reduce thorium, radium, uranium, and suspended solids to acceptable levels.

Should levels of leached uranium, thorium, radium, or suspended solids exceed applicable terms of the NPDES permit, treatment that could be used to reduce the excess concentrations to acceptable levels would be ion exchange to remove the uranium; sulfate ion and barium chloride addition, followed by settling in ponds to precipitate and separate the radium; and lime addition, followed by settling in ponds or filtration to precipitate and separate the thorium. The settling ponds required to settle the precipitates would be designed large enough to settle other suspended solids. If the need for treatment of such pollutants arises, a specific treatment process will be designed to reduce to acceptable limits the concentrations of the specific elements, ions, or solids present in the liquid.

3.3.2 Radioactive release from the mining operation

Mining operations will remove approximately 192,000 tons of ore and 3.4×10^6 m^3 of intact overburden (4.5×10^6 bank yd^3) per year (ER, p. 3-48). Both ore and overburden will be coarse and will contain sufficient moisture (10-15%) to minimize dusting. The mining operation is not expected to contribute to the emission of radioactive particulates. However, overburden and ore piles will eventually dry out and become subject to wind erosion. Radon-222, a noble gas, is the major radioactive effluent released to the atmosphere by the mining operation. Estimates show (Appendix E) the annual radon-222 release from the mine to be about 55 Ci.

3.3.3 Transportation of ore to mill

The roads at the Pitch Project will be snowpacked, frozen, or muddy for most of the year. However, the roads will be dry and prone to dusting during the summer when most ore transportation will occur. Minor spills of ore from truck beds during transportation will be a source of contamination. Spilled material will be coarse in size and will not be subject to dusting. Vehicle traffic and weathering will eventually break up the ore and mix it into the soil in the road bed. Because of the small amounts of ore involved and the sprinkling of haul roads during dry periods, the release of radioactive particulates to the atmosphere from ore transportation will contribute little to the overall emission of radioactive materials.

3.3.4 Ore pads, feed to mill, and ore grinding

Sufficient ore will be stored adjacent to the mill to allow six months of mill operation. Storage of this quantity is necessary because mining activities will be curtailed during the winter. Ore of different grades will be stored in separate piles to allow later blending and feed to the mill. The ore will be stored on clay pads with a surrounding water collection system to control and minimize potential soil contamination. The installed perimeter ditching will be designed to collect runoff from the piles and direct it to a plastic-lined holding pond. Effluents from the holding pond will be directed to the mill circuit or delivered to the tailings pond.

Radioactive materials will be lost from the piles through radon diffusion and dusting from wind erosion and heavy equipment operation. Within a month after deposition, the concentration of radon-222 will approach secular equilibrium levels. Radon release will occur by diffusion from the pile or by disturbances of the pile by grading or feeding operations. The annual radon-222 release will be approximately 82.4 Ci per year. Operation of front-end loaders and dozers in the ore storage area will generate about 0.7 kg/ha (4 lb/acre) of fugitive dust per hour of operation.[39] Drying of the pile, accompanied by wind erosion, will further increase the radioactive particulate release. It is estimated that these processes will annually release 0.003 Ci of uranium-238 and its daughters (Appendix E). However, most of this particulate matter is expected to be relatively coarse, and so it will be redeposited close to the mill.

Additional releases will occur in the ore crushing unit. Particulates will be produced at conveyor transfer points and in the dry crusher unit. Dust hoods will direct the dust through a wet scrubber designed to reduce the particulate by about 93.6%. The remaining dust will be released to the environment. The approximate annual release from this source is 1×10^{-3} Ci of uranium-238 and its daughters. Crushing and grinding also release additional radon-222 estimated to be 10% of the uranium-238 activity in the ore.[3] As a result, these operations will release approximately 9.8 Ci of radon-222 (Appendix E).

3.3.5 Leaching operation

Leaching is a wet process and will not make any significant contribution to the emission of particulates. The use of autoclaves speeds up the leaching process, reducing the residence time of the ore to under one day. Therefore, radon-222 will not build up to concentrations high enough to give a significant gaseous release.

3.3.6 Uranium concentrate drying and packaging

The mill process will produce uranium in the form of an ammonium or sodium diuranate (yellow cake) slurry. After washing and dewatering by a vacuum filter, the moist yellow cake will be dried at 371 to 593°C (700 to 1100°F). The yellow cake product will contain approximately 93% of the uranium and 2% of the radium initially present in the ore. The largest loss of uranium will be from the yellow cake drying stage. The dryer discharge, together with the oil combustion products, will be subjected to wet scrubbing. Although the scrubber should operate at over 98% efficiency, there will be a small amount [less than 0.04 kg/hr (0.09 lb/hr)] of solid product escaping through the stack. The slurry product containing the "scrubbed" uranium particles will be recycled back to the uranium precipitate thickener. The total dust losses will be approximately 0.025% of the product.[3] Using these assumptions, one could postulate that the average annual releases of uranium-238 and radium-226 and its daughters is 23 mCi and 0.46 mCi respectively (Appendix E).

The yellow cake drum packaging station will be enclosed and hooded. Air will be drawn in through a bag-type dust collection system prior to being exhausted with the stack gases from the drier. The bag-type collector is more efficient than the liquid scrubbers, so the concentrate loss from packaging should be substantially less than in the drying stage. The entire precipitation, purification, drying, and packaging sections will be in an enclosed section within the mill building, having its own air supply and dust collection systems. If bag leaks are observed, the system will be shut down until repairs are completed.

3.3.7 Tailings

The applicant has proposed the construction of a 43-m (142-ft) high earth and rock fill dam. The 408-m (1340-ft) long dam would create an impoundment enclosing 28 ha (69 acres)(Fig. 3.14). The dam would be located in Hale Gulch which, during seasons of high runoff, is a tributary of Marshall Creek. The impoundment area will have a capacity of over 4.5×10^6 metric tons (5×10^6 tons) of tailings while the reservoir will have sufficient capacity to accommodate a probable maximum flood from the total upstream drainage area plus 1.5-m (5-ft) freeboard (ER, Appendix A, Plate 8).

A drainage diversion ditch, located just above the dam crest elevation of 2842 m (9325 ft) will intercept runoff from the upper portion of the Hale Gulch drainage and limit the drainage area of the impoundment area to about 28 ha (69 acres). This interceptor ditch will be isolated from the tailings slurry and water decant pipelines by construction of a culvert where the pipelines and the interceptor ditch cross.[40]

The dam and tailings area will be constructed in stages, with each stage having sufficient capacity for four to six years of operation so that areas are not disturbed until additional capacity is needed. The dam will be constructed with a core of compacted clays and will be raised by use of the centerline method. The bottom of the pond will be stripped of topsoil and will be sealed with a 0.6 m- (2-ft) layer of compacted clay. The topsoil removed by this operation will be stockpiled for future use in reclamation. The top 0.6 m (2 ft) of the exposed natural clays will be worked and recompacted to form the liner. Where excavation is difficult or where the natural clay is thin, offsite clays will be utilized in liner construction. To minimize seepage through the dam, alluvial soils under the dam site will be removed and a cutoff trench excavated so that the core of the dam will be properly keyed to the pond liner.

A transition zone of fine sand, gravel, and mine waste will be constructed on the downstream face of the core. A shell of alluvium, coarse rock, and mine overburden would be completed over the transition zone. The shell would be graded to a 3:1 slope. The upstream face of the core will be initially covered with coarse tailings, creating a slope of 2.5:1. As milling operations proceed, the tailings will begin to fill the impoundment, and the upstream slope will decrease.

The dam will continue to be developed throughout the life of the project. The initial crest elevation of the dam is 2824 m (9265 ft), which is 25 m (82 ft) in height, and the final crest elevation will be 2843 m (9328 ft), which is 43 m (142 ft) in height. As the main dam approaches its final elevation, a smaller dam will be constructed in a saddle (a small depression) along the south edge of the tailings basin. This small dam will also have a crest elevation of 2840 m (9319 ft) but will be only 4 m (12 ft) in height. The dams will be designed to withstand earthquakes and flooding. Final construction plans will be submitted for approval by the appropriate State and Federal agencies before a Radioactive Materials License is issued.

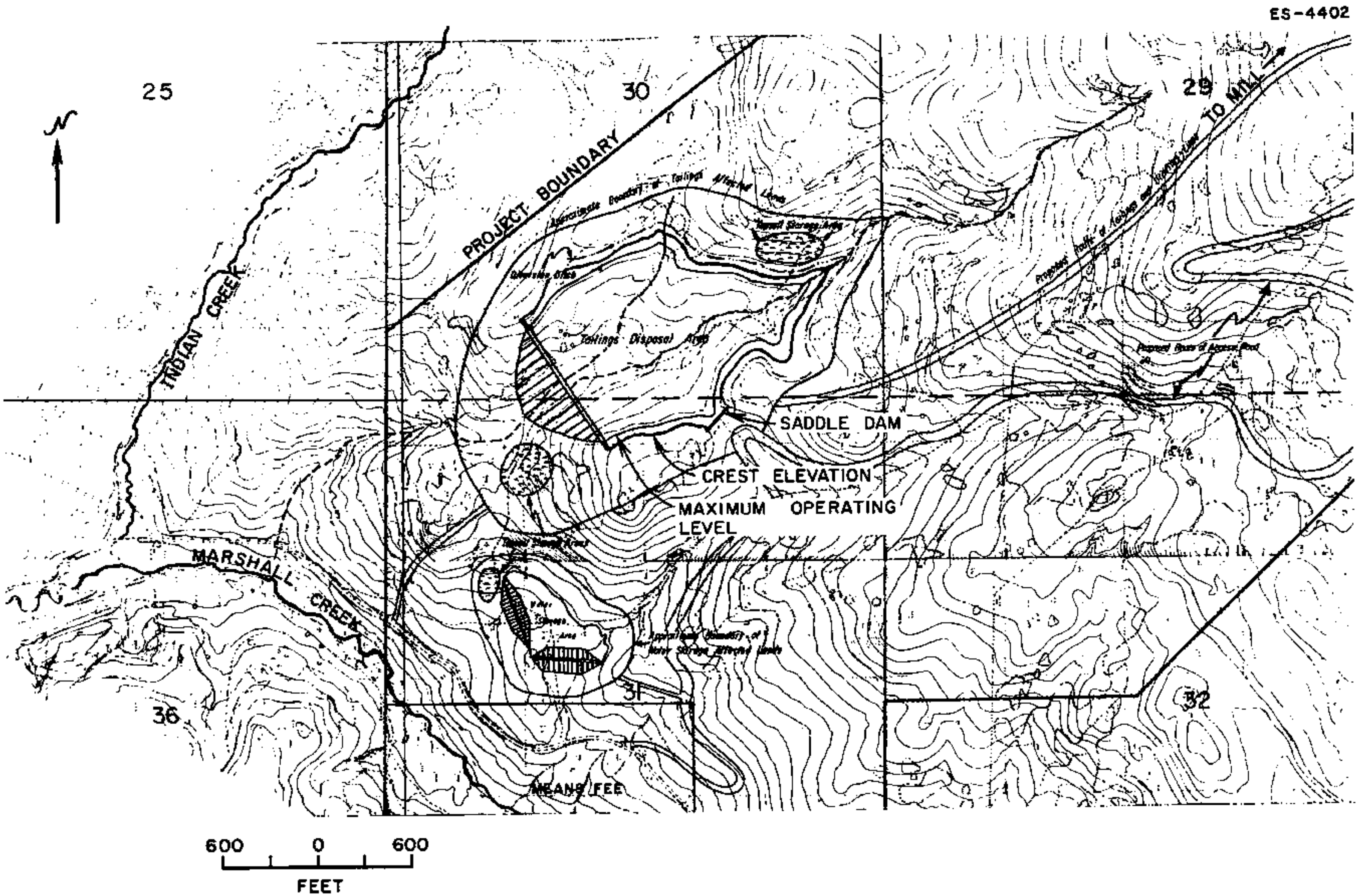

Fig. 3.14. Tailings disposal area and environs.

The construction of the tailings impoundment area over dense bedrock and the use of a clay core in the dam limit the leakage of radioactive liquid wastes from the impoundment. The applicant estimates that at full capacity (25-year dam) and after a possible maximum flood the leakage rates through the dam and pond bottom would be 0.0006 m^3/sec (10 gpm). The migration of radionuclides out of the pond will be retarded by the adsorption and/or ion exchange properties of the bedrock and soil materials. Any seepage through the dam will be collected and pumped back to the tailings pond. Should excessive seepage enter the groundwater system, monitor wells around the impoundment will also be pumped to return the seepage to the tailings pond.

The greatest quantity of waste from the milling operation will be in the form of solid tailings — approximately 544 metric tons (600 tons) daily. These tailings would contain 7% of the uranium-238 and uranium-234, nearly 100% of the thorium-230, and 98% of the radium-226 and its daughters originally present in the ore. This would amount to a total of about 138 Ci of uranium-238 and uranium-234, 7 Ci of uranium-238, 1967 Ci of radium-226 and each daughter after 20 years of mill operation.

The use of water sprays to moisten the tailings beach area will minimize the dust release from the tailings and inhibit radon diffusion. Radon diffusion will be the major radioactive release from the tailings area. Assuming 2 ha (5 acres) of dry tailings and 10 ha (25 acres) of wet beach, one would expect 234 Ci of radon-222, 0.23 mCi of uranium-238 and uranium-234, 3.3 mCi of thorium-230, and 3.2 mCi of radium-226 and daughters to be released annually. Stabilization measures (Sects. 3.4 and 10.4) will greatly reduce the emissions after the cessation of mill operations.

3.3.8 Uranium concentrate transportation

The uranium concentrate will be transported in 0.2-m^3 (55-gal) drums by truck because no rail transportation is available at the site. Uranium shipment, about 1000 drums each year, will result in an external radiation dose[41] to an individual of 2 mR/hr at any edge of the truckbed. Under normal operating conditions, no significant release of radioactive particulates would occur. However, release could occur during transportation accidents as discussed in Sect. 5.3.1.

3.3.9 Source terms

Sections 3.3.1 and 3.3.8 describe the nature and quantity of radioactive effluents expected to be generated by mining and milling operations at the Homestake Mining Company Pitch Project. Estimates employed in the above discussions were derived from project design parameters and data from similar mines and mills.[7-38] The estimates reflect operation of the fully developed mine, mill, and tailings area. Initial releases from the tailings area will be lower than the estimated values for several years after startup. Therefore, the use of full-scale operation as the basis for estimates adds some additional conservatism to the analysis. The proposed treatment systems are acceptable, and the releases appear to be as low as reasonably attainable within state-of-the-art mining and milling operations. Table 3.4 gives the design parameters used in estimates of radioactive release rates. The source terms for the individual mining and milling operations and areas are presented in Table 3.5.

Table 3.4. Principal parameters used in radiological assessment of Homestake Mining Pitch Project

Parameter	Value
Ore grade of U_3O_8, %	0.20
Ore activity of Ra-226, pCi/g	565
Ore activity of Th-230, pCi/g	565
Days of operation per year	320
Ore feed rate, tons/day	600
Total mine area, ha	61
Active mine area, ha	0.4
Total tailings area, ha	23
Tailings pond area, ha	11
Tailings density, g/cm^3	2.0
Fraction of U to tailings	0.07
Fraction of Th to tailings	1.00
Fraction of Ra to tailings	0.98
Ore pad area, ha	2

Table 3.5. Average annual emissions (in curies) resulting from the Homestake Mining Pitch Project active mining and milling operations[a]

Source	Nuclide U-238	Th-230	Rn-222	Ra-226 and daughters
Mine			55	
Ore pad and feeding	3.0E−3[b]	3.0E−3	82.3	3.0E−3
Crushing and grinding	1.0E−3	1.0E−3	9.3	1.0E−3
Yellow cake drying and handling	2.3E−2			4.6E−4
Tailings[c]	2.3E−4	3.3E−3	234	3.2E−3

[a] Releases from stabilized and reclaimed areas are discussed in Sects. 4.8 and 10.4.
[b] Read as 3.0×10^{-3}.
[c] Calculations based on 2 ha of dry tailings, 10 ha of wet beach, and 11 ha of pond.

3.4 STABILIZATION AND DECOMMISSIONING

In accordance with the Colorado Mined Land Reclamation Act of 1976, the FS requirements of 36 CFR Part 252, and the requirements of the NRC (Regulatory Guide 3.8) which have been adopted by the State, the applicant has prepared a stabilization plan for the tailings area (Sect. 10.4). The goal of the applicant's plan is to return the proposed tailings area to uses consistent with the regulations in effect at the time the stabilization is completed. Approximately 261 ha (645 acres) will be reforested, and approximately 206 ha (510 acres) will be revegetated to rangeland. It is anticipated that a lake, covering about 12 ha (29 acres), will form in the northern portion of the pit. If, for any reason, the lake does not form or does not reach the projected size, the area not covered by the lake will be returned to forest vegetation in the manner proposed for the rest of the pit.

Principal land uses in the area are mining, grazing, hunting, and fishing. The applicant's reclamation plan, involving forest vegetation and revegetating rangeland, is consistent with existing land use plans. The revegetation of the mine will provide more acres of forage than presently exist, thus improving the area for wildlife and grazing habitat. Roads constructed by the applicant will provide additional access to the area for outdoor recreation.

As the type of reclamation to be implemented varies with the different areas to have the reclamation specifically suited to the type of disturbance, the types of reclamation for each area are different. The applicant's plan includes a reclamation time table, grading specifications, topsoiling, seeding specifications, and need for fertilization. The final appearance of the area will be rangeland, forest vegetation, and possibly a lake.

The proposed stabilization program calls for the establishment of a clay cap over the tailings impoundment area. The clay will be compacted to form a barrier to radon emanation. This layer would be 0.6 m (2 ft) thick over the sand beach and 1.2 m (4.1 ft) thick over the slimes area, where most of the radium will be concentrated. To ensure the integrity of the clay cap, the final design must consider differential settlement of the tailings and shrinkage of the clay.

The cover would also be graded and sloped at a grade of 0.002 to prevent impoundment of surface runoff. A layer of overburden material 1.5 m (5 ft) in depth will be placed on top of the compacted layer of clay. Finally, 23 cm (9 in.) of topsoil would be placed over the overburden and the surface seeded with grasses and forbs similar to those used in reclamation of road, mine, and mill areas (Sect. 3.1). Grasses and shrubs whose root structures could penetrate the clay cap will not be planted. The approximate volumes of material required would be 265,000 m^3 (346,500 yd^3) of clay, 425,600 m^3 (556,600 yd^3) of overburden and 58,000 m^3 (76,000 yd^3) of topsoil.

Restrictions on land use and human occupancy of the site would be enforced, and monitoring and maintenance programs would be instituted as required by applicable State of Colorado rules and regulations after project termination. Should monitoring or environmental surveys indicate the release or exposure of tailings due to wind or runoff-induced erosion, mitigation and maintenance procedures would be instituted. These procedures would include altering of the embankment slope cover, placement of additional surface cover material, and erection of permanent wind barriers or appropriate regrading and reshaping. Reseeding or other measures would be used to maintain appropriate vegetative cover should the initial seeding and subsequent plant succession fail to establish a suitable cover. An agreement for providing financial surety for such care until stability is demonstrated as well as initial reclamation is required by the regulations of the State of Colorado.

In addition to the reclamation and stabilization plans submitted by the applicant, it is recommended that, as a condition for the issuance of a Radioactive Materials License by the Colorado Department of Health (CDH), the applicant be required to submit a detailed decommissioning plan for the project that will include commitments outlined by the following:

- decontamination of all contaminated areas and facilities in accordance with the then existing State regulations;
- disposal of all fuels and contaminants by an acceptable method suited to the nature of the materials and their potential for environmental damage;
- dismantling and removal or burial of all buildings and other structures; and
- grading, covering with topsoil, and revegetating the mill area.

Prior to terminating the license at the end of the useful life of the project, the applicant will be required to submit detailed information that includes data from radiological surveys taken at the site and plans for any mitigating measures required as a result of radiological surveys and State inspections. Before release of the premises or removal of buildings, the applicant will be required to demonstrate that levels of contamination are within limits prescribed by the CDH and their then current regulations. Depending upon the circumstances, the CDH may require the applicant to submit an environmental report on the decommissioning operations prior to terminating the license.

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4. ENVIRONMENTAL IMPACTS

4.1 AIR QUALITY

4.1.1 Mine site

The major nonradiological air pollutants associated with surface and underground mining activities are gases generated by internal combustion engines and fugitive dusts generated by moving vehicles, by wind erosion, and by blasting. In general, these emissions will not produce significant impacts upon air quality.

Fugitive dust emissions from vehicles moving along haul roads may be estimated from particulate loading values.[1] The ER (p. 4-2) uses values of 1.4-2.8 kg/vehicle·km (5-10 lb/vehicle·mile) at 48 km/hr (30 mph) for average vehicles. Some 58% of this dust came from the tires of the vehicles and 42% from wind erosion. Because the mine vehicles have wide tires and will move slowly, these emission values are probably higher than those that will be observed. The applicant estimates that four 75-ton overburden removal trucks and four 35-ton ore haulage trucks will be travelling at any one time.

If these eight vehicles were assumed to move at all times, an average speed of 12 km/hr (7.5 mph) could be expected. The resulting fugitive dust emission is approximately 4.7 g/sec to 9.4 g/sec per vehicle during dusty conditions. Using the most conservative χ/Q (sec/m^3) values from Table F.5 in Appendix F, the calculated atmospheric concentration of particulates from each vehicle would range from 56 to 116 μg/m^3 at 500 m (1639 ft). Because the larger dust particles would deposit rapidly, a condition not accounted for in the calculation, these values are very conservative. The range of values would not exceed Colorado State and Federal secondary 24-hr particulate standards of 150 μg/m^3 offsite (Table 2.12). The applicant will sprinkle all roads during dry periods, and it is unlikely that dusty conditions will exist.

Estimates of average particulate emissions at the mine itself were calculated by the applicant[2] as 9.73 g/sec, with the χ/Q (sec/m^3) values from ER Table J-53 being applied. Downwind particulate concentrations from the mine ranged from 4 μg/m^3 to 283 μg/m^3. Background particulate concentrations of 22 μg/m^3 (ER, Suppl., Table 2.7-17), combined with those from the mine, total 26 to 305 μg/m^3. Although these values will fluctuate considerably depending upon the dryness of the season, the wind conditions, and the actual area of disturbed soil available to generate dusts, these estimates indicate that State and Federal air quality standards occasionally could be exceeded by the proposed mining operations. These standards, however, will rarely be exceeded because of the mitigating measures proposed by the applicant (Sect. 6.1), such as sprinkling haul roads during dry periods, and because the flat-terrain dispersion models significantly overestimate atmospheric particle concentrations in mountainous regions, as discussed at the end of this section.

Release rates of chemical pollutants from mine vehicles were estimated by the applicant at 1.5 g/sec of particulates, 1.5 g/sec of SO_2, 11.4 g/sec of NO_2, 1.5 g/sec of hydrocarbons, and 2.7 g/sec of CO, based upon USEPA estimates[3] of emission rates for heavy-duty diesel-powered and gasoline-powered construction vehicles, and upon the following equipment inventory: two track-laying tractors, one wheeled dozer, one motor grader, one wheeled loader, and ten off-highway trucks.[2] Atmospheric pollutant concentrations derived from the same χ/Q values (ER, Table J-53) above and the lowest applicable air quality standard are

SO_2, 0.6 to 44 μg/m^3 (State standard, 15 μg/m^3)

NO_2, 4.7 to 332 μg/m^3 (Federal primary standard for annual average only, 100 μg/m^3)

HC, 0.6 to 44 $\mu g/m^3$ (Federal primary standard for 3-hr increment, 6-9 AM only, 160 $\mu g/m^3$)

CO, 1.1 to 78 $\mu g/m^3$ (Federal primary standard for 8-hr increment only, 10,000 $\mu g/m^3$)

It is highly unlikely that annual average NO_2, CO, and hydrocarbon concentrations will reach the Federal standard. In addition, these data suggest that the 24-hr Colorado State SO_2 standard in Category I areas may be exceeded occasionally at the mine site. Generally, however, atmospheric pollutant concentrations are expected to be insignificant, for the reasons described at the end of this section.

4.1.2 Mill site

The major nonradiological air pollutants associated with the milling operation, and their emission rates, were estimated by the applicant. Concentration values, calculated as above, range as follows: 0.6 to 41.6 $\mu g/m^3$ for particulates, 1.3 to 91.4 $\mu g/m^3$ for SO_2, 0.4 to 29.1 $\mu g/m^3$ for NO_2, 0.2 to 13 $\mu g/m^3$ for hydrocarbons, and 0.6 to 42 $\mu g/m^3$ for CO. Again, concentrations of particulates, NO_2, hydrocarbons, and CO are unlikely to reach or exceed the appropriate State or Federal standards. However, the State standard for SO_2 (15 $\mu g/m^3$, Category I areas) is likely to be exceeded at least on occasion.

The applicant reached the same conclusion and subsequently evaluated the SO_2 problem in more detail (ER, pp. 5-38 through 5-40). Model simulations using three different sets of worst-case conditions revealed that SO_2 standards could indeed be exceeded under such conditions. The models used, however, are designed for flat terrain (ER Suppl., pp. 5-3 and 5-4), rather than for the mountainous terrain of the proposed project, where mixing conditions are considerably enhanced. (The same criticism applies to the use of χ/Q values to calculate atmospheric pollutant concentrations.) When actual dispersion data from a comparable mountainous situation are used, the resulting maximum expected SO_2 concentrations (ER Suppl., Tables 5.3-1, 5.3-2, and 5.3-3) are within State and Federal standards. Therefore, it is believed that the applicant's analysis is correct and that applicable State or Federal standards will rarely be reached or exceeded by atmospheric pollutants emitted at the proposed mill and mine operation.

It should be pointed out that regulations promulgated by the USEPA* require any major source of air pollutants to comply with the Prevention of Significant Deterioration (PSD) of air quality. The purpose of these regulations is to keep clean air clean, and the primary focus is on limiting new emissions of sulfur oxides and particulate matter. Should the release of either of these materials exceed permissible limits, the applicant will be required to modify his system and/or operations to bring the level of emissions into compliance with PSD regulations.

4.2 LAND USE

4.2.1 Topography

Construction, mining, and milling operations will change the topography in certain parts of the project area with the creation of pits, waste dumps, tailings dump and dam, roads, and possibly a lake. Although this construction could alter the configuration of about 458 ha (1131 acres), the change would generally be consistent with the existing character of the Homestake site. During operation, there will be sharp contrasts that would readily attract attention, for example, buildings, machinery, equipment, and waste dumps.

Recreation patterns will be temporarily changed by the project. After reclamation, existing recreational activities could be resumed.

4.2.2 Mine

Open-pit mining will involve the removal and dumping of overburden in surface piles, the removal of ore, and the replacement of some overburden materials in the south pit. Land disturbance in the mine area will include an open pit of 61 ha (152 acres), 88 ha (216 acres) of

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* *Fed. Regist.* 43(118): 26380-26410 (1978) and 44(11): 3274-3285 (1979).

dumps, and 4 ha (10 acres) associated with a possible underground mine. A 150-ha (370-acre) zone surrounding this area will have such features as haulage roads, power lines, diversion ditches, and explosives storage. Eventually all of the land, except the pit highwalls, will be reclaimed or covered by a lake. Trees growing on the benches within the pit will serve to screen the highwalls. Attempts to reduce the highwall slopes and to eliminate benches could result in unstable slopes, both difficult and dangerous to revegetate.

4.2.3 Mill

Construction and operation of the mill to process uranium will temporarily remove about 87 ha (215 acres) from production. This portion includes the area occupied by mine buildings, the mill, the tailings pond and dam, roads, parking lots, and storage piles. All of the disturbed lands will be reclaimed when the mill is decommissioned and will become available for other uses, except for the 28-ha (69-acre) tailings impoundment. An access road may remain from the Marshall Creek road through the mill site, as determined by the U.S. Forest Service (FS).

4.3 WATER RESOURCES

4.3.1 Groundwater

4.3.1.1 The mine and waste dumps

Impacts on the groundwater as a result of construction and operation of the mine and waste dumps include disruption of flow patterns, degradation of quality, and groundwater consumption. Each of these impacts will be discussed.

Disruption of groundwater flow patterns

The open pit mine will alter the groundwater flow in the Chester Fault zone and, to a lesser extent, in the Paleozoic rocks west of the fault zone. Springs SP-21 and SP-25 through SP-31 (Fig. 2.5) are within the proposed open pit and will be eliminated by mining. Springs SP-20, SP-32, and SP-33 are close enough to the proposed pit so that their flow could be eliminated. The estimated cumulative flow of these six springs is 4 to 6 gpm (Table 2.3). The discharge will be collected in the pit and used in the mining and milling operations or treated, if necessary, and released.

Springs SP-18, SP-19, SP-20, SP-22, and SP-23 are south of the open pit site. Mining may significantly reduce the flow in each of these springs, and in some, flow may stop. Cumulative discharge of these five springs is about 4 to 6 gpm (Table 2.3).

Farther south, springs SP-1 through SP-11 and SP-18 through SP-23 could also have reduced flows because of mine dewatering. These springs, however, are believed to receive some recharge from south of the proposed pit, so they should be affected less than the springs near the pit. Cumulative flow of these springs is 8 to 9 gpm (Table 2.3).

None of the spring discharge in the vicinity of the mine reaches a perennial stream such as Indian Creek or Marshall Creek. Most of the water evaporates or is transpired by plants. Therefore, no measurable change in stream flow would result from reduction or elimination of these springs.

Surface-water flow from the old Pinnacle Mine portal was measured in 1970 at 20 to 40 gpm. During the first few years of operation, mining will intercept these old workings and out-flow from the mine will be stopped. Because this water is poor in quality (Table 2.6) and discharges into Indian Creek, stopping the flow will have a beneficial impact on the water quality of Indian Creek.

After mining is completed and final reclamation is under way, probable lake formation in the north pit will restore groundwater flow patterns below the lake level of 3139 m (10,300 ft).

4.3.1.2 Degradation of groundwater quality

Part of the water entering the open pit will be used in the mining and milling operations. Any excess will be treated if necessary and either used for dust control and reclamation or discharged to the surface (Sect. 4.3.2). The right to this water was established by the District Court, Case No. W-2903, on November 15, 1977.

The quality of the near-surface groundwater in the vicinity of the waste dumps might be degraded as a result of leaching by precipitation and surface runoff. The applicant estimates that precipitation over the maximum extent of the waste disposal areas is about 3.7×10^5 to 4.6×10^5 m^3 (300 to 380 acre-ft) per year. If 10% of this precipitation infiltrates through the waste overburden, then 3.7×10^4 to 4.6×10^4 m^3 (30 to 38 acre-ft) per year could potentially leach and transport toxic and nontoxic materials into the groundwater. Much of this contaminated groundwater would probably discharge into Indian Creek somewhere below the waste dumps. Any leached material entering Indian Creek would be diluted by natural stream flow by a factor of 70, on an annual basis, at the confluence with Marshall Creek. Overburden testing by the applicant has shown that of the 33 layers tested, only five had a pH less than 7.0.

The Colorado School of Mines Research Institute has performed leaching tests on composited low-grade waste (0.013% U_3O_8) and barren overburden from the site. For six bed volumes of leaching (about 36 days of exposure), the pH remained between 7.7 and 8.3. Selenium in the leachate remained below 0.01 ppm. Molybdenum remained below 0.1 ppm for barren overburden but reached levels of 0.2 and 0.4 ppm for two of the bed volumes percolated through low-grade waste. The other four bed volumes were below 0.1 ppm.

Details on these experiments, leachate analyses for 40 additional parameters, and estimates of expected water quality have been supplied to the FS, the Colorado Department of Health, and the Colorado Mined Land Reclamation Board.

The conclusion was that waste dump water quality will be similar to, if not better than, the present water quality at monitoring station SW-1.

The sediment dam on Indian Creek below the waste dumps serve as catchment areas. The water will be monitored, treated if necessary, and discharged in conformance with the applicant's NPDES permit. Once the waste dumps are revegetated, transpiration will significantly reduce percolation. No long-term impacts are expected, and short-term problems are unlikely.

4.3.1.3 Groundwater consumption

The groundwater regime at the mine site has been established (Fig. 2.6 and Table 2.4). Inflow into the proposed open pit has been estimated by the applicant at 190 to 590 gpm peak flows. Yearly mine dewatering would be about 3.6×10^5 to 1.1×10^6 m^3 (295 to 910 acre-ft) per year. Some of the groundwater entering the open pit may be discharged into Indian Creek. If all the mine water is used in the mining and milling operations, a slight reduction in the discharge of Indian Creek may result. However, if all the mine water is discharged to Indian Creek (treated if necessary), the groundwater that would have otherwise been transpired by plants and evaporated from the near-surface environment would now discharge into Indian Creek and cause a slightly increased flow. At present, the applicant does not know the exact volume of mine water available for the mining and milling operations. If water is discharged to Indian Creek, it will meet the requirements of the NPDES permit.

4.3.2 The mill and tailings impoundment

Construction and operation of the mill and tailings impoundment will also affect groundwater flow patterns and possibly groundwater quality. Much of the water discharged with the tailings will be recycled for further mill use.

4.3.2.1 Disruption of groundwater flow patterns

The relatively impermeable core of the tailings disposal dam, which will extend below the permeable near-surface alluvial soil to prevent seepage under the dam, will also create a barrier to the natural flow of near-surface groundwater down Hale Gulch. Because of this barrier, part of the near-surface groundwater will move upward to the surface behind the dam, and part will probably infiltrate into deeper rocks. During excavation for the core, this water will surface and will be either discharged into Hale Gulch below the dam site or used for dust control. The near-surface groundwater flow down Hale Gulch was estimated by the applicant to be about 30 gpm (see Sect. 2.4.1). The yearly average discharge of Marshall Creek at its confluence with Indian Creek is approximately 5800 gpm. During construction, an increased surface flow down Hale Gulch of 30 gpm would be a 0.5% increase in the average discharge of Marshall Creek in this area.

Construction of the dam cutoff trench may reduce or eliminate the 1-gpm discharge of spring SP-53, located below the dam (Fig. 2.5).

4.3.2.2 Degradation of groundwater quality

As the tailings impoundment fills with wastes, some of the liquid will seep through the bottom and sides of the impoundment and contaminate the near-surface groundwater. The volume of liquid waste seeping through the impoundment was estimated by the applicant based on the following assumptions: (1) a full reservoir (25-year capacity) and (2) a hydraulic gradient equal to one. Using these assumptions, Darcy's law, and an infiltration velocity of 0.01 ft/year, seepage from the full reservoir would be about 5 gpm (a maximum of 10 gpm after a probable maximum flood), which is equal to 9.8×10^3 to 1.9×10^4 m^3 (8 to 16 acre-ft) per year. The presence of high concentrations of sodium enhances the sealing of soil pores and thus decreases permeability.[4] Homestake will use an alkaline leach solution high in sodium in the milling process.

Precipitation that infiltrates ore stockpiles at the mill site could potentially seep into the ground and contaminate the groundwater. However, the groundwater at the mill site is at least 11.6 m (38 ft) below the surface, and the intervening volcanic rocks are relatively impermeable. The ore stockpiles will be placed on a relatively impermeable clay pad. Any adverse impact from leaching ore stockpiles will be on surface water and vegetation. No adverse impacts on groundwater are expected.

4.3.2.3 Water consumption

The volume of groundwater consumed during mining and milling and for potable and sanitary requirements at the mill has been estimated at less than 3.7×10^5 m^3 (300 acre-ft) per year. Because the applicant is negotiating for 8.63×10^5 m^3 (700 acre-ft) per year of water from Marshall Creek and because mine water will also be used for milling if available, any impact from groundwater consumption at the mill is expected to be minor. Validation for the 8.63×10^5 m^3 (700 acre-ft) of creek water by the Water Court, Case No. W-3017, is pending.

4.3.3 Surface water[5]

The impacts associated with the construction and routine operation of mine and mill on the surface-water quality are inseparable since both construction and routine operation involve the continuous removal of vegetation, topsoil, and overburden material in Indian Creek watershed until the existing open pit and expected local underground operations are completed.

Water use

The applicant plans to use recovered mine groundwater as milling process water if available in sufficient quantity and quality. Under the preferred tailings management plan, process water will be recycled from the tailings pond for reuse. Makeup water [a maximum of 8.63×10^5 m^3 (700 acre-ft) per year] to supplement the process water and additional potable and sanitary water will be obtained from the water supply reservoir or other sources. The applicant has been decreed the right in Water Court to divert up to 8.63×10^5 m^3 (700 acre-ft) per year from Marshall Creek at a pumping rate of 0.1 m^3/sec (4.4 cfs), contingent upon the success of negotiations presently under way among the applicant, the Upper Gunnison River Way Conservancy District, and the U.S. Bureau of Reclamation to establish an exchange program by which water in the Curecanti Unit Reservoirs would be available to replace the applicant's diversions should downstream water rights be imperiled. (See Appendix A, response to DOI, October 3, 1978, comment 1.)

Diversion of 8.63 x 10^5 m^3 (700 acre-ft) per year from Marshall Creek just above the creek's confluence with Indian Creek would represent 7.5% of the estimated average annual flow of 1.15 x 10^7 m^3 (9.37 x 10^3 acre-ft) per year and 17% of the minimum annual flow of 5.14 x 10^6 m^3 (4.17 x 10^3 acre-ft) per year at the same point from 1938 through 1971. At Mean's Pasture, approximately 4.5 stream miles below Indian Creek, this diversion would reduce the estimated annual and minimum flows by 4.4% and 9.9% respectively. Tomichi Creek, immediately below its confluence with Marshall Creek, would incur a 1.6% reduction in average annual flow and a 3.6% reduction in minimum annual flow. Based on the 5520-km (3430-sq-mile) drainage area of the Gunnison River at Blue Mesa Reservoir, the slight reductions in flow through these systems will be inconsequential. The applicant has committed to making diversions only when and in such a manner as will protect downstream senior water rights.

However, no committments have as yet been made by the applicant with regard to either limiting diversion to periods of high flows or observing recommended minimum stream flows. The Colorado Division of Wildlife has recommended that Marshall Creek diversions not reduce stream flows in the reach between Indian Creek and Tank 7 Creek below 0.1 m^3/sec (4 cfs) in winter and 0.2 m^3/sec (8 cfs) in summer. According to hydrographs for Marshall Creek prepared by the applicant's consultants and based on the 80 days required to divert 8.63 x 10^5 m^3 (700 acre-ft) at a continuous pumping rate of 0.1 m^3/sec (4.4 cfs), such diversion would reduce creek flows by 50% or more for at least 30 days during an extremely dry year (once in 20 years), even when pumping is limited to the period of highest creek flows. These conditions would probably measurably diminish total productivity, including trout productivity, of the stream between Indian and Tomichi creeks (about 6 stream miles) below what would otherwise occur without pumping. During years of average or higher stream flows, diversion of creek water would probably have little effect on stream productivity if diversions are limited to the late spring and early summer months of high creek flows. The staff recommends that diversions from Marshall Creek be limited to periods of high creek flows only, that is, spates and spring and summer snowmelt. The staff estimates that the applicant will not need more than 3.6 x 10^5 m^3 (300 acre-ft) per year of water from Marshall Creek.

Suspended solids

During the period of construction and operation of the mine and mill, vegetation, topsoil, and overburden will be disturbed continuously on the site. From the mining operation large amounts of unconsolidated overburden will be deposited on ridges above the headwaters of Indian Creek (Sect. 3.1.2). The exposed overburden will be subject to erosion during the spring snowmelt and during occasional spring and summer spates. During the spring snowmelt, total suspended solids usually reach concentrations as high as 33 mg/liter (ER, Table 2.6.7). Although specific data are not available, it is well established that with increased suspended solids total bed load will also increase considerably.

It is believed that these activities will introduce additional sediments into Indian Creek in the form of bed load and suspended solids. The existing benthic fauna and trout populations in Indian Creek are well adjusted to the occasional high bed and suspended solids loads occurring naturally in Indian Creek; however, the increased frequency and quantity of suspended solids in Indian Creek may degrade the quality of habitat to a degree where scouring by bed load and high concentrations of suspended solids could jeopardize the well-being of the stream community.

Since March 1978, the Colorado Department of Health's Water Quality Control Division field service has been conducting a survey of Indian and Marshall creeks. Their results to date indicate that negative impacts have already occurred on these creeks because of increased suspended sediment loadings. Principal sources appear to be "straightening" of the Marshall Creek bed and road runoff (up to 3.5 x 10^4 mg/liter) from access roads and from the existing pit area. Visual observations by State personnel indicated habitat destruction in upper Indian Creek above Little Indian Creek since 1977. (See details of survey results in Appendix A, Colorado Department of Health comment 56.) The applicant has recognized the potential for increased sediment bed and suspended solids loads as well as habitat degradation in Indian Creek and therefore plans to minimize these impacts by constructing a large settling pond to retain excess bed and sediment loads in the intermittent portion of Indian Creek Pond. Construction will commence as soon as State approvals and weather permit. The new pond, to be built immediately downstream of the existing sedimentation pond, has been designed to contain the runoff from a 25-year, 24-hr precipitation event. Total design storage of 7.94 x 10^4 m^3 (64.4 acre-ft) includes 4.80 x 10^4 m^3 (39.0 acre-ft) of flood storage, 2.32 x 10^4 m^3 (18.8 acre-ft) of sediment storage, and 8.14 x 10^3 m^3 (6.6 acre-ft) of mine dewatering storage.

The NPDES permit issued by the Colorado Department of Health requires the applicant to limit total suspended solids in discharges to Indian Creek to a 30-day average of 20 mg/liter and a daily maximum of 30 mg/liter. Compliance with these limitations should adequately protect Indian Creek biota, including trout, from adverse effects due to suspended solids in runoff from overburden dump and mine areas. The effectiveness of the planned settling pond cannot be predicted with certainty; therefore, suspended solids monitoring will be required to ensure compliance with NPDES limitations and protection of stream water quality. If monitoring shows the pond to be ineffective, further mitigative measures will be required. One possibly effective measure would be another settling pond downstream of the proposed pond. If problems arise, they will be resolved through Forest Service-State of Colorado interaction, with development and approval of new sediment control measures to be implemented by the applicant.

Trace elements

The mining operation will require the disposal of 32.9×10^6 m^3 (43×10^6 yd^3) of overburden (ER, Sect. 3.6.3.5.10); this overburden material exposed to weathering may provide a source for undesirable trace elements through leaching. Because a considerable overburden disposal area will be located in the headwaters of Indian Creek watershed, water quality degradation of Indian Creek by the addition of trace elements may occur. The low occurrence of pyrites and the presence of carbonate rocks in the overburden (ER, Sect. 2.4.3.4) will reduce the danger of acid drainage; however, Wentz[6,7] has indicated that several heavy metal ions (manganese, copper, zinc, cadmium, and vanadium) may occur in concentrations high enough to be detrimental to aquatic biota in streams. The applicant has recognized the potential for increased concentrations of some elements leached from the overburden and intends to minimize water quality degradation of Indian Creek by the construction of appropriate facilities to treat the leachate before discharge to Indian Creek if necessary (ER, Response to Question No. 4, October 14, 1977). To safeguard against failure to detect detrimental concentrations of trace elements in Indian Creek, monitoring measures have been specified in Sect. 6. In addition, leaching experiments (Sect. 4.3.1.2) on barren overburden and low-grade waste indicate that little degradation will occur.

Tailings pond

A tailings pond which will collect mill tailings wastes is proposed for construction in Hale Gulch. The construction activities associated with the dam and other earth-moving operations will disturb surface vegetation and soil. These activities could result in increased erosion and increased bed and suspended loads into Marshall Creek. To minimize impacts of added sedimentation in Marshall Creek, it is recommended that construction activities should coincide with the low period of precipitation as much as feasible. Soil stabilization and revegetation of denuded areas should be accomplished as soon as possible.

During the routine operation of the mill, the tailings pond will receive mill waste slurry which contains suspended solids and high concentrations of trace elements (Sect. 3.2.2). Because the dam core and bottom surface of the tailings pond are clay, no significant surface-water and/or groundwater seepage is expected to occur (Sect. 3.2.4). With no surface discharge from the tailings pond, the water quality of Marshall Creek should not be affected significantly. Natural precipitation which occurs in Hale Gulch watershed will be collected and diverted above the tailings pond (Sect. 3.2.4). The runoff should have ambient water quality without any detrimental effects on the receiving stream, Marshall Creek (ER, Appendix A).

Water storage reservoirs

The applicant is planning to construct a freshwater storage reservoir in a gulch draining into Marshall Creek just to the south of Hale Gulch (ER, Fig. 2.6.1). After the initial dam construction, which may temporarily increase sediment input to Marshall Creek, adverse impact from this source on the water quality of the creek should cease. Up to 8.63×10^5 m^3 (700 acre-ft) of makeup water will be pumped into the reservoir from Marshall Creek each year. The applicant has committed to diverting water only when and in such manner as will protect downstream senior water rights. The potential impacts of diversion on stream productivity are discussed earlier in Sect. 4.3.3.

4.4 MINERAL RESOURCES

The project is not expected to have any impact on economically recoverable deposits of other minerals. Until pit and tailings pond reclamation, any minerals comingled with uranium and of economic importance found could be recovered from the overburden piles and the tailings pond.

4.5 SOILS

The general impacts associated with both mine and mill activities include the disruption of natural soil-forming processes, mixing of soils, destruction of soil structure, soil compaction, and accelerated wind and water erosion.

The removal of natural vegetative cover from construction sites and active mining areas will expose surface materials to accelerated wind and water erosion. Soil compaction, due to operation of heavy construction and mining equipment, will likewise cause increased runoff, erosion, and sedimentation.

Stripping and stockpiling of topsoil material will result in disruption of all existing physical, chemical, and biological systems of the soil environment. Both fauna and flora of the soil will be variously affected, including microorganisms which convert organic matter, elements, and compounds to available plant nutrients. The overall impacts of stripping, storing, and replacing of topsoil will result in a general reduction in natural soil productivity. The mixing of soil with sterile materials of the substratum and leaching, erosion, and anaerobic interactions associated with stored topsoil are some of the factors or conditions that will adversely affect soil productivity.

Long-term effects of project activities include destruction of soil structure and related characteristics that have developed over periods of hundreds and thousands of years. Upon completion of project activities, natural soil characteristics such as horizonation and other physical properties will be completely different from those existing prior to initiation of the project.

The maximum acreage to be disturbed by project activities is about 458 ha (1131 acres), as follows:

	ha	acres
Access road	34	83
Tailings disposal area	70	174
Water storage	13	33
Mill site — mine shops	15	37
Haul road	16	40
Mine area	303	748
Settling ponds	7	16
	458	1131

4.6 VEGETATION

Changes in existing vegetation resulting from site preparation and construction of mine, mill, tailings reservoir, and associated facilities will consist of two types: (1) long-term removal and (2) short-term disturbance. Long-term removal will occur at the mine, mill, and tailings sites and along haul and access roads when the existing vegetation is removed and the area is occupied by project facilities that preclude reestablishment of vegetation until project reclamation begins. A short-term disturbance will result along the pipeline and transmission line routes when the land area is excavated but allowed to reestablish after completion of construction.

Mining will remove primarily lodgepole pine and some spruce-fir stands. Most of the trees in the proposed mining area are of pole or small sawtimber size. Most of the 150-ha (370-acre) mining area has already been cleared. The timber was removed by previous exploration and mining phase activities.

Mill site construction will remove about 10 ha (24 acres) of forest vegetation, mostly lodgepole pine. Limited numbers of aspen occur in conjunction with the lodgepole pine. The lodgepole is generally small sawtimber size, and the aspen is mainly pole size.

Construction of the tailings dam and preparation of the tailings and possible water storage reservoirs will remove 34 ha (85 acres) of range forage vegetation. Most of this area is covered by sagebrush-grass vegetation with Thurber fescue as a subdominant species. Some aspen and lodgepole will also be affected. The proposed tailings area lies within the 3036 ha (7500 acres) of usable grazing land of the Agate C&H Allotment and affects approximately 1% of this area. Assuming that current use of 1400 animal unit months (AUM) is uniformly distributed through the 3036 ha (7500 acres) of usable grazing land, approximately 14 AUMs would be removed by the operation of the tailings facility at maximum capacity.

Construction of the haul road from the mine pit to the mill site through lodgepole pine and aspen vegetation types will remove approximately 15 ha (38 acres) of forest vegetation. Access road construction will remove about 7 ha (17 acres) of vegetation through lodgepole pine and aspen forest types, and sagebrush-grass vegetation on 2 ha (5 acres) will be removed with construction of the tailings slurry pipeline.

Weeds are likely to occur where activities disturb the surface soil, creating bare areas. Such areas include the tailings slurry pipeline; the transmission line routes; the edges of haul, access, and other roads; and the perimeter of the mill and other surface facilities. Unless these areas are seeded, weedy species will probably take over.

Secondary impacts on vegetation resulting from project activities will be caused by gaseous and fugitive dust effluents, dewatering of mine pits, and the potential invasion of noxious weeds.

Dust from the mining and milling operations and from the road surfaces may have an adverse effect on vegetation in the area. Dust deposits on vegetation may lower plant vigor by slowing the photosynthetic process. Dust will also cause plants to be less palatable to the animals that consume them. Gaseous effluents from the mill operation may combine with atmospheric moisture, forming products that subsequently deposit on and adversely affect vegetation. The magnitude of this potential effect is not known. The applicant will sprinkle all operating areas during dry periods to minimize the potential problem.

4.7 WILDLIFE

4.7.1 Environmental impacts of mining

4.7.1.1 Terrestrial

Mining activities at the Pitch Project will result in various impacts on wildlife including direct destruction of 153 ha (378 acres) of habitat, with 150 ha (370 acres) affected to a lesser extent, loss of certain associated animals, detrimental interactions of wildlife with a larger human population, and secondary and offsite impacts. Land clearing, haul road construction, operation of earth-moving equipment, and other mining activities will destroy primarily small mammals, amphibians, and reptiles that move slowly or which retreat to burrows for protection. Larger mammals (such as weasels, deer, or elk) and birds are likely to abandon the mining area, resulting in some mortality in adjacent areas where densities of established populations are already at the carrying capacity of the system.

Increased human activities will result in greater wildlife mortality because of road kills. Restriction of hunting in the general area is recommended as a means of protecting big game herds. Dispersal of human-intolerant species, particularly elk, will occur, and additional losses will be sustained by wildlife because of destruction of habitat by recreational vehicles. Although quantitative data necessary to estimate these losses are not available, impacts of mining activities appear to be acceptable. Endangered or threatened plant or animal species are not known to occur at the project site and, thus, will not be affected by mining activities.

4.7.1.2 Aquatic

The development and routine operation of the mine will require the removal of vegetation and topsoil, the disposal of overburden, and the storage of uranium ore. These activities will occur in the Indian Creek watershed (ER, Sect. 4.1.2.1). During the period of snowmelt and the periods of rain, erosion and leaching may occur from these areas and could possibly result in sedimentation and increased trace element concentrations in stream water and stream sediments.

Trace elements

The applicant stated (Sect. 4.1.2.1 of the ER), that the poor-quality groundwater presently discharging into Indian Creek from the old Pinnacle Mine will be intercepted, resulting in higher water quality of Indian Creek. The exposed overburden that will extend to a much larger area may, in turn, decrease water quality in Indian Creek. The quantity and quality of leaching will be affected by two factors: (1) the limestone-dolomite nature of the overburden, which may keep runoff and seepage water well buffered and at an alkaline pH, and (2) the low occurrence of pyrite (FeS_2), which in the presence of O_2 (in air or water), could produce sulfuric acid. Both of these factors indicate that the runoff and seepage water will have an alkaline pH and will tend to reduce the quantity of trace elements which could go into solution.[8-10]

The careful considerations of the concentrations of trace elements which could be released into Indian Creek from the overburden dumps are important in protecting and enhancing the aquatic biota in Indian and Marshall creeks. Biological information presented in Sect. 2.8.2 indicates that inadequate water supply and poor water quality inhibit the development of a diverse stream community at Station 1 on Indian Creek. Although trace element concentrations measured in the water of Indian Creek (Stations 1 and 2) were usually low or below detection limits (Table 2.8), these concentrations may be higher at times (periods of snowmelt) and may recharge the sediments and biological components of the stream. Because components of the stream community have different uptake and concentration pathways, trace element concentrations in water may not present the holistic picture.[5]

To indicate the vulnerability of trout stream biota to trace elements, a partial review of aquatic organisms (Table 4.1) and a summary of stream criteria for aquatic biota (Table 4.2) were prepared. Table 4.1 lists some of the more common trace elements and some species that may be part of the aquatic community of Indian Creek. These partial data indicate that trace elements such as cadmium, chromium, copper, mercury, and zinc can be, if not lethal, inhibitory on growth, reproduction, or long-term survival in very low concentrations. Complementary to these data, Table 4.2 suggests some concentrations of trace elements to protect aquatic biota.

To ensure that the surface-water runoff from the exposed overburden does not contain leached trace elements in concentrations that may be detrimental to the aquatic biota, a series of sediment and water analyses (Sect. 6) are recommended.

Any excess groundwater invading the mine will also be discharged into Indian Creek if its quality is acceptable and meets the requirements of the NPDES permit.

Suspended solids

The applicant estimated maximum and base discharge rates of 200 and 113 liter/sec (7 and 4 cfs), respectively, from Indian Creek (Sect. 2.4.2.2). Further, it was suggested that water yield from the Indian Creek watershed would only increase approximately 2.0% because of removal of vegetation and the disturbance of the thin layer of topsoil (ER, Sect. 4.1.1.2.1). As the result of these activities, suspended solids above the new settling pond (see Sect. 4.3.3, Suspended solids) are expected to increase by a factor of 15 from ambient during the initial 4 to 5 years of construction and development of the mine and overburden areas until the revegetation program becomes effective (ER, Sect. 4.1.1.2.2). This sediment increase is expected to be produced from much less than the 2.6 km^2 (1 sq mile) of the mine and dump areas. Minimum and maximum total suspended solids (TSS) measured in Indian Creek were 4 and 33 mg/liter respectively. The projected 15-fold increase from mining could push TSS concentrations to a

Table 4.1. Toxicity of certain trace elements

Element	Concentration (mg/liter)	Organism	Type of effect	Time
Al	5.0	Rainbow[a]	Loss of equilibrium	5 min
As	1.0	Rainbow	Reduction in growth	3 weeks
	1.1	Mayfly	Lethal and toxic	
	2.3	Mayfly	Lethal	
Cd	0.0009	Rainbow	LC-50	96 hr
	0.0030	Rainbow	LC-50	17 days
	0.0034	Brook[b]	Behavioral interference in spawning	
	0.0040	Rainbow	LC-50	2 weeks
	0.0060	Brook (alevin)	Growth reduction	
	3.000	Rainbow	LC-50	1 week
	3.000	Rainbow	Lethal	1 week
	4.000	Brook	LC-50	1 week
Cr	0.0050	Rainbow	Growth inhibited	
	0.030	Rainbow	Survival impaired	
	0.032	Diatoms	Growth inhibited	
	0.2080	*Nitzschia linearis*	LC-50	120 hr
	0.2500	*Navicula* spp	LC-50	
	3.50	*Stenonema*	LC-50	48 hr
	5.00	Rainbow	LC-40	15 days
	5.20	Brown	Toxic	
	26.00	Rainbow	LC-50	24 hr
	50.00	Trout	Lethal	
	27.30	*Asellus aquaticus*	Near total kill	24 hr
Cu	0.0050	*Nitzschia* sp	No growth	
	0.0174	Brook (alevin)	Growth and survival reduced	
	0.02	Rainbow	LC-50	96 hr
	0.0325	Brook	LC-57 egg hatch reduction	
	0.0400	*Chironomus* sp	LC-50	96 hr
	0.0600	Rainbow	LC-50	48 hr
	0.0800	Mayfly	Lethal	
	0.20	*Nitzschia* sp	Lethal	
	0.28	Trout (young)	Lethal	
Hg	0.0010	Brook	Egg hatchability reduced	
	0.0010	Brook	Embryo deformed	
	0.0010	Brook (alevin)	Growth reduced	
	0.0080	Rainbow	LC-80	204 hr
	0.015	Rainbow	LC-80	96 hr
Mn	1.4000	*Nitzschia*	Toxic	
	1.4000	*Navicula*	Toxic	
	2.2000	Brook	Lethal	24 hr
Ni	92.000	Brook	LC-50	48 hr
	102.000	Brown	LC-50	48 hr
Pb	0.3300	Brown	Lethal	
	0.800	Rainbow	LC-50	
	1.000	Rainbow	Lethal	100 hr
U	2.800	Stone roller	LC-50	96 hr
	3.0	Fish	LC-50	96 hr
V	4.800	Stone roller	LC-50	96 hr
	5.000	Fish	LC-50	96 hr
Zn	0.01	Rainbow (young)	LC-50	28 days
	0.01	Brown (eggs and alevin)	Toxic	
	0.04	Rainbow (eggs)	Hatching inhibited	
	0.110	Rainbow	LC-50	96 hr
	0.130	Rainbow (fingerlings)	Lethal	24 hr
	0.20	Rainbow	Lethal	64 hr
	0.96	Brook	LC-50	14 days
	1.00	Brook	Lethal	
	3.00	Rainbow	Lethal	
	3.9	Periphyton	88% of species eliminated	14 weeks

[a]Rainbow trout.
[b]Brook trout.

Source: R. M. Cushman, S. G. Hildebrand, R. H. Strand, and R. M. Anderson, *The Toxicity of 35 Trace Elements in Coal to Freshwater Biota: A Data Base with Automated Retrieval Capabilities,* Report ORNL/TM-5793, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1977.

Table 4.2. Summary of stream criteria for fish and other aquatic life
All values expressed as micrograms per liter, unless otherwise specified

Water quality parameter	Maximum suggested concentration	Source
Arsenic	1000	*a*
Cadmium	10	*b*
Chromium	50	*a*
Cobalt	500	*b*
Copper	10–20	*b*
Iron	300	*b*
Lead	5–10	*c*
Manganese	1000	*a*
Mercury	1	*b*
Molybdenum		*d*
Nickel	50	*b*
Selenium	1000	*c*
Silver	0.1	*c*
Vanadium		*d*
Zinc	30–70	*c*
pH (units)	6.0	*e*

[a] F. E. McKee and H. W. Wolf, *Water Quality Criteria,* 2nd ed., Publication No. 3-A California State Water Quality Control Board, 1963.

[b] Based on data presented by McKee and Wolf (Footnote *a*); R. F. Schneider, *The Impact of Various Heavy Metals on the Aquatic Environment,* Technical Report 2, U.S. Environmental Protection Agency, Division of Field Investigation, Denver, Colo., 1971.; Great Lakes Laboratory, *Chromium, Cadmium, Arsenic, Selenium, Mercury and Aquatic Life: A Brief Literature Review,* Special Report 9, New York State University at Buffalo, N.Y.

[c] J. P. Goettl, J. R. Sinley, and P. H. Davies, *Water Pollution Studies,* Project F-33-R-6, Colorado Game, Fish, and Parks Division, Denver, Colo., 1971; J. P. Goettl, J. R. Sinley, and P. H. Davies, *Water Pollution Studies,* Project F-33-R-7, Colorado Division of Wildlife, Denver, Colo., 1972; J. P. Goettl, J. R. Sinley, and P. H. Davies, *Water Pollution Studies,* Project F-33-R-8, Colorado Division of Wildlife, Denver, Colo., 1973.

[d] Not enough information available to allow recommendation of a realistic criterion.

[e] Federal Water Pollution Control Administration, Water Quality Criteria: Report of the National Technical Advisory Committee to the Secretary of the Interior, U.S. Government Printing Office, Washington, D.C., 1968.

Source: D. A. Wentz, *Effects of Mine Drainage on the Quality of Streams in Colorado,* U.S. Geological Survey in cooperation with the Colorado Water Pollution Control Commission, Colorado Water Conservation Board Circular No. 21, 1974.

maximum of approximately 500 mg/liter in the intermittent portion of Indian Creek. Total suspended solids concentrations in discharge from the settling pond must not exceed a 30-day average of 20 mg/liter and a daily maximum of 30 mg/liter as required by the applicant's NPDES permit.

The annual precipitation at the project area has been described in Sect. 2.1.2. These data indicate that annual precipitation varies from 400 to 500 mm. Over half of this occurs during the summer months of June through September; the remaining occurs as snow. The range of greatest snowpack (usually measured in early April) varies from 150 to 1650 mm (Sect. 2.1.2). The TSS measured in Indian Creek in 1976 were associated with an April snowpack of 991 mm (representing 267 mm water content) (personal communication, Colorado Office, U.S. Soil Conservation Service, 23 February 1978). It appears that the snowpack accumulation — hence the volume of snowmelt in 1976 — was very close to the mean (1070 mm); given the right climatic conditions, it could be much higher (1650 mm maximum for the period of 1960-1975). Associated with a higher snowpack, the intensity and duration of the snowmelt could also be larger. The 33 mg/liter maximum TSS concentration associated with the 1976 snowpack and stream discharge (200 liter/sec) is also an average value. A good correlation exists between suspended load and stream discharge. The relationship can be expressed by the formula:

$$M = kQ^n \ .$$

where M = rate of sediment load, Q = discharge rate, and k and n are empirical constants specific to the stream.[11] The relationship plotted on a log-log scale offers a straight line. From these concepts, it can be safely assumed that increased snowpack implies increased runoff, which results in an increased sediment loading. From the 1976 discharge and sedimentation data, TSS of up to 500 mg/liter from the mine and dump areas were projected. Because this value was associated with average snowpack conditions, a higher TSS concentration can be expected with runoff of a deeper snowpack from the disturbed surface topography.

Brown and brook trout are fall spawners, depositing the eggs in the gravel substrate. The eggs hatch in the spring. The yolk-sac larvae stay in the gravel until the yolk sac is absorbed; then, the organisms must come out of the substrate and establish small feeding areas in quiet waters. Initially, their food consists of small aquatic organisms of insect larvae and crustaceans.[12] The increased sediment input to Indian Creek may result in several adverse effects on the survival of the different stages of eggs, yolk-sac larvae or alevins, larvae, and juveniles, and on the food supply of trout. The redds (spawning beds) that contain the eggs and alevins could be covered with sediment in a degree such that these life stages suffocate from the lack of oxygenated water circulation or are locked in so that the larvae cannot emerge.[13] If high suspended solids persist, the gills of juveniles can become clogged with silt and clay resulting in suffocation in a very short period.[13] Because trout are site feeders generally, persistent turbidity prevents them from effective feeding.[13] Juveniles grow rapidly in the first few months after hatching; thus, they must feed vigorously. Therefore, persistent high turbidity could decrease their early rate of growth.[13,14] The benthic community, which is the major food supply of trout, has developed in a stream in close relationship with the environmental conditions, specifically in relationship to low turbidity. Therefore, the existence and stability of the benthic community depends largely on the same environmental characteristics as the trout populations. Increased TSS would also be detrimental to the benthic community and would severely limit or destroy the food source of juvenile trout.[15]

Both the brook and brown trout require clean rubble or gravel to build redds for successful spawning. Sedimentation in Indian and Marshall creeks could alter and/or reduce the available sand and gravel beds for adequate spawning.[12]

During the site visits in October 1977, several beaver dams, both active and abandoned, on Indian Creek were observed. These beaver dams, in view of the potential increased sediment load, pose a special problem. The beaver dams can slow down the flow in the stream and initiate the deposition and accumulation of sediments. Correspondingly, the active beaver dams are in danger of sedimentation to a degree that the beaver colony would have to abandon them. Potential mitigation of the impacts these beaver dams may pose for the stability of the stream are addressed in Sect. 6.

Summer rains, usually occurring as spates, will similarly increase erosion. Runoff could further degrade Indian Creek through temporary increases in total suspended solids and sedimentation if allowed to enter the creek untreated.

In general, increased runoff and erosion from the overburden dump areas and roads will increase total suspended solids and sedimentation, which could be detrimental to the benthic community and reproducing trout populations in Indian Creek. As stated earlier, the applicant has committed to constructing, as soon as possible, a large settling pond designed to contain runoff from a 25-year, 24-hr precipitation event. The pond will intercept runoff from mine and overburden dump areas. The applicant's NPDES permit allows no more than 30 mg/liter total suspended solids in discharge. Compliance with this requirement will provide adequate protection to biota of Indian and Marshall creeks from adverse effects of total suspended solids from overburden dumps and mine areas. However, the efficiency of suspended solids removal cannot be predicted with certainty. Although the settling pond will certainly remove the coarser particles from runoff, it may not, for example, remove some of the silt or colloidal clays.

Consequently, Indian Creek and possibly Marshall Creek could still be subject to degradation from suspended solids originating in the dump and mine areas. Further, the settling pond will not intercept runoff from some project roads, which will also be a likely source of total-suspended-solids-laden runoff during construction and use. The construction of haul roads in the Indian Creek watershed will require the removal of vegetation and grading. Stabilization of disturbed areas by revegetation, spreading of slash materials from harvested trees, and other appropriate methods should be accomplished concurrently with road-bed construction and grading to minimize the duration of loose soil exposure to snowmelt and rain runoff.

4.7.2 Environmental impacts of milling

4.7.2.1 Terrestrial

Milling activities at the Pitch Project will produce impacts to wildlife similar to those described above with respect to mining. These impacts include direct destruction of 44 ha (111 acres) of habitat and associated small animals (about 1460 deer mice, 910 chipmunks; ER Suppl., p. 4-13), detrimental interactions of wildlife with a larger human population, and displacement with some mortality of larger mammals and bird species.

During operation of the mill, the tailings impoundment will remove 28 ha (69 acres) from production. The chemical composition of the tailings pond water is alkaline (pH ~9). Resident animals are not expected to utilize the pond, but migrating waterfowl may land there, and raptors may hunt prey near the impoundment. Potentially harmful amounts of radionuclides and other contaminants are not expected to result in significant direct or indirect (via food chains) wildlife mortality. Few waterfowl are expected to land on the pond, and the pH level is not high enough to cause harm to those that do.

Because no endangered or threatened plant or animal species were observed on the site, the milling activities are not expected to affect such biotic components of the region.

4.7.2.2 Aquatic

The construction and routine operation of the mill will require (1) the removal of vegetation and the preparation of the grounds for the mill facilities, (2) the removal of vegetation from the tailings impoundment area and the construction of a tailings pond dam in Hale Gulch, (3) the construction of a water storage reservoir and dam near Marshall Creek, and (4) the operation and maintenance of the tailings pond in Hale Gulch and of the mill facilities.

Site preparation and construction of the mill

The area of the mill site is drained into the Indian Creek watershed to the north, into Marshall Creek to the southwest, and into Hale Gulch to the west. Site preparation and construction activities are expected to increase erosion into these water courses. Detrimental sedimentation from these areas would be minimized if soil stabilization with mulching and revegetation follow grading and construction as soon as possible to reduce the time in which raw surfaces are exposed to snowmelt and summer precipitation.

The applicant has indicated that the storm channels collecting runoff from the grounds of the mill will be diverted into the tailings pond. This diversion will be accomplished as soon as practical to avoid sedimentation and trace element contamination from the uranium ore stockpile.

Ground preparation and construction of tailings pond and dam

The tailings pond will be located in Hale Gulch. The preparation of the impoundment area and dam will disturb up to 28 ha (69 acres). Hale Gulch is drained by an intermittent stream. The runoff from the drainage area other than the tailings pond will be diverted by a collection channel and discharged into the next small watershed to the south to avoid any additional runoff into the tailings pond. During construction, increased runoff and sedimentation can be expected from Hale Gulch. Because the stream in Hale Gulch is intermittent, the impacts caused by increased sedimentation would be intermittent. Mulching and appropriate revegetation would further minimize these impacts.

During the preparation of the pond area and retaining dam, a layer of compacted clay will be placed on the bottom. This action will minimize seepage of surface water and groundwater from the tailings pond. Monitor wells below the dam will indicate if contaminated seepage occurs. Such seepage will be intercepted by a trench to be constructed across Hale Gulch downstream from the embankment and pumped back to the tailings pond. At the time of decommissioning of the tailings pond, water will be evaporated and the top of the tailings will be capped with a compacted layer of clay to minimize the movement of water into the tailing sediments. This method of tailings storage is acceptable and involves no foreseeable adverse impacts.

Water storage reservoir

The applicant proposes to build two small dams on a drainage southeast of Hale Gulch to convert part of this watershed into a water storage reservoir. Initial site preparation and dam construction will increase erosion and sedimentation from this area. However, these impacts will be minimized by appropriate mulching and revegetation of disturbed areas (Sect. 6.2.3). No significant long-term impacts from construction of this reservoir are foreseen.

A maximum of 8.63×10^5 m^3 (700 acre-ft) of makeup water will be pumped from Marshall Creek to the reservoir each year. Diversion of 8.63×10^5 m^3 (700 acre-ft) per year would represent 7.5% of the estimated average annual flow of 1.15×10^7 m^3 (9.37×10^3 acre-ft) per year and 17% of the minimum annual flow of 5.14×10^6 m^3 (4.17×10^3 acre-ft) per year from 1938 through 1971.

Operation of mill facilities and tailings pond

Any chemical liquid effluents including the tailing slurry will be discharged into the tailings pond via a tailings slurry pipeline (ER, Sect. 3.3.4.2). After settling, the supernatant liquor will be pumped back to the mill for reuse. It is anticipated that the net annual evaporation from the tailings pond will take care of any surplus water from the mill operation, resulting in zero discharge of chemical liquid wastes from the mill operation.

The sanitary wastes will be collected in a septic tank, and the septic tank will be discharged into a leach field or into the tailings pond (ER, Sect. 3.5). Effluents from the laundry facilities will be discharged directly into the tailings pond (ER, Sect. 5.2.2).

4.7.3 Summary

The construction and operation of the mine and mill will expose surface areas and overburden to erosion and possibly leaching. Siltation and trace elements transported to Indian Creek from the overburden disposal area may impact adversely the stream biota by affecting the trout food source of benthic macroinvertebrates, by eliminating spawning of trout, and/or by reducing their potential growth. The settling basins proposed by the applicant may minimize these impacts; however, additional procedures may be required to adequately reduce these impacts to acceptable levels. If adverse effects are observed, the applicant will take such additional measures as may be required by the State of Colorado and/or the FS.

Approximately 6.5 stream miles of Marshall Creek downstream of the water diversion facility may be subject to reduced aquatic productivity during very dry years because of water diversion. During average and wetter-than-average years, no measurable adverse impacts on stream productivity are anticipated if diversion is limited to spates and periods of high flow.

4.8 RADIOLOGICAL IMPACTS

The sources of radiological impact to the environment of the Pitch Project milling and mining sites are the natural radiation background of the area (Sect. 2.10) and the contribution of certain mill and mine effluents. The exposed population is considered to be comprised of the workers at the site as well as the general public within a 80-km (50-mile) radius of the mill and mine.

4.8.1 Preoperational radiation environment

The natural radiation environment at the Pitch Project has been discussed in detail in Sect. 2.9. Radiation exposure to the public from the natural radiation environment results primarily from (1) direct cosmic radiation and cosmogenic radionuclides; (2) terrestrial radiation, principally from radionuclides in the uranium-238 and thorium-232 decay series and potassium-40; and (3) inhalation or ingestion of members of the uranium-238 and thorium-232 decay series and from potassium-40. The dose to the total body from all sources of natural background radiation, estimated by actual site measurements and from literature data,[20] is about 230 millirems per year for the project site.

4.8.2 Radiological impacts for routine operations

Radiation doses were estimated for both individuals and the general population living near the Pitch Project. These estimates were calculated on the basis of recommendations of the International Commission on Radiological Protection[16] and the report of the Task Group on Lung Dynamics for Committee II of ICRP.[17] The following information was used in dose calculations:

1. estimated radioactive releases as presented in Table F-7 of Appendix F,
2. meteorological and hydrological considerations discussed in Sects. 2.1 and 2.6, and
3. land-use information as discussed in Sect. 2.5.

AIRDOS-II, a FORTRAN computer code,[18] was used to estimate individual and population dose resulting from continuous atmospheric releases of airborne radioactive materials from the uranium milling and mining operations. Where possible, site-specific environmental parameters were used in dose determination. Where the information was not available, conservative parameters were used; that is, values were chosen to maximize intake by man. Reducing factors, such as shielding provided by dwellings and time spent away from home, were not considered, and because the nearby ranchers have vegetable gardens, it was assumed that all the produce and meat consumed was raised locally. A more detailed discussion of methods used in estimating radiation dose is provided in Appendix F of this report and may also be found in ref. 19.

4.8.3 Exposure pathways

The potential environmental exposure pathways for radiation exposure to man are presented schematically in Fig. 4.1. The estimates of dose commitments to man were made for radioactive effluent discharges to the environment using actual locations and characteristics of the mill and mine site environs and the actual pathways by which members of the public can be exposed to the discharges. Included in the analysis are dose-commitment evaluations of three effluent categories: (1) pathways associated with particulate releases to the atmosphere, (2) pathways associated with gaseous releases to the atmosphere, and (3) pathways associated with seepage into groundwater. For the Pitch Project mining and milling operation, the pathways of importance for producing the most significant dose commitment to individuals and population are (1) inhalation of radon and its daughters, (2) inhalation of radioactive dust particles, and (3) ingestion of radionuclides in beef and vegetables. All other exposure pathways are estimated to contribute less significant dose commitments.

4.8.4 Radiation dose commitments to individuals

A summary of the predicted doses to individuals at selected offsite locations (see Fig. 4.2) where doses are calculated to be the largest are listed in Table 4.3. Estimates are presented for the significant exposure pathways discussed in Sect. 4.8.3.

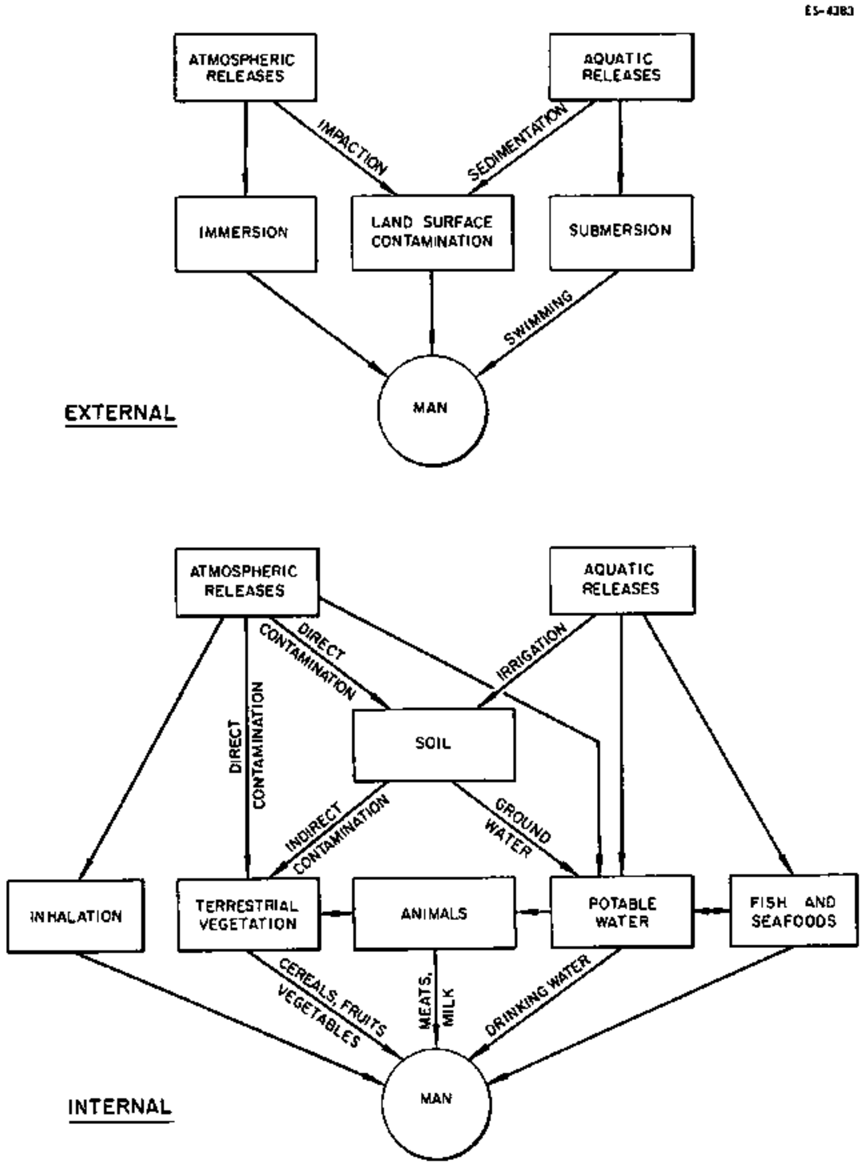

Fig. 4.1. Pathways for external and internal exposure of man.

The highest doses received by individuals living in the vicinity of the Pitch Project occur at the village of Sargents, Colorado, approximately 9.9 km (6.2 miles) west of the mine and 8.5 km (5.3 miles) northwest of the mill. The highest annual dose commitments were 0.02 millirem to the total body, 0.22 millirem to the bone, 0.32 millirem to the lungs, and 1.9 millirems to the bronchial epithelium.

An evaluation of the potential land use near the Pitch Project was carried out to identify locations where individuals might live in the future on a permanent basis during milling and mining operations. This evaluation indicated that the "fee land" located approximately 2.9 km (1.8 miles) east of the mine (see Fig. 4.2) would be the nearest likely site of residence. The dose commitments for this site are also shown in Table 4.3. The doses at this location, due to its proximity to the mine, resulted almost entirely from radon-222 and its daughters originating from the mine operation. The doses to individuals living at the site of the potential nearest residence are less than those to individuals living at the Sargents location because the potential site, while closer to the mine, is located at a greater distance from the mill and tailings impoundment. None of the doses are greater than present NRC regulations (10 CFR Part 20) or the future EPA standards (40 CFR Part 190), as listed in Table 4.4.

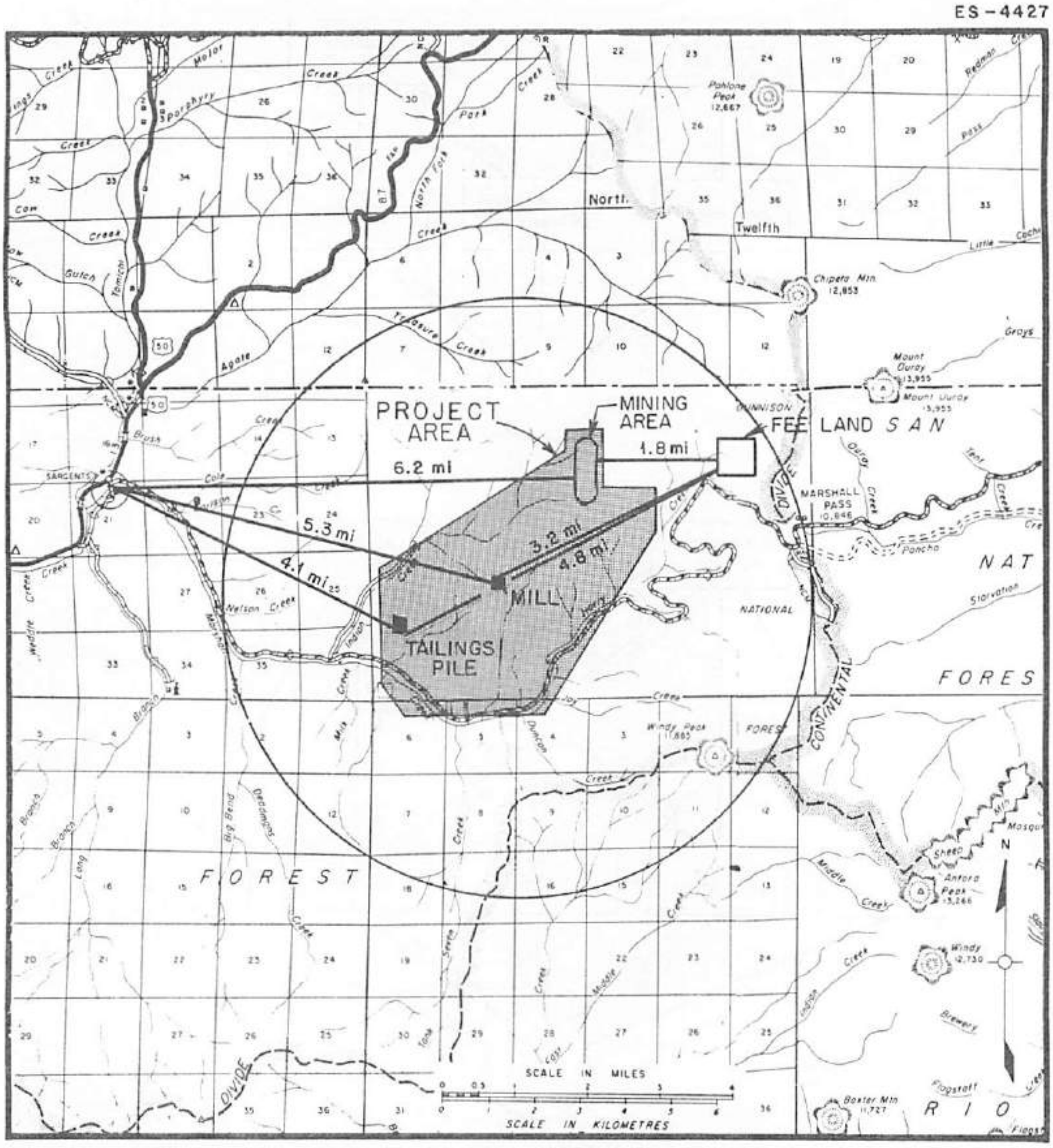

Fig. 4.2. Distances to nearest residence (Sargents) and nearest potential residence (fee land) from the Homestake Mining Pitch Project facilities. Source: ER, Plates 2.1-3 and 2.2-2, pp. 2-5 and 2-27.

At locations farther from the mill and mine operations (Table 4.5), individuals will receive lower doses than those estimated for the two locations shown in Table 4.3. A brief discussion of various pathways for radiation exposure to individuals living near the Pitch Project is presented in the following sections.

4.8.4.1 Internal exposures

Air pathways

The average rate of release of airborne radioactivity during the active mining and milling operations is given in Table 3.5 (Sect. 3.3). The quantity of radioactivity released from the tailings pond and mine areas is not constant throughout this period. The rate of radon emanation (Appendix E) is dependent on the exposed surfaces of the tailings pond (beach areas) and the size of the mine walls.

Food pathways

The main radiation exposure pathway from food for individuals living near the Pitch Project is expected to be through consumption of meat. The local meat diet is principally beef and, to a much lesser extent, mutton, deer, elk, and trout. A survey of residents at Sargents, Colorado, indicated that some cultivate vegetable gardens. For this assessment, it was assumed that all meat and vegetables consumed by these residents was produced at the reference location. This assumption, of course, is very conservative and, thus, the individual dose estimates will be higher than actually expected. It was assumed that the individual consumes daily 0.25 kg of vegetables and 0.30 kg of beef, which would result in a maximum annual dose commitment of 0.015 millirem to the total body, 0.17 millirem to the bone, and 0.018 millirem to the lung by way of the ingestion pathway (Table 4.3).

Because the fee land site (site of nearest potential future residence) is a forested area at an elevation greater than 3048 m (10,000 ft), it was assumed that no food or beef would be grown locally and that the ingestion pathway would not be significant.

4.8.4.2 External exposure

The concentration of radioactivity deposited on the ground was based on a 20-year lifetime for the mill operation. The methodology of air dispersion and deposition has been discussed in detail.[18] External exposures from immersion in contaminated air and from contaminated surfaces were considered. As shown in Table 4.3, external gamma radiation exposures to individuals living in the vicinity are quite low.

4.8.5 Radiation dose commitments to populations

The Colorado Division of Planning (ER, p. 2-11) has projected a 16% increase (1.1% annual increase) in the population of Saguache County, Colorado (where the Pitch Project is located), from 1975 to 2000. Assuming this rate of growth continues throughout the 80-km (50-mile) radius of the plant, projected population dose commitments for the year 2000 have been estimated and are summarized in Table 4.5. Natural background doses are also presented for comparison. Dose commitments produced by normal operations of the Pitch Project represent only very small increases in the population radiation dose rates from natural background sources.

4.8.6 Evaluation of radiological impacts on the public

The predicted annual individual dose commitments (Table 4.3) resulting from the normal operations of the mill and mine are only a small fraction of the present NRC dose limits for members of the public outside of restricted areas as specified in 10 CFR Part 20, Standards for Protection Against Radiation. The predicted dose commitments are also below the EPA Radiation Protection Standard for Normal Operations of the Uranium Fuel Cycle (40 CFR Part 190), which is to become effective for uranium mills in December 1980. Table 4.4 presents a comparison of the predicted maximum annual dose commitments to individuals living in the nearest residence to the Pitch Project with radiation standards for individual members of the public.

The population dose commitments (Table 4.5) resulting from the Pitch Project are only small fractions of the dose received from natural background radiation.

4.8.7 Occupational dose

The uranium mill will be designed and built to minimize radiation exposure to both the general public and the mill workers. The doses are expected to be similar to or less than those of currently operating mills. Special studies at selected mills elsewhere have shown that the exposures to the workers are normally 25% of the allowable concentrations[21] and that the external exposures are normally less than 25% of the 10 CFR Part 20 limits.[21,22] Occupational exposures in surface mining are low. The highest external exposure measured in one study was 160 millirems per year, and the average radon and radon daughter concentration was 0.06 working level.[23] Occupational doses will be monitored and kept below CDH limits in accordance with the requirement of maintaining exposures as low as reasonably achievable.

4.8.8 Radiological impact on biota other than man

Although no guidelines concerning acceptable limits of radiation exposure have been established for protection of species other than man, it is generally agreed that the limits for humans are also conservative for those species.[24-31] Doses to terrestrial biota, such as birds and mammals, because of gaseous effluents are quite similar to those calculated for man and arise from the same dispersion pathways and considerations. Since the effluents of the mill and mines will be monitored and maintained within safe radiological protection limits for man, no adverse radiological impact is expected for resident animals.

4.9 SOCIOECONOMIC IMPACTS

Without detailed information on other proposed local projects, no projection of cumulative impacts can be made. Projected growth locally from the Colorado Division of Planning is given in Table 2.16. The impacts discussed here only apply to the Homestake Mining Company Pitch Project.

4.9.1 Physical impacts

4.9.1.1 Pollutants

Construction activities during the early stages of site preparation include harvesting of timber, clearing of shrub and herbaceous vegetation, grading, and deep excavation. These activities will produce a variety of pollutants, including noise, smoke, engine exhaust fumes, and dust.

These temporary disturbances will have essentially no impact on the general public because of the considerable distance to the nearest offsite human habitation. The remoteness of the project also ensures that pollutants resulting from continuing operation will have little impact on surrounding communities.

4.9.1.2 Vehicular traffic

Transportation patterns would be significantly altered in the immediate project vicinity. Gunnison and Salida would be affected to a lesser extent. Marshall Pass Road would require increased maintenance because of its use by heavy construction vehicles and transport trucks. Peak traffic volume for July 1976 on Route 50 at Sargents was 2365 average daily trips (ADT) (ER, p. 4-69). Assuming 286 workers during the construction phase and carpooling of two workers per car, the traffic count would rise to 2651 ADT, an increase of 12.1% over the 1976 peak figures. During the operational phase of the project, 150 employees at two workers per car would cut back the use to 2515 ADT, 6.3% over the 1976 base figure. These increases are comparable to the annual traffic increase rate of 10.6% reported near Sargents since 1974 (ER, p. 4-69).

The combined increases of project and unrelated traffic will add to the congestion of Highway 50. However, impact from the project will be minimized by operating on a three-shift working schedule so that project-related traffic will be distributed throughout the day rather than cause further congestion during periods of peak traffic flow.

Implications of the traffic for the 15 permanent and 20 summer residents at Sargents would include increases in noise and dust levels. Traffic along the main streets in Gunnison and Salida, too, would show an increase in proportion to the rates of population influx and increase in economic activity. Because of the low volume of current traffic, however, the projected increase of vehicular traffic is not expected to cause any generally unacceptable road or traffic conditions.

4.9.2 Population, employment, and income

4.9.2.1 Construction

Population

The applicant's estimates for the size of the construction force as a function of time are shown in Table 4.6. If all construction workers and miners are assumed to come from outside the area, the maximum increase in workers will be 286, which will occur first during the period from the phased increase in employment between June and August of the second year of construction until November of that year. However, because the applicant has indicated a willingness to employ local residents, the actual number of workers imported for construction should be smaller than the applicant's estimate of total required workers, depending upon the availability and adequacy of local labor.

Table 4.6. Estimates of maximum monthly work forces

		Year 1		Year 2		
	Prior to construction	June to August (phased increases)	August to November (peak employment)	December to May (winter slowdown)	June to August (phased increases)	August to November (peak employment)
Construction workers	*a*	0 to 86	86	25	25 to 150	150
Mine operators						
Preproduction removal of overburden	10	10 to 40	40	40		
Miners					40 to 136	136
Mill operators and office personnel	*b*	*b*	*b*	*b*	*b*	*b*
Total	10	10 to 126	126	65	65 to 286	286

[a]No employment planned.

[b]Because it is expected that mill operating workers will not arrive until after completion of construction, their impact will be less than that of the construction crew.

To obtain an estimate of the maximum total increase in population due to workers and their families, the applicant used three empirically based multipliers, one each for construction workers (2.14), miners, (3.47), and mill operators (3.97).

The influxes of population estimated on the basis of these multipliers for three stages of construction are shown in Table 4.7. The maximum influx of workers and families occurs during the peak period of the second year (August to November) and amounts to about 800 workers, spouses, and children. Although it is impossible without knowledge of the housing market to determine in advance where workers and their families will locate, most of the population increase is expected to occur in and around Gunnison and Salida, because these are the major sources of services in the area. The community of Poncha Springs is closer to the site but is small (250 persons), without a school or water system. Furthermore, there is no available housing. The location of all construction-related workers in Gunnison County would represent a 10% population increase; if all construction-related workers located in Chaffee County, the population would increase approximately 6.7%.

However, because of the applicant's commitment to employing local residents, the estimates of the numbers moving into the area are maximum and are not likely to be achieved.

Table 4.7. Estimated maximum project-induced population

	Peak period year 1	Winter	Peak period year 2
Construction crew			
Workers	86	25	150
Spouses	46	14	80
Children	52	15	92
Total	184	54	322
Mine operation			
Workers[a]	40	40	136
Spouses	35	35	119
Children	64	64	217
Total	139	139	472
Mill operation	b	b	b
Workers			
Spouses			
Children			
Total			
Total			
Workers	126	65	286
Spouses	81	49	199
Children	116	79	309
Total[a]	323	193	794

[a]Since 10 preproduction workers are Gunnison residents who have been employed since 1976, the population increment associated with workers from outside the area totalled no more than 288 in 1977. This table reflects estimated project-related population, whether that population be brought in or permanent residents of the project area.

[b]Because it is expected that mill operating workers will not arrive until after completion of construction, their impact will be less than that of the construction crews.

Source: ER, Table 4.1-15, p. 4-44.

-Employment

Construction of the Pitch facility will provide some short-term employment for the residents of Saguache, Gunnison, and Chaffee counties. How much employment, however, depends on the availability of a labor force with suitable skills and cannot presently be predicted. Because of the greater availability of labor in Gunnison and Chaffee counties as well as the ease of access to the site from these counties, it is probable that the construction-related employment will draw predominantly from the labor pools of these counties.

Income

Gross wage and salary of the construction work force will be approximately $540,000 per month during peak activity periods and will total approximately $5 million for the entire construction period. In addition, miners employed during the construction period will earn an additional $1.6 million. Income for construction-related workers will be somewhat higher than the averages for the three counties, making construction jobs relatively more attractive.

4.9.2.2 Operation

Population

The applicant has stated that the long-term employment at the facility will be approximately 150. With the highest multiplier for determining the total population, a maximum population increase of 596 persons is expected. In view of the applicant's willingness to hire locally, this figure should be regarded as an upper bound. However, the applicant estimates that a minimum of 40 highly trained individuals will have to be imported (Comments and Revisions to the ER, p. 99).

As in the case of the construction-related workers, the operations workers are likely to locate in and around Gunnison and Salida. How many locate in each place depends on the housing nearby and other factors that cannot be determined at this time. If all located in Gunnison County, a population increase of approximately 7.5% would occur. If all located in Chaffee County, the population increase would be approximately 5%.

Employment

Long-term operation of the Pitch Project will provide an additional 150 jobs for the area. At least 40 of these jobs will be filled by newcomers to the area (Comments and Revisions to the ER, p. 99). The number of remaining jobs filled by local residents will depend on the state of the labor market at the time of operation and other factors that cannot be determined presently.

Income

According to the applicant, total gross wage and salary income of miners and mill operators should amount to $245,000 a month (in 1978 dollars). This income (adjusted for inflation) should endure for the 16- to 20-year operating life of the facility.

4.9.3 Social and cultural characteristics

4.9.3.1 Construction

The short duration of the construction period, and particularly of the period of maximum employment, should reduce social and cultural impacts to involved communities substantially. The most immediate impacts are likely to be shortages of goods and services in the private sphere, as discussed in Sect. 4.9.6 below. Even these shortages and the conflicts they might cause may be utilized advantageously by careful advance planning. Another factor that will reduce possible social and cultural impacts is that both population centers, Gunnison and Salida, are also centers of tourism and are thus likely to be accustomed to influxes of transient populations.

4.9.3.2 Operation

Social and cultural impacts during operations of the Pitch Project should be minimal because of the relatively small size of the operating force and its expected stability.

4.9.4 Housing

4.9.4.1 Construction

Migration of additional population (in the form of construction workers) into Gunnison and Salida will increase demand in an already tight housing market. However, the applicant's determination to hire most of the construction force out of the local population will minimize the influx of new workers seeking housing. The extent of the impacts will depend on the number of new workers entering the area, their distribution between Gunnsion and Salida, and the ability and willingness of the housing industry to respond to brief surges in demand.

4.9.4.2 Operation

During the operational phase of the Pitch Project, approximately 40 highly trained professionals will be imported. The remainder of the work force will be hired locally. As a result, minimal strain will be placed on the existing housing market by project operation.

4.9.5 Government, public service, and public finance

The applicant estimates that 40 workers will migrate into the region as the result of the Pitch Project. These workers will be long-term employees involved in the mining and milling operations of the Homestake Mining Company. In addition, the maximum number of construction workers has been estimated by the applicant to be 150, occurring in the second summer of construction. The following analysis will be based on these figures and the assumption that new residents and construction workers will locate in Salida or Gunnison.

On the basis of population estimates of 12,000 for Chaffee and 8700 for Gunnison County, the per capita county General Fund expenditures in 1975 were estimated to be $51 and $58 respectively. The applicant has estimated that 40 workers and their families will migrate into the area, causing the population to increase by approximately 160 individuals. Assuming the families are distributed evenly between the counties, estimates of new county expenditures would be $4080 for Chaffee and $4640 for Gunnison County. This estimation process assumes that the marginal cost to the respective county of providing appropriate services to these individuals is approximately equal to the average cost but does not account for inflationary impacts from 1975 to the year expenses are borne. These assumptions also apply to estimates that follow. The new expenditures represent approximately 1% of the 1975 General Fund budget estimates for both Chaffee and Gunnison counties.

Estimated 1975 General Fund expenditures for the cities of Salida and Gunnison were $369,663 and $573,042 respectively. On the basis of population estimates for July 1975 from the Colorado Division of Planning, Demographic Section, April 1976, the per capita expenditures can be estimated at $80 for Salida and $100 for Gunnison. Assuming the new families locate within the city limits of either town, total expenditures would increase $6400 in Salida and $8000 in Gunnison, or 2% and 1% respectively. Estimates for expenditures other than General Fund for both the county and city are shown below.

	Total	Per capita	New expenditures
Chaffee	1,750,000	145	11,600
Gunnison (county)	1,592,000	183	14,640
Salida	242,720	53	4,240
Gunnison (city)	1,791,000	326	26,080

These totals assume the ratio of county General Fund expenditures to total county expenditures remained constant between estimated 1975 expenditures and budgeted 1976 expenditures (35% for Chaffee County and 32% for the town of Gunnison). The original data used were provided by the applicant.

Total new expenditures at the city and county level are given below:

Chaffee	15,680
Gunnison (county)	19,280
Salida	10,640
Gunnison (city)	34,080
	79,680

The estimate of total new expenditures required in Chaffee County, including both city and county expenditures, would be $26,320, and the equivalent amount for Gunnison is $53,360.

The Gunnison School District operates four elementary, one junior high, and one high school; the Salida School District operates one school in each category. There is also a private elementary school in Salida, St. Joseph School, with a 1976 enrollment of 112 students. Assuming each worker had two children but not considering St. Joseph School, the student-teacher ratios for the two districts would change as indicated below:

	1976 Enrollment	1976 Student-teacher ratio	Projected new student-teacher ratio
Gunnison	1394	15:1	16:1
Salida	1551	20:1	20:1

The 1976 excess capacity of the two districts is estimated as follows:

	Elementary	Junior high	High school
Gunnison	180*	58	78
Salida	139	35	100

*This estimate does not include Crested Butte Elementary School since the grades taught overlap with Roland Junior High. There was no reliable method of estimating capacity of grades K-6 versus that of grades 7-8 for Crested Butte.

The cost per pupil was $1070 in Gunnison and $1030 in Salida, estimated on the basis of information provided by the applicant. Using this average figure, the incremental operating cost for the school districts could be estimated at $42,800 in Gunnison and $41,200 in Salida.

The applicant estimated that the tax revenues resulting from the project will be (1) production taxes: $800,000 per year for full production and $600,000 per year on property, approximately $950,000 per year to the Gunnison School District and $450,000 per year to Saguache County; (2) corporate income taxes: $219,000 per year to the State of Colorado and $2,000,000 per year to the U.S. Government; (3) States sales and use tax revenue for the 18-month construction period: $680,000; and (4) sales taxes: $19,200 (Gunnison, $2400; Chaffee County, $2400; and the State of Colorado, $14,400). The sales taxes are based on average monthly family expenditures of $1000 for the permanent residences. These estimates are direct taxes; that is, they do not account for increased taxes due to secondary effects.

Impacts on local governments, public services, of public finances arising from temporary construction workers will depend upon several factors. First, if a majority of these employees are local and unemployed prior to employment on the project, the impacts will include decreased transfer payments and increased tax revenues. Second, if the construction workers are local and already employed, it is difficult to determine the final impacts since the fact that employees would be leaving existing jobs would have to be considered in the analysis. Third, if the workers come from outside the area and move to either Salida or Gunnison for only a few months, impacts would include both increased tax revenue and increased costs for public services.

4.9.6 Availability of other goods and services

The applicant has estimated that approximately 160 individuals will migrate into the area as the result of the Pitch Project. Throughout this analysis it has been assumed that 80 will locate in Salida and 80 in Gunnison. Under these circumstances, the discussion provided in Sect. 2.10.5 indicates that most public goods and services will be in adequate supply to meet the increased demand of these new residences. In the town of Gunnison, a moratorium on new natural gas services has been in effect for the last few years. Peoples Natural Gas anticipates lifting this moratorium sometime this year, but the total number of new customers allowed on the system will be limited. In Salida, Salida Gas Service is not accepting new customers. The firm of Wright-McLaughlin Engineers is undertaking an engineering study of the sewage treatment plant.

4.9.7 Summary

The applicant's determination to hire the majority of project workers from within the region (Chaffee and Gunnison counties) is commendable. If the applicant's program is successful, the project-induced net migration of population into the area will be approximately 40 families, which will have minimal long-term impact on the community.

However, where workers are hired away from existing jobs, the net influx of population will be greater and will exert greater impact on public services, housing, and taxes. Significant short-term impacts from the influx of construction workers will be greatest on housing availability and on public service cost and availability.

4.10 RECREATIONAL IMPACTS

Fishing, camping, hiking, and hunting on the site will be affected by the project. Elk hunting, the most popular recreation on the site, will be eliminated for the duration of the project, but the elk will be available elsewhere. Fishing, second in popularity to elk hunting, will be affected to the extent that project operations affect the local fish population.

4.11 AESTHETIC IMPACTS

The overburden piles, mine pit, and tailings impoundment will contrast sharply with the natural landscape. They will not be visible offsite, and because there are no unique features in the area to attract visitors, the impact will be minimal.

4.12 ARCHAEOLOGICAL AND HISTORICAL IMPACTS

The applicant (ER Supp., p. 4-15) agrees to protect such resources as recommended by the Forest Service Regional Archaeologist with the concurrence of the State Historic Preservation Officer. Minor impacts are expected.

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5. ENVIRONMENTAL EFFECTS OF ACCIDENTS

The occurrence of accidents related to operation of the Homestake Mining Company Pitch Project mill will be minimized through the proper design, manufacture, and operation of the process components and through a quality assurance program designed to establish and maintain safe operations. In accordance with the procedures set forth in the appropriate regulations, Homestake Mining Company has submitted applications containing descriptions of the facility design, the organization of the operation, and the quality assurance program. These documents, together with the Environmental Report and supplements, will be reviewed by various agencies to ensure that there is a basis for safe operations at the site. Moreover, those agencies will maintain surveillance over the plant and its individual safety systems by conducting periodic inspections of the facility and its records and by requiring reports of effluent releases and deviations from normal operations.

Despite the above precautions, accidents involving the release of radioactive materials or harmful chemicals have occurred in operations similar to those to be conducted by the applicant. Therefore, in this assessment, accidents that might occur during milling operations have been postulated and their potential environmental impacts evaluated. Section 5.1 deals with postulated accidents involving radioactivity, Sect. 5.2 with those not involving radioactivity, and Sect. 5.3 with transportation accidents involving both radioactive and nonradioactive materials. The probabilities of occurrence and the nominal consequences are assessed, using the best available estimates of probabilities and realistic assumptions regarding release and transport of radioactive materials. Where information adequate for a realistic evaluation was unavailable, conservative assumptions were used to compute environmental impacts. Thus, the actual environmental impacts of the postulated accidents would be less, in some cases, than the effects predicted by this assessment.

5.1 ACCIDENTS INVOLVING RADIOACTIVITY

5.1.1 Mine accidents

Potential mine accidents involving radioactivity are related to an employee who receives a higher than acceptable dosage level of radiation; those radionuclides contributing to a primary health hazard (radium-226 and thorium-230) could cause tissue damage largely through inhalation or ingestion of the given radionuclide. Also, radon-222, a radioactive gas, could diffuse from uranium-bearing deposits. It is generally accepted that lung cancer of underground uranium miners is associated more directly with the inhalation and retention of airborne, short-lived radon daughters than with the effects from radon itself.[1] Moreover, other evidence suggests that a long latent period (perhaps as much as 25 years) may be associated with the inhalation of radon before the resulting damage becomes apparent.[2] Various monitoring programs designed to prevent the exposure of mining personnel to abnormally high concentrations of radionuclides have been proposed. Generally, underground mining of uranium poses no radiological threat to the general public.

The Pitch Project will involve both open pit and underground mining of uranium ore. Radon diffusing from exposed ore bodies would be rapidly dissipated and diluted in the atmosphere. The extensive use of open pit mining reduces the exposure of mining personnel to radon gas while slightly increasing the exposure to the general public. The radiological exposure to the general public resulting from normal gaseous emissions during routine mining and milling operations was evaluated in Sect. 4.8 and was found to be negligible. The radiological exposure to workers is monitored; prior experience at other sites indicate that it will be well below permissible limits. In general, mill accidents in the tailings area, yellow cake handling facilities, or ore storage pads have a greater potential for significant radiological impact than do mining accidents. Therefore, the effects of mine accidents can be subsumed under the effects of mill accidents discussed in following sections.

5.1.2 Mill accidents

The specific activities of the radioactive materials handled at the mill are extremely low: $\sim 10^{-10}$ Ci/g for the ore and tailings and $\sim 10^{-6}$ Ci/g for the refined yellow cake products.* The quantities of materials handled, on the other hand, are relatively large: 360 tons of yellow cake per year, representing ~185 Ci of radioactivity. These very low specific activities require the release of exceedingly large quantities of materials to be of concern; driving forces for such releases will not exist at the Pitch Project mill.

Guidelines have not been published for the consideration of accidents at uranium mills; therefore, the postulated plant accidents involving radioactivity are considered here in the following categories:[3]

1. trivial incidents, that is, those not resulting in a release to the environment;

2. small releases to the environment (relative to the annual release from normal operations); and

3. large releases to the environment (relative to the annual release from normal operations).

Trivial incidents include spills, ruptures in tanks or plant piping that contain solutions or slurries, and rupture of a tailings disposal system pipe in which the tailings slurry is released into the tailings ponds. Failure of the air cleaning system serving the concentrate drying and packaging area and an explosion in the yellow cake dryer constitute small releases. Large releases may involve a major tornado strike or a tailings dam failure.

For most of the postulated cases resulting in a release to the environment, the analysis gives the estimated magnitude of the release, the corresponding maximum individual dose at various distances from the mill, and the estimated annual likelihood of occurrence. The latter estimates are based on a diversity of sources, including incidents on record, chemical industry statistics, and failure prediction methodologies. Data and models for the behavior of radiation in accident situations were taken from AIRDOS-II computer code[1] and from the International Commission on Radiological Protection[2] and updated by dose conversion factors based on the lung model of the ICRP Task Group on Lung Dynamics.[3]

During the three decades of nuclear facility operation, the frequency and severity of accidents have been markedly lower than in related industrial operations. The experience gained from the few accidents that have occurred has resulted in improved engineering safety features and operating procedures, and the probability that similar accidents may occur in the future is very low. Based on analysis, it is believed that even if major accidents did occur there would probably not be a significant release of contamination offsite and that radiological exposures would be too small to cause any observable effect on the environment or any deleterious effect on the health of the human population.

5.1.2.1 Trivial incidents

The following accidents, due to human error or equipment failure, would not result in the release of radioactive materials to the environment.

Leaks or rupture in tanks or piping

Uranium-bearing slurries and solutions will be contained in several tanks that comprise the leach, washing, precipitation and filtration, and purification stages of the mill circuit. Human error during filling or emptying of tanks or the failure of valves or piping in the circuit would result in spills which might be expected to occur several times annually during the operations. Large spills from tank failures or uncorrected human error might involve the release of several hundred pounds of uranium in the liquid phase to the room. However, the entire contents of the tank would be contained, therefore not reaching the environment.

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*In contrast to the relatively high specific activities of a number of prominent radionuclides, that is, $\sim 10^{-1}$ Ci/g for plutonium-239 and $\sim 10^{-3}$ Ci/g for cobalt-60.

Rupture of a pipe in the tailings distribution and decant return system

At the design milling rate of approximately 544 metric tons (600 tons) of ore per day, roughly 25 metric tons of solids and 44 m^3 (11,600 gal) of solution are transferred to the tailings pond each hour through the tailings disposal system piping. The applicant plans to install the decant line above ground between two berms that will provide containment in the event of a rupture. The pipe will be protected from freezing and will be inspected visually at frequent intervals to detect leakage.

5.1.2.2 Small releases

The following accidents, due to human error or equipment failure, would release small quantities of radioactive materials to the environment. The estimated releases, however, are expected to be small in comparison to the annual release from normal operations.

Failure in the air cleaning system serving the yellow cake drying area

The off-gases from the yellow cake dryer, containing entrained solid particles of uranium oxide, pass through a wet scrubber before they are discharged to the environment through a 21.3-m (69.8-ft) stack.

For this mill, based on similar existing operating facilities,[4] it is estimated that 2.0 kg/hr (4.5 lb/hr) of U_3O_8 is released to the scrubber. For the current analysis, it is assumed that the scrubber failed completely during the night shift and that the release continued over an entire 8-hr shift. This failure would result in a release to the environment of approximately 16.3 kg (36.0 lb) of insoluble uranium, assumed to be in the respirable size range. Figure 5.1 plots the 50-year dose commitments to the lungs (highest organ dose) of individuals at various distances from the mill at this level of release.

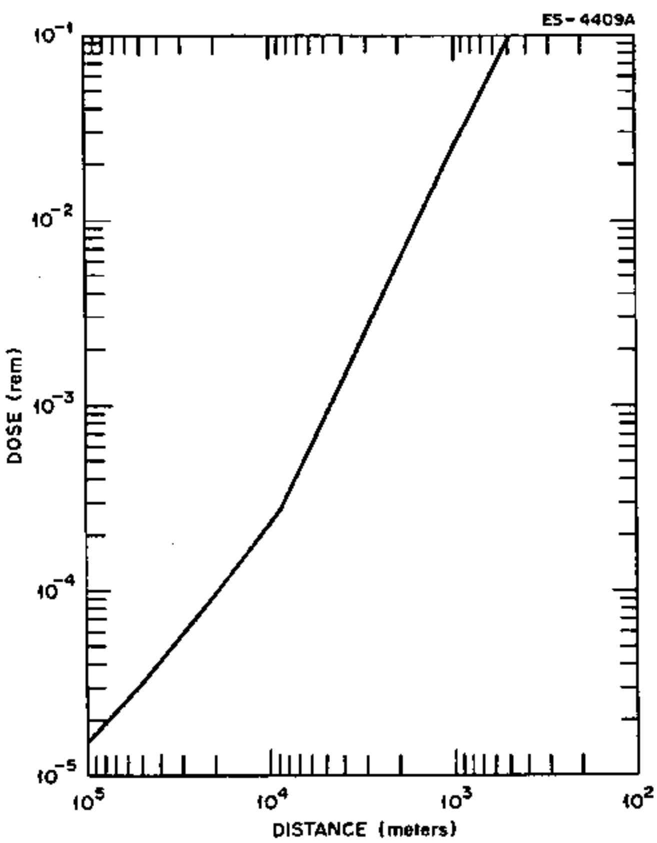

Fig. 5.1. Failure in the air cleaning system: 50-year dose commitment to lungs. (The element of concern is insoluble uranium.)

Because the meteorological data at the time of the postulated accident is unpredictable, it was assumed that for this stack release the conservative meteorological conditions of 1 m/sec wind speed and a Pasquill type-B stability would exist. It was also assumed that all the material was distributed over a single 22.5° sector. The maximum doses to the nearest residence (Sargents, Colorado) were as follows: total body, 7.4×10^{-4} millirem; bone, 1.7×10^{-2} millirem; lung, 2.9×10^{-1} millirem; and kidney, 4.9×10^{-3} millirem.

5.1.2.3 Large releases

Incidents which might release large quantities of radioactive materials to the environment compared to the annual release from normal operations are considered in this section. By virtue of complex and highly variable dispersion characteristics, however, the individual impacts will not necessarily be proportional to the total amount of radioactivity released to the environment.

Tornado

The probability of the occurrence of a tornado calculated by a method developed by Thom,[5] in the 1° square in which the Pitch Project is located is considered negligible. Using the closest available data for the site, the probability of occurrence is approximately 3×10^{-5} per year. The area is categorized as region 3 in relative tornado intensity,[6] that is, for a "typical" tornado, the wind speed is 386 km/hr (240 miles/hr) of which 305 km/hr (190 miles/hr) is rotational and 80 km/hr (50 miles/hr) is translational. None of the mill structures are designed to withstand a tornado of this intensity.

Because little could be done to secure the mill with advance warning, a "no-warning" tornado was postulated. It is not possible to predict accurately the total amount of material dispersed by the tornado; thus, a highly conservative approach was taken. The yellow cake product has the highest specific activity of any material handled at the mill, and as much as 23 metric tons of the product may be accumulated prior to shipment. Consequently, it may be assumed that the tornado lifts 2275 kg (5015 lb) of yellow cake.

A conservative model,[7] which supposes that all the yellow cake is in respirable form, was used for the dispersion analysis. The model assumes that all of the material is entrained in the tornado as the vortex passes over the site. Upon reaching the site boundary, the vortex dissipates, leaving a volume source to be dispersed by the trailing winds of the storm. The material supposedly exists as a volume source representative of the velocities of the tornado and disperses through an arc of 45°. Because of the small particle sizes postulated, the settling velocity is assumed to be negligible.

The model predicts a maximum exposure at a distance of approximately 4 km (2.5 miles) from the mill, where the 50-year dose commitment to the lungs of an individual is estimated to be 6.0×10^{-8} rem. The 50-year lung dose commitment as a function of distance is plotted in Fig. 5.2. The dose to the lung for the nearest resident (Sargents, Colorado) would be approximately 4.8×10^{-8} rem.

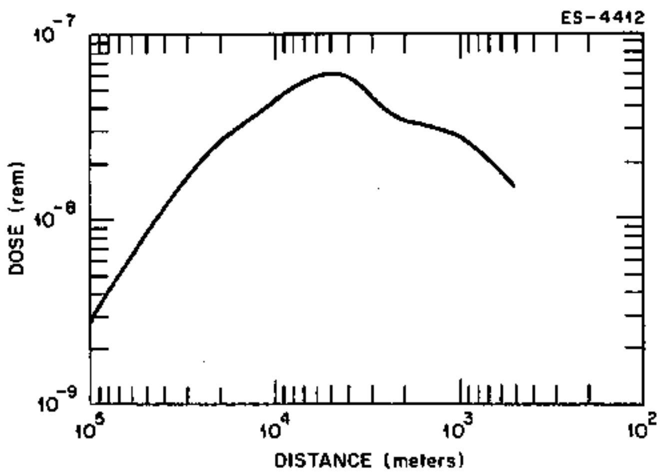

Fig. 5.2. Tornado damage: 50-year dose commitment to lungs.

Release of tailings slurry

The tailings pond will receive tailings slurry and yellow cake purification circuit liquid wastes. A portion of the water in the pond will be recycled for use in the leach circuit and to repulp the tailings filter cake from the final filter stage. The tailings pond will receive about 544 metric tons (600 tons) of solids per day of operation. The ultimate capacity of the tailings facility is about 4.5×10^6 metric tons (5.0×10^6 tons). Inadvertent release of this material to the environment may result from an overflow of the tailings slurry or a failure of the tailings dam. Failure of the tailings dam could be attributed to a destructive earthquake, floodwater breaching, structural failure, or a pipeline failure.

The facility is designed to minimize the flood hazard. The runoff interceptor ditch located in the drainage above the tailings facility will divert precipitation runoff around the pond. In addition, the facility will be operated so that the pond will be able to receive the volume from a probable maximum flood and maintain 1.6 m (5 ft) of freeboard.

The Homestake Mining Company Pitch Project site is in the Zone One (minor damage) seismic risk category (intensities of V and VI on the Modified Mercalli Scale) (Sect. 2.5.3). The tailings dam is presently designed to withstand, without damage, an earthquake having an intensity of VI on the Modified Mercalli Scale. However, there is a small probability that an earthquake of intensity VIII may occur.[8] The applicant will be required to provide a dam design to withstand this potential event for the approval of the Colorado State Engineer, Dam Safety Branch.

From the foregoing discussion, it is clear that sufficient data are not available to estimate the small probability of the occurrence of a natural disaster with sufficient intensity to result in a release of the tailings slurry to the environment. Even if the probability were known accurately, it would be difficult to predict the magnitude of the release. However, tailings slurry releases have occurred in the past, and the consequences associated with these events have been documented to varying levels of detail in reports to the NRC and will be used to estimate a nominal release. Table 5.1 summarizes recorded incidents during the period 1959-1977.

Table 5.1. Summary of accidental tailings slurry releases, 1959–1977

Cause	Solids released		Liquids released		Reached watercourse
	kg	lb	liter	gal	
Flash flood	14×10^6	3×10^7	1.2×10^7	3×10^6 (a)	Yes
Dam failure	9×10^5	2×10^6 (a)	9.1×10^5	2×10^5	Yes
Dam failure	5×10^5	1×10^6	4×10^5	1×10^5 (a)	No
Dam failure	2×10^5	4×10^5	2×10^5	5×10^4 (a)	Yes
Pipeline failure	3×10^5	7×10^5	2×10^5	5×10^4	Yes
Flooding	1×10^8	2×10^8 (a)	8.7×10^7	2×10^7	Yes
Pipeline failure	6.4×10^4	1×10^5 (a)	6.1×10^4	2×10^4	Small amount
Flooding	2×10^6	4×10^6 (a)	1.7×10^6	4×10^5	Yes
Dam failure	1×10^6 to 14×10^6	2×10^6 to 3×10^7 (a)	1×10^6 to 11×10^6	3×10^5 to 3×10^6	Yes
Pipeline failure	1×10^5	2×10^5 (a)	1.3×10^5	3×10^4	Yes
Dam failure	9×10^3	2×10^4 (a)	8×10^3	2×10^3	No
Pipeline failure	No quantitative information				No
Pipeline failure	4.5×10^7	1×10^8	8×10^6 to 30×10^6	2×10^6 to 8×10^6	No
Dam failure	8.2×10^6	1.8×10^7 (a)	7.6×10^6	2×10^6	No
Pipeline failure	1.1×10^3	2.5×10^3	1.5×10^4	4×10^3	Roughly 80% of solids and 20% of liquids reached watercourse

[a] Assuming equal weights of solids and liquids released and density of the liquids to be approximately 1.1 kg/liter (9 lb/gal).

Sources: Directorate of Licensing, U.S. Atomic Energy Commission, *Environmental Survey of the Uranium Fuel Cycle,* Report WASH-1248, Fuels and Materials, April 1974; also a Report from Teknekron, Inc., to NRC dated 14 March 1978.

From these historical data, the average release from tailings dam failure or flooding was approximately 1.2×10^7 liters (3.1×10^6 gal) of liquids and 1.4×10^7 kg (3.1×10^7 lb) of solids. Ten of the fifteen releases reached the watercourse, and nine involved dam failure or flooding. Thus, considering the 394 mill-years of operation in the 1959-1977 period, the apparent likelihood of release from the tailings pond to the watercourse is 1×10^{-2} to 2×10^{-2} per plant-year or roughly one release per 30×10^6 MT (33×10^6 tons) of ore processed. This figure is unrealistic for impoundment dams for new facilities because all of the failures listed in Table 5.1 were for structures composed primarily of tailings and were not designed to an engineering standard such as Regulatory Guide 3.11. Present criteria call for carefully engineered structures with design features that take into account such possibilities and probabilities as earthquakes and floods.

The solid tailings are estimated to have a radioisotope composition of approximately 30 μCi of uranium-238 and uranium-234, 438 μCi of thorium-230, and 429 μCi of radium-226 per ton of ore. The chemical and radiological composition of the tailings water as estimated by the applicant is presented in Table 5.2.

The estimated 1.5×10^7 kg (3.3×10^7 lb) of solid tailings released from the impoundment area as a result of an overtopping or failure of the tailings dam would be expected to settle out below the dam. Because the Hale Gulch drainage is steep (approximate slope 1:7) and narrow, both liquids and solids may be expected to reach Marshall Creek.

Table 5.2. Expected composition of tailings water at the Homestake Mining Company Pitch Project

Component	Expected concentration	Maximum permissible concentration in unrestricted areas[a]
	(g/liter)	
CO_3	15.2	
HCO_3	0.5	
SO_4	56.5	
Chlorine	3.0	
Sodium	39.4	
	(ppm)	
Ammonia	60	
Selenium	0.8	
Molybdenum	65.0	
Vanadium	40.0	
Arsenic	3.2	
Cadmium	0.2	
Copper	1.0	
Lead	1.0	
	(μCi/ml)	(μCi/ml)
U-238	1.4E–5[b]	4.0E–5
U-234	1.4E–5	3.0E–5
Th-230	2.0E–8	2.0E–6
Ra-226	9.8E–8	3.0E–8

[a] From: 10 CFR Part 20, Appendix B, Table 2, Column 2.

[b] Read as 1.4×10^{-5}.

The extent of the area covered, which would depend on the details of the failure, is difficult to assess. Scaling from previous estimates[9] on the basis of the total mass of tailings released, the material may be assumed to cover an area 30.5 m (100 ft) wide by 610 m (2000 ft) long in Hale Gulch and to cover an area 137 m (450 ft) wide by 1850 m (6070 ft) long in Marshall Creek. The average depth of the tailings is assumed to be 4 cm (1.6 in.). Transport of the solids farther down Marshall Creek would depend on stream flow and other hydrologic considerations.

The main radiological concern associated with the deposition of the tailings material is the small increase in background radiation levels in the affected and adjacent areas and the eventual transport of these low levels of contamination by stream flow, wind, and rain. These long-term effects may be mitigated by removing the contaminated material from the environment. Accordingly, a measure of the impact associated with the release of the solid tailings from the impoundment is the cost of excavating the area, removing the tailings and contaminated soil, and transporting the material back to the tailings impoundment. Assuming that 15 cm (6 in.) of contaminated soil or stream sediments must be removed along with the tailings and that the average travel distance back to the tailings impoundment is 3.2 km (2 miles), the estimated cost for excavation, removal of contaminated materials, and truck transport of the material to the tailings impoundment is approximately $128,000.

The solution released by a dam failure or overtopping event would be a source of chemical and radiological pollutants. The anticipated concentrations of significant chemical and radiological species are listed in Table 5.2. Of the listed radionuclides, only radium-226 is in excess of 10 CFR Part 20 limits. Solutions reaching Marshall Creek would be diluted by the natural stream flow. The extent to which the dilution occurs depends on the stream conditions at the time of release.

The applicant calculated the effects of dilution on contaminant concentration[10] downstream from the confluence of Indian and Marshall creeks and at Blue Mesa Reservoir on the Gunnison

River near Gunnison (the first downstream reservoir). Dilution factors were derived (Table 5.3), using historical average and low flow data for Marshall Creek below Indian Creek, historical average and minimum water volumes in Blue Mesa reservoir, and two postulated failure modes for the impoundment. A gradual release was assumed to occur during a period of normal stream flow and normal volume in Blue Mesa Reservoir; a rapid release was assumed to occur during a period of low stream flow and low water volume in Blue Mesa Reservoir.

Table 5.3. Assumptions used in computing dilution factors for postulated accidental liquid releases from Pitch Project tailings impoundment

	Unfavorable conditions	Favorable conditions
Quantity of tailings liquid released (V_T)	8.88×10^4 m^3 (3.14×10^6 ft^3 or 2.3×10^7 gal)	3.70×10^4 m^3 (1.31×10^6 ft^3 or 9.8×10^6 gal)
Duration of release (t)	10 min	24 hr
Tailing liquid flow rate ($Q_T = V_T/t$)	148 m^3/sec (5233 cfs)	0.43 m^3/sec (15.1 cfs)
Flow in Marshall Creek below Indian Creek (Q_m)	0.21 m^3/sec (7.4 cfs)	0.47 m^3/sec (16.6 cfs)
Marshall Creek dilution factor $[Q_T/(Q_T + Q_m)]$	0.999	0.48
Volume in Blue Mesa Reservoir (V_B)	2.32×10^8 m^3 (8.18×10^9 ft^3 or 6.1×10^{10} gal	6.5×10^8 m^3 (2.3×10^{10} ft^3 or 1.7×10^{11} gal)
Blue Mesa dilution factor $[V_T/(V_T + V_B)]$	3.8×10^{-4}	5.7×10^{-5}

Source: Modified from Homestake Mining Company, "Comments and Revisions to Environmental Report, Pitch Project" (no date), p. 129.

Table 5.4 gives the concentration of contaminants in Marshall Creek and Blue Mesa Reservoir from the postulated accidents. By this conservative analysis, the major impact from a tailings solution release would occur along Marshall Creek where the solution may be essentially undiluted.

Aquatic biota in the immediate area would be destroyed. At greater distances downstream, the concentration of contaminants will be reduced by further dilution by tributary streams and absorption of contaminants by stream sediments. Therefore, immediate impacts to aquatic biota would be reduced at greater distances downstream. Long-duration residual concentrations of contaminants resulting from the initial release may also cause long-term impacts to the productivity of the aquatic biota in the affected streams.

Blue Mesa Reservoir would experience minimal effects from any accidental release of tailings solution as all contaminants would be diluted to well below existing permissible limits.

5.2 ACCIDENTS NOT INVOLVING RADIOACTIVITY

5.2.1 Mine accidents

Environmental effects of nonradiological accidents in the open pit mine, such as a wall collapse, will be minimal. However, injury to personnel and damage to equipment from a large wall collapse could be extensive. A computer-simulated, slope stability study of the proposed open pit mine was conducted in 1976 by the applicant's consultants. Although the results indicate that an open pit mine can be developed at this site with dimensions as indicated in Sect. 3.1, the study also concluded that large wall failures were possible, especially failures of the eastern wall. Aside from the potentially disastrous effects to life and equipment from a large wall collapse, the only environmental impacts would be the need for disposal of additional overburden at the waste dumps.

Table 5.4. Water quality resulting from Pitch Project tailing liquid release from postulated accidents

	Marshall Creek below Indian Creek		Blue Mesa Reservoir	
	Unfavorable conditions[a]	Favorable conditions	Unfavorable conditions	Favorable conditions
Dilution factor	0.999	0.48	3.8×10^{-4}	5.7×10^{-5}
		g/liter		
Carbonate	15.2	7.3	5.8×10^{-3}	8.7×10^{-4}
Bicarbonate	0.5	0.24	1.9×10^{-4}	2.8×10^{-5}
Sulfate	56.5	27.1	2.1×10^{-2}	3.2×10^{-3}
Chloride	3.0	1.4	1.1×10^{-3}	1.7×10^{-4}
Sodium	39.4	1.9	1.5×10^{-2}	2.2×10^{-3}
		ppm		
Ammonia	60	28.8	2.3×10^{-2}	3.4×10^{-3}
Arsenic	3.2	1.5	1.2×10^{-3}	1.8×10^{-4}
Cadmium	0.2	0.096	7.6×10^{-5}	1.1×10^{-5}
Copper	1.0	0.48	3.8×10^{-4}	5.7×10^{-5}
Lead	1.0	0.48	3.8×10^{-4}	5.7×10^{-5}
Molybdenum	65.0	31.2	2.5×10^{-2}	3.7×10^{-3}
Selenium	0.8	0.38	3.0×10^{-4}	4.6×10^{-5}
Vandium	40.0	19.2	1.5×10^{-2}	2.3×10^{-3}
		µCi/ml		
Uranium-238	1.4×10^{-5}	6.7×10^{-6}	5.3×10^{-9}	8.0×10^{-10}
Uranium-234	1.4×10^{-5}	6.7×10^{-6}	5.3×10^{-9}	8.0×10^{-10}
Thorium-230	2.0×10^{-8}	9.6×10^{-9}	7.6×10^{-12}	1.1×10^{-12}
Radium-226	9.8×10^{-8}	4.7×10^{-8}	3.7×10^{-11}	5.6×10^{-12}

[a] An essentially undiluted tailings solution with a pH of 9.

Source: Modified from Homestake Mining Company, "Comments and Revisions to Environmental Report, Pitch Project" (no date), p. 130.

Another potential mining accident would be the accidental detonation of the explosives contained in the magazines. The magnitude of such an explosion would depend on the amount of explosives currently stored. The result, nonetheless, would be a violent pressure-shock wave and possible casualties. The environmental impacts of such an explosion would be a possible crater at the explosion site, dust, and the disturbance of all animals in the vicinity. Because stored explosives will be isolated from mining operations, injury to miners and damage to mining equipment is unlikely to occur. The mill is far enough away from explosives use and storage to prevent any effect on mill circuits.

5.2.2 Mill accidents

The potential for environmental effects from accidents at the Pitch Project mill will be small. Failure of the leach circuit autoclaves or the mill boiler could cause injury to workers but would not involve release of chemicals or radionuclides to the environment. Ammonia will be the only mill chemical that has a harmful vapor. Forced-air ventilation systems will limit hazardous fumes and vapors to safe working levels. Failure of these ventilation systems might result in the interim collection of these vapors in the air of the building. Because the vapors are ultimately discharged to the atmosphere in either case, such a failure would have no effect on the environment.

A number of chemical reagents used in the process will be stored in relatively large quantities on the site (ER, p. 1-4). Specifically, storage tanks will be provided for approximately 23 m^3 (6000 gal) of concentrated sulfuric acid, 15 m^3 (4000 gal) of anhydrous ammonia, 46 m^3 (12,000 gal) of concentrated sodium hydroxide solution, and 200 tons of sodium carbonate.

Additionally, several storage tanks containing fuel oil, diesel fuel, gasoline, oil, and antifreeze will also be on the site. The tanks containing liquid reagents are surrounded by containment embankments.

The other chemical that might affect the immediate environment is ammonia. A break in the external piping of the anhydrous ammonia tank would not result in a release because an excess flow valve would automatically close on a drop in pressure, thus preventing the escape of ammonia. It is possible that the line carrying ammonia to the storage tank from the tank truck could be ruptured, in which case the release rate would be limited to 100 g/sec (400 liters/sec) of ammonia vapor.[9] In this event, the resulting concentration of ammonia at the closest residence is conservatively estimated to be approximately 12 $\mu g/m^3$ during the entire period of release. This concentration, which is well below the 600 $\mu g/m^3$ short-term air quality standard derived from State of Colorado regulations (at 1/30 threshold limit values),[11] is well under both the 40,000 $\mu g/m^3$ needed to produce a detectable odor and the 34,800 $\mu g/m^3$ recommended limit for prolonged human exposure (see Appendix A, HEW comment letter). Thus, the released ammonia would not be a health risk. On the other hand, workers at the mill within a radius of 50 m (164 ft) from the rupture line could be exposed to an ammonia concentration in excess of 10^6 $\mu g/m^3$. At these levels, there exists a risk of suffocation due to tracheal spasm or, for individuals with myocardial disease, of heart attack. Following the initial detection of a strong ammonia odor (at $\sim$40,000 $\mu g/m^3$), however, most healthy individuals should be able to escape the area. Some permanent damage to the pulmonary or ocular tissues is possible, however, depending upon the exposure time to the high concentrations.

5.3 TRANSPORTATION ACCIDENTS

Transportation of materials to and from the mill can be divided into three categories: (1) shipments of refined yellow cake from the mill to the uranium hexafluoride conversion facility, (2) shipments of ore from the mine pit to the mill, and (3) shipments of process chemicals from suppliers to the mill. An accident in each of these categories has been postulated and analyzed, and the results are given in the following discussion.

5.3.1 Shipments of yellow cake

Refined yellow cake product is generally packaged in 208-liter (55-gal), 18-gage drums holding an average of 364 kg (800 lb) and classified by the Department of Transportation (DOT) as type A packaging (49 CFR Parts 171-189 and 10 CFR Part 71). It is shipped by truck an average of 2100 km (1300 miles) to a conversion plant where the yellow cake is transformed to uranium hexafluoride for the enrichment step of the water-cooled reactor fuel cycle. An average truck shipment contains approximately 45 drums, or 16 metric tons (17.5 tons) of yellow cake. Based upon the Pitch Project mill capacity of 174,000 metric tons (192,000 tons) of ore annually and a yellow cake yield of 330 metric tons (360 tons), approximately 20 such shipments are required annually.

From published accident statistics,[12,13] the probability of a truck accident is in the range of 1.0 to 1.6 x 10^{-6} per kilometer (1.6 x 10^{-6} to 2.6 x 10^{-6} per mile). Truck accident statistics include three categories of traffic accidents: collisions, noncollisions, and other events. Collisions involve interactions of the transport vehicle with other objects, whether moving vehicles or fixed objects. Noncollisions are accidents in which the transport vehicle leaves the transport path or deviates from normal operation in some way, such as by rolling over on its top and side. Accidents classified as "other events" include personal injuries suffered on the vehicle, records of persons falling from or being thrown against a standing vehicle, cases of stolen vehicles, and fires occurring on a standing vehicle. The likelihood of a truck shipment of yellow cake from the mill being involved in an accident of any type during a one-year period is approximately 0.06.

The ability of the materials and structures in the shipping packages to resist the combined physical forces arising from impact, puncture, crush, vibration, and fire depends on the magnitude of the forces. These magnitudes vary with the severity of the accident. A generalized evaluation of accident risks classifies accidents into eight categories, depending upon the combined stresses of impact, puncture, crush, and fire. On the basis of this classification scheme, conditional probabilities (i.e., given an accident, the probabilities that the accident is of a certain magnitude) of the occurrence of the eight accident severities were developed.

These fractional probabilities of occurrence for truck accidents are given in column 2 of Table 5.5. To assess the risk of a transportation accident, it is necessary to know the fraction of radioactive material that is released when an accident of a given severity occurs. Two models are postulated for this analysis, and the fractional releases for each model are shown in columns 3 and 4 of Table 5.5. Model I assumes complete loss of the drum contents; Model II, based upon actual tests, assumes partial loss of the drum contents. The packaging is assumed to be type A drums containing low specific activity (LSA) radioactive materials. If the fractional occurrence and the release fractions (loss) for Model I and Model II are considered, the expected fractional release in any given accident is approximately 0.45 and 0.03 respectively.

Table 5.5. Fractional probabilities of occurrence and corresponding package release fractions for each of the release models for LSA[a] and Type A containers involved in truck accidents

Accident severity category	Fractional occurrence of accident	Model I LSA & Type A	Model II LSA & Type A
I	0.55	0	0
II	0.36	1.0	0.01
III	0.07	1.0	0.1
IV	0.016	1.0	1.0
V	0.0028	1.0	1.0
VI	0.0011	1.0	1.0
VII	8.5E−5	1.0	1.0
VIII	1.5E−5	1.0	1.0

[a]LSA: low specific activity.

Source: U.S. Nuclear Regulatory Commission, *Final Environmental Statement on the Transportation of Radioactive Materials by Air and Other Models,* Nureg-0170, Office of Standards Development, February 1977 (draft).

For Model I and Model II, the quantity of yellow cake released to the atmosphere in the event of a truck accident is estimated to be roughly 7400 kg (16,200 lb) and 500 kg (1100 lb) respectively. Most of the yellow cake released from the container would be deposited directly on the ground in the immediate vicinity of the accident. Some fraction of the released material, however, would be dispersed to the atmosphere. Battell Northwest Laboratories has developed expressions, based on actual laboratory and field measurements over several years,[13] for the dispersal of similar material to the environment. The following empirical expression was derived for the dispersal of the material to the environment via the air following an accident involving a release from the container

$$f = 0.001 + 4.6 \times 10^{-4} \, (1 - e^{-0.15ut})u^{1.78}$$

where

f = fractional airborne release,
u = wind speed at 15.2 m (50 ft) expressec in meters per second,
t = duration of the release in hours.

In this expression, the first term represents the initial "puff" immediately airborne when the container fails in an accident. If one assumes that the wind speed is 5 m/sec (10 miles/hr) and that 24 hr are available for the release, then the environmental release fraction is estimated to be 9×10^{-3}. Moreover, if one assumes conservatively that all the yellow cake is insoluble, that all particles are in the respirable size range, and that a population density of 160 people per square mile is characteristic of the eastern United States, the consequences of a truck accident involving a shipment of yellow cake from the mill would be a 50-year dose commitment* to the general population of approximately 13 and 0.9 man-rem to the lungs for Models I and II respectively.

A recent accident (September 1977) involving a commercial carrier, carrying 50 steel drums of uranium concentrate, overturned and spilled an estimated 6800 kg (15,000 lb) of concentrate on the ground and in the truck trailer. Approximately 3 hr after the accident, the material was covered with plastic to prevent further release to the atmosphere. Using the above formula and values of wind speed for a fractional airborne release for this 3-hr release, one approximates that 56 kg (123 lb) of U_3O_8 would be released to the atmosphere. The consequence of this accident would be a 50-year dose commitment to the general population of 11 man-rems for a population density of 160 people per square mile. The consequence for the accident area where the population density is estimated to be 2.13 people per square mile would be a 50-year dose commitment of 0.146 man-rem. This estimate can be compared to a 50-year integrated lung dose of 19 man-rems from natural background.

*Doses integrated over a 50-year commitment following exposure.

The applicant will be required to submit to the CDH an emergency action plan for yellow cake transportation accidents. This emergency action plan is intended to ensure that personnel, equipment, and materials are available to contain and decontaminate the accident area. Submittal of this plan will be a licensing condition.

5.3.2 Shipments of ore to the mill

Uranium ore is shipped to the mill in 32-metric ton (35-ton) batches. The distance from the mine pits to the mill is approximately 3.2 km (2 miles). With mill capacity of roughly 174,144 metric tons (192,000 tons) of ore annually, approximately 5500 trips per year will be required. Although the ore will be shipped on private roads, it is assumed that the probability of a truck accident is in the range cited in the previous section. Therefore, the estimated likelihood of an ore truck being involved in an accident during a one-year period is roughly 0.02.

The ore as it comes from the mine contains a significant fraction of moisture and has a lower percentage of fines than crushed ore. Because of the low specific activity of the ore and the ease of decontamination, the radiological impact is not considered to be significant.

5.3.3 Shipments of chemicals to the mill

Truck shipments of anhydrous ammonia to the mill, if involved in a severe accident, would conceivably result in a significant environmental impact. Approximately six shipments of anhydrous ammonia will be made annually in 18,900-liter (5000-gal) tank trucks from Denver, Colorado, a distance of approximately 282 km (175 miles) from the mill.

The annual U.S. production of anhydrous ammonia that is shipped in that form is approximately 6.9×10^6 metric tons (7.6×10^6 tons). It is estimated that about 26% of the shipments is made by truck (with the remainder by rail, pipeline, and barge). Assuming that the average truck shipment is roughly 19 metric tons (21 tons), it is estimated that 93,000 truck shipments of anhydrous ammonia are made annually. From accident data collected by DOT, there are about 140 accidents per year involving truck shipments of anhydrous ammonia.* For an estimated average shipping distance of 560 km (350 miles), the resulting accident frequency is roughly 2.7×10^{-6} per kilometer (4.3×10^{-6} per mile). The DOT data also reveal that a release of ammonia [770 kg (1700 lb) on the average] resulted from approximately 80% of the reported incidents and that an injury to the general public occurred in roughly 15% of the reported incidents involving a release. (Most of the injuries were sustained by the driver.)

On the basis of these data, the probability of an injury to the general public resulting from an average shipment of anhydrous ammonia is roughly 3×10^{-7} per kilometer (4.8×10^{-7} per mile). These estimates would be expected to be an overestimate for shipments in the vicinity of the Homestake Mining Company Pitch Project because of the relatively low population density.

Nevertheless, accepting this estimate, the likelihood of an injury to the general public resulting from shipments of ammonia to the mill is predicted to be roughly 7×10^{-4} per year. Because neither sodium hydroxide nor sulfuric acid are volatile, the probability of injury to a member of the public not directly involved in the accident is much lower than that for ammonia.

*The DOT accident statistics are extrapolated from the number of shippers reporting, estimated to constitute approximately 10% of the total number of shippers.

REFERENCES FOR SECTION 5

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10. Homestake Mining Company, "Comments and Revisions to Environmental Report — Pitch Project" (no date).

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12. Directorate of Regulatory Standards, U.S. Atomic Energy Commission, *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,* Report WASH-1238, December 1972.

13. Battelle Northwest Laboratories, *An Assessment of the Risk of Transporting Plutonium Oxide and Liquid Plutonium by Truck,* Report BNWL-1846, August 1975.

6. MONITORING PROGRAMS AND MITIGATING MEASURES

6.1 AIR QUALITY

6.1.1 Sampling programs

Meteorological data have been collected since November 1975 at three locations in the Homestake Mining project area. On a 12-m (39-ft) tower near the proposed mine site, wind speed and direction and temperature data were collected to characterize general wind patterns of the region. On a second 12-m (39-ft) tower in the vicinity of the mill and tailings pond, wind speed and direction and temperature data were collected to characterize local wind patterns (ER, p. 6-16). At ground level near this second site, precipitation and evaporation data were collected, beginning in summer 1976. At 3 m (10 ft) above both sites, relative humidity and temperature data were collected from November 1975. The third meteorological station was located near the old Pinnacle Mine, where rainfall and snow were measured.

Air quality data were collected at the old Pinnacle Mine. Quantitative data on particulates were collected once every four days since 21 December 1975. Qualitative samples of atmospheric sulfates and nitrogen dioxide by sulfation plates and acidic gas plates were collected at the sites of the Pinnacle Mine, the proposed mine, the proposed mill, and along Marshall Creek, west of the Indian Creek fork (Fig. 2.1). Because ambient deposition values for sulfur dioxide and nitrogen dioxide were at or below detection thresholds, quantitative measures of these pollutants were not employed (ER, p. 2-209).

Additional air quality data (suspended particulates) from Alamosa, Great Sand Dunes National Monument, Gunnison, and Crested Butte, collected by the Colorado Department of Health (CDH), were utilized to characterize further ambient conditions. Other air pollutants have not been monitored in the region by either governmental or private concerns.

The applicant is committed to collection of suspended particulate samples at six locations near the mill and tailings area. Samples will be collected quarterly during one-week periods and analyzed for suspended particulates, U_3O_8, gross alpha, and gross beta activities (ER, p. 6-60). Preoperational meteorological sampling will also continue unchanged through the period of operations. Further recommendations are that quantitative sampling adequate to determine atmospheric concentrations ($\mu g/m^3$) of sulfur dioxide, oxides of nitrogen, carbon monoxide, and hydrocarbons should be undertaken because the widely accepted models for estimating pollutant concentrations are not particularly valid in mountainous terrain (Sect. 4.1), and no widely accepted model is available for use at the project site. Therefore, valid pollutant measurements that cover at least two years of full-scale operation at the project are required. Results will be submitted annually to the CDH. If pollutant concentrations are well below State standards as expected, discontinuation of the sampling program after two years is likely to be recommended.

6.1.2 Mitigating measures

The applicant is committed to the implementation of the following measures designed to mitigate impacts of the operations upon air quality:

1. To reduce wind erosion of dump surfaces, blasted rock with a minimum amount of fine material will cover all dump areas (ER, p. 3-66).
2. To reduce the volume of exhaust fumes, all internal combustion diesel engines will be maintained in proper operating condition (ER, p. 3-74).

3. To minimize dust emission from drilling, water will be added to the drills' air streams. When blasted material is dry enough to emit dust clouds, the material will be sprinkled with water (ER, p. 3-74).
4. To reduce fugitive dust, all haul roads will be sprinkled as needed (ER, p. 3-74). Exposed construction areas will be watered as needed and will be reclaimed with rapid-growth grasses (ER, p. 4-3). Overburden, ore stockpiles, and the tailings area will be kept moist with water or chemical wetting agents as needed to minimize dusting.
5. State-of-the-art effluent abatement equipment will be utilized in the mill process area. Inspection and maintenance programs will be implemented to ensure that equipment is in proper working order.

These measures, combined with the applicant's operational monitoring program and recommended supplemental air quality monitoring, will be sufficient to ensure minimal impact of mining and milling operations upon air quality.

6.1.3 Prevention of significant deterioration

It should be pointed out that regulations promulgated by the USEPA* require any major source of air pollutants to comply with the Prevention of Significant Deterioration (PSD) of air quality. The purpose of these regulations is to keep clean air clean, and the primary focus is on limiting new emissions of sulfur oxides and particulate matter. Should the release of either of these materials exceed permissible limits, the applicant will be required to modify his system and/or operations to bring the level of emissions into compliance with PSD regulations.

6.2 LAND USE AND TOPOGRAPHY

6.2.1 Mine

Prompt reclamation will be implemented to restore the productivity of mined land as quickly as possible. Utilities and transportation facilities serving the area will be placed to minimize aesthetic and environmental impacts.

The south pit will be partly backfilled with overburden and then revegetated. Benches in the pit will be revegetated. A lake may form in the north end of the pit. Water quality will be monitored long enough to allow it to reach equilibrium and simultaneously treat any discharge as necessary to meet water quality regulations. If the water quality is not acceptable, one of the following actions will be taken: (1) treat the water until acceptable, (2) drain the lake, or (3) eliminate the problem in some other way. If the lake does not form, this part of the pit will be revegetated in the same manner as the rest of the pit. The lake is expected to become a recreational feature and attraction if it forms. Geotechnical programs have been specified by the Colorado Mined Land Reclamation Board (see Appendix K).

6.2.2 Mill

The mill buildings and ancillary structures will be designed to occupy and disturb the minimum area practicable. Sound construction practices will be followed, and such side effects as erosion and sedimentation will be controlled by using acceptable methods. The tailings impoundment will be located to take advantage of the existing topography.

The reclamation measures discussed in Sect. 3.1.3, with respect to grazing, land forms, etc., shall apply, where appropriate, to the construction, operation, and decommissioning of the mill. In addition, the following requirements shall be met:

1. Power line and road alignments shall be designed to preserve natural landscapes, where possible.
2. Mill facilities shall be designed to be attractive in and of themselves.
3. The particular colors used for mill structures will be designed to promote harmony with the natural landscape.

Fed. Regist. 43(118): 26380-26410 (1978) and 44(11): 3274-3285 (1979).

6.2.3 Mitigating measures

The most important impacts to land use will involve disturbance of some 458 ha (1131 acres) of grazing, hunting, trapping, and fishing land. The applicant is committed to a reclamation program (ER, Suppl., Sect. 9) to mitigate long-term impacts of the operations. The program includes the following measures:

1. The overall goal of long-term stabilization will be directed toward establishing permanent forb and shrub species to meet habitat requirements of both livestock and wildlife (ER, p. 9-4).
2. About 12 ha (29 acres) of the open pit mine may be left to form a lake; pit wall slopes will be approximately 45° (ER, p. 9-5).
3. Tailings disposal pond area will be covered with 1 m (3 ft) of compacted clay and 1.5 m (5 ft) of mine overburden, then with about 23 cm (9 in.) of topsoil, and will be revegetated with shallow-rooted grasses and forbs. This area will be restricted as long as required by regulations in effect at the time of reclamation.
4. Overburden dumps will be graded to blend with surrounding topography; sloped toward drainage ditches in the center of each dump to minimize slippage; covered with limestone, sandstone and siltstone consisting of sufficient fine-grained material to promote plant growth, and sufficient coarse material to reduce erosion; and stabilized if needed with mulches during reseeding to control erosion until vegetative cover is established (ER, pp. 9-8 and 9-9).
5. Access and haulage road construction disturbance will be reclaimed upon completion of the roads by (a) respreading available topsoil on shoulders, (b) reseeding shoulders to grass, then where forest land is traversed, seeding trees several years in succession (ER, p. 9-11).
6. The area disturbed by the slurry pipeline will be revegetated with grass seed mixtures after construction, and staging areas, laydown areas, interception canal banks, road cuts, and all other disturbed areas will be revegetated with perennial grasses after construction to prevent erosion and to restore productivity (ER, p. 9-12).

These mitigating measures should be adequate to ensure that impacts to land use will be minimized. The applicant must conform to any additional requirements of Colorado State Agencies and/or the Forest Service.

6.3 WATER RESOURCES

6.3.1 Surface water

6.3.1.1 Environmental monitoring

The applicant has collected environmental baseline information for surface-water quality and aquatic biota in a manner described in the ER, Sect. 6. In part, these data were adequate to predict environmental impacts for the construction and routine operation of mine and mill. In the following sections, specific recommendations will be made to obtain additional information necessary to provide adequate baseline data for the determination of appropriate measures to ensure that any adverse impacts to the environment are minimized and/or mitigated.

None of the spring discharges in the vicinity of the mine reach a perennial stream such as Indian Creek or Marshall Creek, but the applicant will be required to analyze discharges of springs in the mining vicinity for total dissolved solids and pH annually. Should significant changes occur, the springs will be sampled for heavy metals.

As discussed in Sect. 4.3.3 and 4.7.1.2, suspended sediments from exposed mine, dump, mill, and road areas could impose potentially significant adverse impacts on Indian Creek and possibly Marshall Creek. The settling pond planned by the applicant or an equivalent measure will be required. Total suspended solids in Indian and Marshall creeks downstream of major construction areas and in all discharges from settling and treatment ponds shall be monitored during all periods of high runoff and at least monthly at other times to confirm compliance with NPDES permit limitations and State water quality standards. If these limitations and standards are exceeded, the applicant shall institute, as soon as possible, such additional measures of total suspended solids control, satisfactory to the State of Colorado and/or the FS, as will ensure compliance with the above limitations and standards.

Water quality: mine

The applicant (ER, Suppl., Appendix A) presents the chemical characteristics and trace elements of Indian and Marshall creeks (Tables 2.7 and 2.8). It is required that these analyses be continued to monitor any changes in the water quality of the streams. In addition, the analyses of trace element concentrations will be required on stream sediment samples. Sample collection times, techniques, analyses, and locations will be specified by the FS and the Colorado Department of Health. Analytical data should provide information for both a minimum and a potentially worst case of accumulation and toxicity from trace elements. Testing should be continued at a frequency sufficient to ensure protection of the biota in Indian Creek and in Marshall Creek below Hale Gulch. These analyses should also be conducted before any major mining and overburden dumpings occur to establish the necessary background conditions that exist before major alteration of the watersheds. If significant toxic trace element increases are noted during project operation, the applicant shall propose a mitigation plan, such as runoff control measures, satisfactory to the State of Colorado and the Forest Service and then implement its procedures.

Water quality: mill

Because the mill's process water is a closed cycle system between the mill and the tailings pond and because there are no liquid discharges planned routinely from this system, monitoring of surface-water quality associated with the mill will not be required. Any seepage that may enter the groundwater will be monitored according to procedures described in Sect. 6.8.

6.3.2 Groundwater

6.3.2.1 Preoperational

Preoperational groundwater quality and aquifer characteristics were determined between June 1976 and October 1977 from 21 wells at the site. Well locations at the proposed mine, tailings disposal site, and mill are shown in Figs. 2.6, 2.7, and 2.8 respectively. Groundwater data, such as quality, temperature, and elevation, were presented in Sect. 2.4. Well completion methods are discussed in the applicant's Supplement to the ER. It is concluded that the preoperational groundwater monitoring program has adequately described the groundwater quality at the site. It is also concluded that aquifer and groundwater flow characteristics are adequately known at the mine site. The monitoring program will be continued during project operation to check for any unexpected groundwater contamination. If observed, mitigating measures will be implemented.

6.3.2.2 Operational

The groundwater will be monitored quarterly at the mine, the tailings disposal site, and the mill throughout the life of the project. Groundwater samples from these wells will be analyzed for the substances and characteristics shown in Table 6.1. Water well samples will be taken with a nonmetallic bailer from wells with a sufficient amount of water. Prior to sampling, the wells will be bailed to remove stagnant water. Chemical analyses will be done according to *Standard Methods for the Examination of Water and Wastewater.*[1] Measurements made at the time of sampling include temperature (°C), dissolved oxygen, specific conductivity, and pH.

Mine

At present, five wells are completed in the vicinity of the proposed open pit mine (Fig. 2.6). Three of the wells are outside the ultimate boundaries of the pit and will be monitored throughout the life of the mine. Wells DM-14 and DM-12 will be destroyed during mine site preparation. Before well DM-14 is destroyed, it will be replaced by a well constructed either to the west or north, but outside the pit boundary. The depth of all wells, except well DM-13A, is about 30 m (100 ft) below the projected pit floor. Well DM-13A is 18 m (60 ft)

Table 6.1. Substances and characteristics that will be measured quarterly from each well in the Homestake Mining Pitch Project area

Well water level	Five-day biochemical oxygen demai
Specific conductivity[a] (lab, field; micromhos/cm)	Chemical oxygen demand
Total suspended solids	Fecal coliform colonies per 100 ml
Temperature (field)	Total coliform colonies per 100 ml
pH (lab, field)	Turbidity in Jtu[a]
Total dissolved solids[a]	Manganese[a]
Dissolved oxygen (field)	Aluminum
Oil and grease	Beryllium
Total hardness as $CaCO_3$[a]	Arsenic
Acidity	Barium
Total alkalinity as $CaCO_3$[a]	Boron
Bicarbonate[a]	Cadmium
Phenols	Chromium
Carbonate[a]	Copper
Hydroxide	Lead
Chloride[a]	Mercury
Cyanide	Molybdenum
Fluoride[a]	Nickel
Nitrate[a]	Selenium
Nitrite	Strontium
Ortho-phosphate	Vanadium
Sulfate[a]	Zinc
Calcium[a]	Silver
Iron, total[a]	Polonium-210[a]
Magnesium[a]	Lead-210[a]
Ammonia nitrogen	Thorium-230[a]
Organic nitrogen	Uranium (natural)[a]
Phosphorus, total	Radium-226[a]
Potassium[a]	Gross alpha[a]
Silica[a]	Gross beta[a]
Sodium[a]	

[a]Also measured from surface water samples each month.

deep and will monitor a perched water table east of the open pit. In addition, a monitoring well has been constructed in Indian Creek Valley, immediately downslope from the maximum extent of the north overburden disposal area. This well will monitor for seepage from the north overburden pile into the near-surface groundwater. Discharge from the old Pinnacle Mine portal will be monitored from groundwater sampling station GW-3 (Fig. 2.4). As the size of the open pit increases, discharge from the mine portal is expected to stop.

Additional monitoring wells will be added as specified by the Colorado Department of Health. If contamination above applicable standards is noted, the wells will be pumped into the settling pond for treatment. Overburden and low-grade ore leaching experiments indicate that such contamination is not likely.

Tailings disposal area

Seven wells (Fig. 2.7) and two groundwater sampling stations (Fig. 2.4) were constructed around the periphery of the proposed tailings disposal area. The wells range from 3 to 47 m (10 to 154 ft) deep and will monitor seepage through the ridges that will confine the tailings as well as any seepage downstream of the dam in Hale Gulch. Well DM-6 was constructed south of the saddle spillway and will monitor the groundwater along the post-reclamation outlet of Hale Gulch. If contaminated or toxic near-surface seepage through the dam is noted, the applicant will return this seepage to the tailings pond (see Sect. 3.2.4.2.).

Mill site

Four monitoring wells were constructed around the proposed mill site to a depth of about 15 m (50 ft), as shown in Fig. 2.8. Based on the applicant's estimate of groundwater flow in the vicinity of the mill (Fig. 2.5), these wells will detect any groundwater contamination quickly, and appropriate mitigating action will be taken.

6.3.2.3 Postoperational

After completion of the mining and milling operation, the applicant will monitor the groundwater quality from all wells for a sufficient period to ascertain that concentrations of toxic materials are below permissible levels. Samples should be taken semiannually for the first three years and annually thereafter until permissible levels are obtained. Results will be reported to appropriate State agencies. If increases in concentrations of toxic or radioactive materials are noted above permissible levels, the applicant will submit a plan to mitigate the problem. Those wells reporting high concentrations of toxic materials that are the result of the mining operation will be monitored quarterly until these concentrations are reduced to permissible levels. Appropriate water treatment measures, such as ion exchange, will be provided in the event that excessive concentrations of toxic materials are found.

6.3.2.4 Mitigating measures

Except for potential seepage, no effects on groundwater are expected. Monitoring will detect any unexpected problems, and appropriate mitigating measures will be initiated.

6.4 MINERAL RESOURCES

The proposed mining and milling operations for the Homestake Mining Company Pitch Project will not affect the exploitation of other mineral resources that may be discovered on or near the site.

6.5 SOILS

Topsoil material will be stockpiled, where sufficient quantities are available, prior to and during the project operations and replaced on the disturbed areas prior to revegetation. Surfaces of stockpiles will be left in a rough condition to promote moisture retention and to reduce erosion potential. The stockpiles will also be seeded with fast-growing grass species to reduce further erosion until the topsoil material is replaced. Overburden material to be used as a "topsoil" will be treated similarly to that described above.

Soil compaction will be mitigated by restricting off-road vehicle traffic and by ripping and tilling of surface materials. Self-loading scrapers minimize soil mixing and will be used wherever practicable for stockpiling and replacing soil material. Productive soil will not be buried or mixed with sterile or toxic materials. Petroleum and other chemical spills will be cleaned up promptly.

A soil survey will be conducted after surface reshaping and topsoil replacement but prior to revegetation of the disturbed areas. It is recognized that genetic soil horizons will be absent and that characterization of the replaced soils will be based on physical and chemical properties of the different layers in the upper 15 cm (6 in.). However, the survey information should be used to designate the kind and distribution of soils in the reclaimed areas. Chemical analysis of the upper 15 cm (6 in.) should be made to determine characteristics of the replaced material and management needs. Soils interpretations and determination of soil capability classes should be used following reclamation to aid in the management and conservation of the disturbed areas as specified by the FS.

Settling ponds will be constructed at the base of the waste dumps to catch runoff and to settle out any contained particulates.

6.5.1 Mine

The establishment of vegetation on overburden piles and backfill materials will be performed as soon as possible to reduce erosion in accordance with operating plans approved by the FS and the Mined Land Reclamation Board. Toxic or undesirable materials, if encountered, will be buried below 6 m (20 ft) of the surface.

6.5.2 Mill

Runoff from the basin above the tailings impoundment area will be intercepted and diverted. The tailings will be kept moist or other preventive methods will be used to control dust. The tailings area will be inspected each shift by the operating mill supervisor so that any conditions that threaten to cause breaching of the dam will be detected and corrected prior to any spill. The dam will be inspected annually by a qualified engineer to ensure dam stability.

The tailings dam will be inspected quarterly by senior management staff to determine whether additional capacity is needed. When the decision is made to raise the dam, topsoil will be stripped from areas to be disturbed or covered by tailings. The dam will be constructed as previously discussed. At the end of construction, all construction-related disturbance will be graded and revegetated.

6.6 VEGETATION

6.6.1 Mine

Vegetation will be reestablished on virtually all disturbed areas during and following the mining process, with the objective of restoring the premining productivity and use of the land. Mine pits, topsoil, and overburden piles will be vegetated concurrently with mining operations in progress. The applicant plans to vegetate disturbed lands, using a mixture of plants as described previously. Browse species can also be established successfully on disturbed sites and may persist for long periods of time.

Following seeding, the vegetation will be monitored for productivity, ground cover density, and species composition (ER, p. 2-211). Noxious weeds, defined by the Colorado Seed Law, will be controlled on areas disturbed and reclaimed by the applicant.

Fugitive dust from mining operations and haul roads, as it affects vegetation, will be minimized by road watering.

6.6.2 Mill

Reclamation and revegetation of the millsite area will be conducted at the conclusion of the project. The tailings area will be covered and revegetated (see Appendix J).

6.7 WILDLIFE

6.7.1 Terrestrial

Bird community composition and density were determined in spring, summer, and fall season field studies in 1976. Transects 840 m (2800 ft) long and 150 m (500 ft) wide, encompassing 13 ha (32 acres), were established in each major habitat type and then were walked for three consecutive days during early morning hours (ER, pp. 6-40 and 6-41).

Small mammal abundance, diversity, and distribution were determined from two trapping grids, one in mixed conifer forest and one in sagebrush. Each grid contained 12 trap lines, with 12 trap stations per line. Grid trap stations were 15 m (49 ft) apart, covering 3.2 ha (8.1 acres). One live trap at each station was checked at morning and at night for three consecutive nights in spring (late April through early May) and in late summer (late August through early September). Each individual captured was tagged and released. Less intensive trapping was also performed in minor habitats where at least two parallel rows containing a total of 20 to 50 traps at 15-m (49-ft) intervals were operated three consecutive nights in the fall.

Bats were sampled with mist nets in two suitable habitats, for one hour before and one hour after sunset, on three consecutive summer evenings. Each captured individual was identified, banded, and released.

Other small mammal species that were more easily or more accurately described by other methods were also sampled. For example, pocket gopher sampling included counts of mounds as well as selective trapping, and red squirrel sampling consisted of visual observations and call counts during bird surveys. Rabbit and hare sampling was obtained by a roadside strip census on three consecutive evenings during spring and fall. Beaver and muskrat sampling was done by visual observations of signs (lodges, dams, ponds, tracks, vegetation cuttings) during walks of major streams in summer. Other medium-sized mammals (badgers, weasels, and porcupines) were observed and noted during other sampling surveys.

Deer and elk populations were assessed through aerial surveys and from searches for signs that indicated calving areas. General reconnaissance surveys that included deer and elk (as well as reptiles, amphibians, upland game birds, raptors, and certain medium-sized mammals) were accomplished by observation of signs or individuals, while the project area was randomly walked or driven. Additional deer and elk data were collected by pellet-group counts along transects of 40 plots (0.0025 acres per plot) during spring and fall. Habitats of Federal and State proposed or official endangered and threatened plants and animals that potentially could occur at the project site were specifically sought.

Prompt reclamation of disturbed areas will be initiated to restore the productivity of the land as soon as possible. Surface-disturbing activities will be kept to a minimum acreage. Hazardous areas will be fenced. Fencing will be kept to the practicable minimum but would generally include the mill and tailings areas. Downstream environments will be monitored for conditions that could cause detrimental effects to wildlife.

6.7.2 Aquatic

6.7.2.1 Monitoring

In the baseline information, the applicant presented data on the relative abundance of periphyton, numerical and biomass density and diversity of benthos, standing crop, age class distribution and age and growth of trout in Indian and Marshall creeks (ER Appendix, Sect. 4.8.2). In part, these data were adequate to assess the potamological impacts of construction and operation of the mine and mill. To adequately predict future impacts, recommendations have been suggested so that additional analyses be carried out. Those analyses should fall into two separate time sequences: (1) analyses to be carried out prior to any construction activities and (2) analyses to be carried out during construction and routine operation of mine and mill.

6.7.2.2 Analyses prior to construction

The applicant should continue leaching experiments on overburden and low-grade wastes to ascertain that initial results indicating that toxic elements in the leachate will probably not pose a problem are valid. In addition, the applicant shall make a baseline determination of trace elements in the creek sediments.

These data should establish the potential for concentrations of trace elements in the biota of Indian and Marshall creeks prior to implementing the full Pitch Project operations, and further they should shed some light on the potential toxicity of overburden and leachates on the biota of the creeks in case trace elements become a matter of concern during mining activities.

6.7.2.3 Analyses during construction and operation

Trace element body burden of macroinvertebrates and fish should be determined at least once per year during construction and operation of the mine to determine any adverse effects on the diversity and productivity of Indian and Marshall creeks. In addition, potential human health effects from possible trace element accumulation and toxicity should be determined resulting from consumption of fish. These analyses should be coordinated with trace element analyses of the creek sediments described above.

Other biological investigations

The applicant (ER, Sect. 6.2.4) made a general reference that the methods used to establish preoperational baseline conditions will be followed during construction and operation of the Pitch Project. However, it is recommended that the applicant submit a detailed plan on the sampling program to be conducted during construction and operation of the mill and mine. This monitoring program must be reviewed and accepted by the State of Colorado and the Forest Service prior to licensing.

6.7.2.4 Beaver dams

The adverse impacts of any increased sedimentation in Indian Creek due to increased erosion from the overburden dump areas were discussed in Sect. 4.7.1.2. An added suspended load in Indian Creek could affect adversely the spawning habitat of fish and degrade the benthic macroinvertebrate community of the stream. The beaver dams in Indian Creek could further reduce stream velocity and aid the deposition of sediments vertically and horizontally above these dams. Therefore, the rate of sediment accumulation and the degree of habitat degradation immediately above the beaver dams should be evaluated periodically. Beavers frequently abandon their lodges or dams due to the depletion of the nearby food supply; thus, if excessive sediment accumulation and habitat degradation is observed in pools above the beaver dams, consideration should be given to the removal of the abandoned dams to allow the free flow of water. The removal of these abandoned dams may only be accomplished with the review and cooperation of the Forest Service, Colorado Division of Wildlife, and the Colorado Water Quality Control Division.

6.8 RADIOLOGICAL

6.8.1 Preoperational program

A preoperational radiological monitoring program has been conducted at the Pitch Project area to establish the baseline radiation levels and concentrations of radioactive materials occurring in air, biota, and soil as well as in regional surface and local groundwater. The location of the sampling stations is shown in Figs. 6.1 and 6.2; types of samples taken are shown in Table 6.2, while the preoperational radiological monitoring program conducted by the applicant is presented in Table 6.3. The preoperational monitoring program has conformed to applicable State of Colorado regulations.

6.8.2 Operational effluent and environmental monitoring program

The objectives of the effluent monitoring program are to ensure that mine and mill discharges are as low as reasonably achievable, to develop criteria that can be used in the design of new operational procedures, and to aid in the interpretation of the results of such other studies as the environmental monitoring program. The procedures for controlling effluent release and performing monitoring and surveys will conform to applicable State of Colorado and U.S. Government regulations. The program recommended by NRC for measuring radioactivity in the air, surface water and groundwater, soil, and biota is shown in Table 6.4. A mill stack sampling program will be initiated as specified by the Colorado Department of Health, who will license the waste dumps. Details of the waste dump monitoring program will be specified in the license.

6.9 COMMUNITY

Most of the negative impacts associated with new development, including the Homestake Mining Company Pitch Project, can only be mitigated by the combined efforts of the developers, governmental entities and agencies, voters, the housing industry, and others. Any mitigating action can only be considered in this broad context.

6.9.1 Monitoring and coordination

Under the assumption that the population influx will occur mainly in the Gunnison and Salida areas, the actual monitoring of the impacts of the population will be done primarily by the

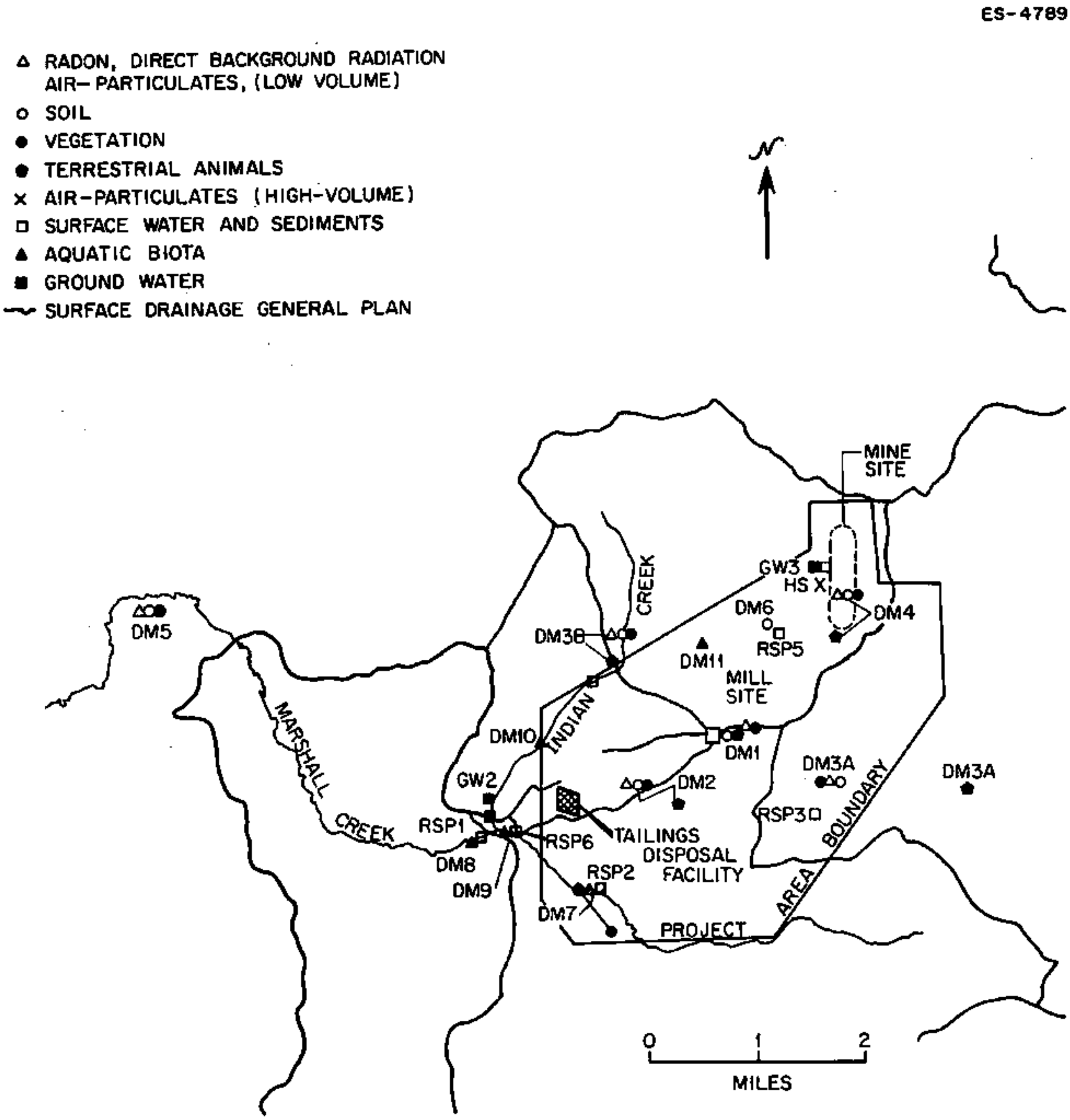

Fig. 6.1. Radiological preoperational monitoring program sampling sites. Source: ER, Plate 6.1-1, p. 6-50.

State and local officials in those areas. To aid them in their monitoring and coordination, it is suggested that the applicant have designated individual responsible for liaison with local and State officials. This individual should be in a position to provide advance hiring information to the local officials so that they can plan mitigation measures. The liaison might also help to relieve impacts by keeping track of the housing market and by notifying potential employees of the availability of housing.

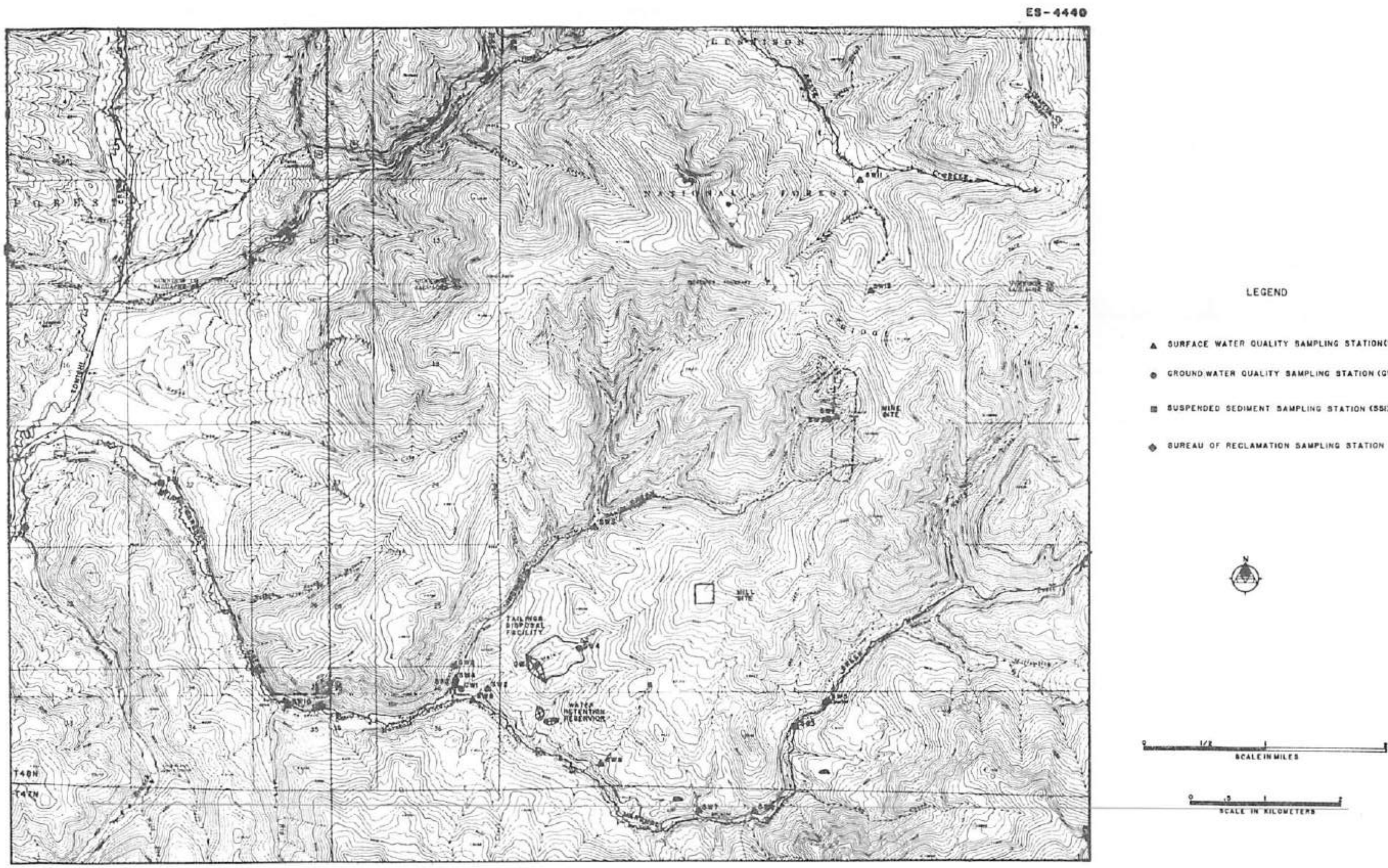

Fig. 6.2. Preoperational water quality sampling stations. Source: ER, Plate 2.6-10, p. 2-159.

Table 6.2. Sample station and type

Station designation	Sample type collected							
	Groundwater	Surface water	Sediment	Air	Soil	Vegetation	Aquatic biota	Terrestrial animals
DM-1				X	X	X		X
DM-2				X	X	X		X
DM-3 (A and B)				X	X	X		X
DM-4				X	X	X		X
DM-5				X	X	X		X
DM-6					X			
DM-7						X	X	X
DM-8							X	
DM-9							X	
DM-10							X	
DM-11							X	
HS				X				
GW-1	X							
GW-2	X							
GW-3	X							
RSP-1			X					
RSP-2		X	X					
RSP-3		X	X					
RSP-4			X					
RSP-5			X					
SW-1[a]		X[a]						
SW-2		X						
SW-3		X						
SW-4		X						
SW-5		X						
SW-6		X						
SW-7		X						
SW-8		X						
SW-9		X						

[a]Surface water sampling locations are indicated on Fig. 6.2.

6.9.2 Public finance

As estimated by the applicant, the impacts on public finance will not result in mitigation being required of Homestake Mining Company. If the tax revenues that were forecast fail to materialize, some financial assistance beyond taxes by Homestake Mining Company may become necessary. The primary candidate for these measures would be the Salida School District because the school taxes are anticipated to be divided by Saguache and Gunnison.

6.9.3 Other goods and services

As indicated in Sect. 2.10.5, the availability of other goods and services is anticipated to be adequate to meet the demands of new community members in Salida and Gunnison. If problems do arise, the sewage treatment facility in Gunnison will probably be the first service to be affected. The availability of natural gas is limited, but alternatives exist in the form of propane, electricity, coal, and oil.

6.9.4 Housing

The applicant will maintain contact with the cities of Gunnison and Salida and the counties of Gunnison and Chaffee to inform city and county officials of employment plans. The purpose of such communications will be to aid advance planning so that housing impacts will be minimized.

Table 6.3. Preoperational radiological monitoring program

Location	Sampling schedule	Radionuclide analysis
	Air	
Downwind (east) of proposed mill building in area of maximum potential deposition at approximate location of restricted area fence	At each location particulate samples collected for one-week periods and radon measurements made, sampling done three times, June, August, and October 1976	Radon-222, uranium, thorium-230, radium-226, polonium-210, lead-210
Downwind (east) of proposed tailings site in area of maximum potential deposition at approximate location of restricted area fence		
Two locations at the project area boundary in the areas of maximum potential concentration (east and northwest of the proposed mill location)		
Generally downwind (east of ore dump area and old leach pad)		
Nearest residence to site (Sargents, WSW of site)		
	Direct radiation	
Two at each air sampling location	TLD measurements read monthly (June–October)	Gamma radiation
	Water	
In Marshall Creek at three locations — upstream (SW8), at point of drainage, and downstream (beyond confluence) of potential tailings drainage	Grab samples collected during August and October to supplement sampling conducted from February to May 1976	Dissolved and undissolved uranium, thorium-230, radium-266, polonium-210, and lead-210
In Indian Creek at three locations — upstream (when possible), in region of drainage from ore dump, and mine portal		
Three existing wells, same as groundwater sampling wells		
	Soil	
In vicinity of each of the air sampling locations	Samples collected during June, August, and October 1976	Uranium, thorium-230, radium-226, polonium-210, lead-210
	Vegetation	
In vicinity of each of the air sampling locations	Samples collected during June, August, and October 1976	Uranium, thorium-230, radium-226, polonium-210, lead-210
In breeding pasture areas south of Marshall Creek		
	Terrestrial animals	
In same location as vegetation samples	Small mammal samples collected during June, August, and October 1976	Uranium, thorium-230, radium-266, polonium-210, lead-210
	Aquatic biota	
In Marshall Creek above, at, and below region of potential drainage	Fish samples collected during June, August, and October 1976	Uranium, thorium-230, radium-226, polonium-210, lead-210
In Indian Creek in region of inflow from ore dumps and below inflow		
	Sediment	
In same locations as surface water samples	Sediment samples collected during May, August, and October 1976	Uranium, thorium-230, radium-226, polonium-210, lead-210

Source: ER, Table 6.1-1, pp. 6–47, 6–48, and 6–49.

Table 6.4. Operational environmental monitoring program

Type of sample	Sample collection			Sample measurement	
	Number	Location	Method and frequency	Test frequency	Type of measurement
Air					
Particulates	3[a]	At site boundaries and in different sectors having the highest predicted concentrations	Continuous; weekly or more frequently as required by dust loading	Quarterly composite	Natural uranium, Ra-226, Th-230, and Pb-210
	1	At nearest existing or potential residence (Sargents or fee land)	Continuous; weekly or more frequently if required by loading	Quarterly composite	Natural uranium, Ra-226, Th-230, and Pb-210
	1	Control location—more than 15 km from mill site in least prevalent wind direction	Continuous; weekly or more frequently if required by dust loading	Quarterly composite	Natural uranium, Ra-226, Th-230, and Pb-210
Radon gas	5[a]	Same as for air particulates	Continuous; at least one week per month at approximately the same period each month	Monthly	Rn-222
Water					
Groundwater	3[a]	Down gradient (hydrologically) and relatively close to the tailings impoundment	Grab; monthly (quarterly after first year)	Monthly	Dissolved natural uranium, Ra-226, Th-230; dissolved Pb-210 and Po-210
	1	Control location—hydrologically up gradient (not influenced by tailings seepage)	Grab; quarterly	Quarterly	Dissolved natural uranium, Ra-226, Th-230; dissolved Pb-210 and Po-210
	1 (from each well)	Each well used for drinking water or watering livestock or crops within 2 km of tailings pond or mine[b]	Grab; quarterly	Quarterly	Total natural uranium, Ra-226, Th-230; total Pb-210 and Po-210
Surface water	2 (from each stream)	Surface waters passing through the mill or mine sites (Indian Creek, Marshall Creek, etc.); one sample upstream and one downstream of location of potential influence	Grab; quarterly	Quarterly	Total natural uranium Ra-226, Th-230; total Pb-210 and Po-210
Direct radiation	5	Same as for air particulate samples	Thermoluminescence dosimeters (changed quarterly) or sensitive gamma radiation survey meter	Quarterly	Measurement of x-ray and gamma-exposure rates
Soil	5	Same as for air particulate samples	Grab; annually	Annually	Natural uranium and Ra-226
Vegetation or forage	3	From animal grazing areas near mill site which have the highest predicted concentration (including Sargents or fee land)	Grab; three times during grazing season (i.e., April, July, and October)	Each sample	Ra-226 and Pb-210

[a]Program component from Regulatory Guide 4.14.

[b]If a large number of wells are located within 2 km, only those wells nearest tailings impoundment or the mine need be sampled.

6.9.5 Cultural impacts

Because both Gunnison and Salida are centers of tourism and because Gunnison is the site of a college, it is assumed that their cultures have evolved in such a way as to create substantial tolerance for newcomers. Therefore, no special provisions for monitoring and mitigating cultural impacts are called for.

6.10 CHANGES IN THE MONITORING PROGRAMS AND MITIGATIVE MEASURES

As data from the various monitoring programs are accumulated, some objectives of the programs will be realized in whole and in part. It may be desirable to modify the existing programs as these objectives are recognized. Proposed modifications initiated by the applicant will be submitted to the appropriate agencies for evaluation and approval. Other modifications may be submitted by these agencies.

After mining and milling operations are completed, the entire site will be surveyed for radioactive contamination. Radioactive material will be removed and disposed of in accordance with regulations in force at the time. Present Colorado license conditions and regulations require that the tailings disposal area be monitored following reclamation.

The applicant is required to post a bond sufficient to guarantee that the above requirements are fulfilled.

REFERENCE FOR SECTION 6

1. American Public Health Association, *Standard Methods for Examination of Water and Wastewater*, APHA, New York, 1971.

7. UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

7.1 AIR QUALITY

An unavoidable impact upon air quality stemming from construction and operation of the mine and mill will be an increase in atmospheric concentrations of chemical and radioactive suspended particulates and other pollutants (Sect. 4.1). The effects of these emissions on regional air quality will be insignificant because of the relatively low release rate and the ample dispersion characteristics produced by the mountainous terrain. Federal and State air quality standards for the area are not expected to be exceeded.

7.2 LAND USE AND TOPOGRAPHY

7.2.1 Topography

Some destruction of natural features will occur, and unfortunately the exact shape and contours of the existing setting are unrestorable due, in part, to overburden expansion and placement. The final high walls exposed in the north pit will remain because of the more serious adverse effects that could result if they were sloped back. The tailings impoundment will remain, containing about 28 ha (69 acres) of tailings.

7.2.2 Land use

There will be a temporary change in land use of about 101 ha (250 acres) for livestock grazing and about 458 ha (1131 acres) for wildlife habitat. Reclamation is expected to restore productivity on most of these lands so that conditions are equal to, if not better than, those previously existing. The north pit, with its possible lake, will remain.

Increased and improved access to the project area will result in additional maintenance costs and a higher potential for accidents. The 28-ha (69-acre) stabilized tailings impoundment, under present Colorado regulations, will not be available for further productive use.

Recreational patterns will change temporarily because of the project. After reclamation, most of the existing recreational activities could resume.

7.3 WATER RESOURCES

7.3.1 Surface water

Construction and routine operation of the mine will require the removal of surface vegetation and the disposal of overburden material above the headwater area of Indian Creek. Although soil stabilization and revegetation will take place as rapidly as possible, erosion from these exposed areas will increase sedimentation and possibly trace element leaching from these exposed areas at least temporarily. Many of these sediments, and possibly the trace elements, may reach Indian Creek and may adversely affect the periphyton, benthic macroinvertebrate, and trout populations in Indian Creek. During the spring period of snowmelt (April, May, and June), total suspended solid (TSS) concentrations in Indian Creek normally increase to approximately 30 to 40 mg/liter. Runoff from these exposed areas could attain total suspended solids concentrations of 500 mg/liter or higher prior to retention in the proposed settling pond. Sediment concentrations may also increase during summer spates, which usually occur in June, July, and August. The proposed pond will reduce total suspended solids and sedimentation in Indian Creek. If State standards or NPDES permit limitations are exceeded after the pond is installed, additional mitigative measures will be required to ensure compliance.

Construction activities associated with the tailings pond and water storage reservoir will expose surface areas to increase erosion temporarily. The impacts from this erosion will be minimal. Because there will not be any liquid discharges from the mill or tailings pond into the surface waters, these facilities and their routine operations will not have any adverse environmental impacts. If surface water is diverted from Marshall Creek for project use only during periods of high stream flow, no adverse effects will occur.

7.3.2 Groundwater

Groundwater flow down Hale Gulch and in the vicinity of the mine pits will be altered as a result of the mining and milling operation. Groundwater quality at the tailings disposal site and waste dumps will be lowered, but the region influenced is expected to be small. Groundwater from mine dewatering will be consumed in the milling process and for road sprinkling and reclamation, if available. Any excess will be treated if necessary and discharged to Indian Creek. The NPDES permit restrictions will control the quality of any water discharged from the site.

7.4 MINERAL RESOURCES

No other minerals have been uncovered at the site in sufficient enough quantity to be considered economically important at present. Therefore, except for the extraction of the uranium ore, no unavoidable adverse impacts to mineral resources are expected.

7.5 SOILS

The alteration of soil horizons, parent materials, and other soil characteristics that have developed over long periods of geologic time cannot be avoided. Disturbance of soils may lower the natural soil productivity to some degree because of soil compaction, accelerated erosion, and mixing of natural soils. The present soil biota and soil forming processes will be affected. Soil development will commence after the disturbed areas are reclaimed, but the developing soils will probably have characteristics unlike those existing prior to mining.

7.5.1 Mine

Soil disturbance on 303 ha (748 acres) of mined area, overburden dump areas, and topsoil stockpiles, along with 6.5 ha (16 acres) of settling ponds, and 16.2 ha (40 acres) of haul roads cannot be avoided (Table 3.1). The mined area will be the most severely disturbed because the entire soil profile and overburden will have been removed.

7.5.2 Mill

Soil disturbance on the 87 ha (215 acres) used for the mill site, tailings area, and stockpiled topsoil cannot be avoided. The soil disturbance at the mill site will not be severe because only a few inches of soil material will be removed and stockpiled. Soil disturbance for the tailings pond may stem from any of three major reasons: (1) the stripping and stockpiling of topsoil, (2) the compaction of subsoils to reduce permeability, and (3) the possible need for additional clay from other sites in the project area.

7.6 VEGETATION

7.6.1 Mine

Vegetation on approximately 324 ha (804 acres) may be removed over the life of the project (Table 3.1); about 12 ha (29 acres) may be converted to a permanent lake. Plant species composition and diversity will be altered temporarily because of the disruption of the natural vegetation and subsequent revegetation. Fugitive dust from haul roads will affect remaining vegetation, but the extent of the impact cannot be quantified.

7.6.2 Mill

Vegetation on about 87 ha (215 acres) at the mill site will be removed with another 47 ha (110 acres) used for access roads and ancillary facilities. Revegetation of disturbed, but not occupied, millsite area will be initiated immediately after construction ends. Revegetation of occupied areas will be initiated when mill facilities are removed. The tailings pile will remain but will be capped with clay and topsoil and then revegetated.

7.7 WILDLIFE

7.7.1 Mine

Loss of habitat and the temporary displacement of wildlife populations will occur. The only permanent losses will be a result of the existence of highwall areas in the north pit. Some replacement will occur because of the revegetated benches on the highwall. However, the benefit is most likely to affect only forest nongame species. Some losses of microfauna will be noticed when their habitats are destroyed during operations. The effect of mine operation on aquatic species is discussed in Sect. 7.3.1.

7.7.2 Mill

The mill and tailings area will contribute to the adverse effects on wildlife populations and their habitats. The tailings pond may contain radioactive materials and other contaminants that may be harmful to wildlife. However, the impact is expected to be minor because access to the pond will be restricted by fencing.

7.8 RADIOLOGICAL IMPACTS

Emissions of radioactive particulates and radon-222 from mining, transportation, storage, and milling of ore will increase the level of radioactivity in the surface environment. The amount of increase, however, is small compared to the natural background level (Sect. 4.8).

7.9 COMMUNITY

7.9.1 Public finance

With less than 150 families moving into the area, the institutional frictions in the public sector should not be noticeable. According to estimates provided by the applicant, the incurred costs of social services should be more than offset by increased tax revenues.

7.9.2 Social impacts

With careful management and planning, there should be no adverse unavoidable and irretrievable societal impacts. The 150 operations workers and their families should be assimilated fairly easily, particularly given the apparent openness of Gunnison and Salida to new faces. Some of these 150 families are already local residents in contrast with those who will move into the area, so there should be even less difficulty in accommodating the newcomers. The Homestake project will have some effects on the local economy through competition in the local labor market and a resulting general increase in prices in the long term.

7.9.3 Cultural impacts

With careful management and planning and with attention to valued aspects of the local culture, there should be no unavoidable or irretrievable cultural impacts.

7.9.4 Present status

On the Pitch Project area, ore was removed from 1959 to 1962 from the underground Pinnacle Mine. In 1967 unsuccessful attempts were made to reopen this mine. In 1969 an open pit mine and attempts to leach ore left in the underground mine stopes were begun. Leaching operations were abandoned in 1972 for economic reasons, but pit mining continued.

The area is not untouched forest, and when final reclamation is complete, it is likely that the final condition of the area will be better than it is at present.

8. RELATIONSHIP BETWEEN SHORT-TERM USAGE AND LONG-TERM PRODUCTIVITY

8.1 AIR QUALITY

Over the expected 11- to 25-year life of the Homestake Mining Company Pitch Project, emissions of suspended particulates and gaseous effluents associated with project activities may contribute to the decline of local and regional air quality, even though predicted concentrations are within State and Federal standards. Following project termination, however, the air pollution sources will be eliminated. The long-term air quality at the Homestake site will not be significantly affected by the project.

8.2 LAND USE AND TOPOGRAPHY

Project operations will cause a short-term reduction in carrying capacity of the local grazing resource and a reduction in hunting opportunities. Reclamation may increase forage yield and thus the amount of forage available to livestock and wildlife. Transportation routes in the area will be improved by upgrading existing roads and constructing new ones. The north pit highwalls and possible surface water are expected to represent a permanent loss of grazing area and timber production. However, the lake that may form in the mining pit would provide an increased amount of surface water which may represent a change in use to include recreation activities and a source of livestock and wildlife water. The tailings area, however, under present regulations must be considered unavailable for further productive use for the foreseeable future.

The short-term disruption of the landscape will not adversely affect the long-term aesthetics with the proper mitigating measures applied. The mill structures will be designed to be interesting and in harmony with the site for the short-term usage of the site. Removal of mill facilities and appropriate site restoration could enhance landscape aesthetics in a long-term time frame.

8.3 WATER RESOURCES

8.3.1 Surface water

Sedimentation and trace element leaching may reduce the biological diversity and productivity of Indian Creek prior to the completion of soil stabilization and revegetation efforts. The water quality and biological productivity of Indian Creek should return to preconstruction levels when such measures are effectively employed. The water usage from Indian and Marshall creeks for this project should have no adverse effects on the surface water quality and biological communities of these creeks.

8.3.2 Groundwater

In general, groundwater movement will be altered, groundwater quality may be lowered, and some springs in or near the open pit either will be destroyed or will suffer a reduction in flowrate. Currently, the area is used primarily for wildlife habitat, livestock grazing, hunting, and fishing. Since the early 1950s, however, the area has been intermittently mined for uranium, and timber has been logged for use in underground mines. Long-term productivity is measured in terms of wildlife habitat, livestock grazing, and recreation. The altered groundwater flow, possible reduced discharge from springs, and the possible lowering of groundwater quality may reduce slightly the long-term productivity of the area.

8.4 MINERAL RESOURCES

As yet, no other mineral resources have been found on the Homestake site in sufficient quantity to warrant serious economical consideration. Therefore, except for the extraction of the uranium ore, the relationship between short-term usage and long-term productivity is not of major importance. The proposed operations do not preclude extracting other minerals of future economic importance from any of the reclaimed areas, with the possible exception of the area under the mill tailings.

8.5 SOILS

8.5.1 Mine

The longterm productivity of soils in the mined areas is expected to be equal to its original potential or to be improved, according to predicted land capability potential, by the reclamation practices proposed by the applicant.

8.5.2 Mill

The possible long-term productivity of soils in the mill area will be equal to its original potential or will be improved. The estimated forage production potential of reclaimed soils should increase compared to the present production levels. Although the tailings area, about 28 ha (69 acres), will be reclaimed, under present regulations it will be removed from productive use for the foreseeable future.

8.6 VEGETATION

8.6.1 Mine

The existing vegetative cover on about 325 ha (804 acres) will be systematically removed as each ore body, or portions thereof, are excavated (Table 3.1). Reclamation and revegetation of the mined areas will be initiated concurrently with cessation of mining activities in a given area. A satisfactory vegetative cover can be reestablished within a two- to three-year period and should be available for use by livestock and wildlife within four years after the ore has been extracted. Conversion of planted vegetation to communities comprised of original species compositions, through natural plant succession, may require as much as 50 to 100 years.

8.6.2 Mill

Vegetation would be removed from about 132 ha (325 acres) during construction of the mill access roads and ancillary facilities. Revegetation of disturbed, but not occupied areas will begin as soon as possible. After mill closure, the rest of the land would be available for revegetation. Long-term productivity and successional implications are the same as those associated with the mine in Sect. 8.6.1.

8.7 WILDLIFE

8.7.1 Mine

Existing wildlife habitat on 325 ha (804 acres) will be destroyed or otherwise altered by mining activities, with varying portions being revegetated and reclaimed during the life of the project. The planted vegetation will undergo natural successional changes, and much of the character of the original vegetation may be restored. This restoration, however, will occur over a long period of time, perhaps 50 to 100 years.

8.7.2 Mill

Development of the 132-ha (325-acre) mill site and the related facilities will affect the local productivity in the same manner as discussed in Sect. 8.7.1.

8.8 RADIOLOGICAL

The buried tailings deposit may constitute a radiation hazard that is minor but will continue far into the future. The operational and postoperational environmental monitoring programs will provide a basis for detecting and assessing any additional impacts that might lead to long-term effects so that timely corrective action can be taken if required.

8.9 COMMUNITY

The construction and operation of the Homestake Mining Company Pitch Project should have minimal long-term socioeconomic impact on the surrounding communities. Because population growth resulting from the project will be small compared to projected growth from other sources, project-induced expansion of community services and facilities will be minimal.

The short-term usage of the site for mining and milling operations will probably preclude any future discoveries of archaeological or other artifacts. Any artifacts within the project area, however, should be found and salvaged before or during project-related activities. Thus, no long-term effects on archaeological resources are expected, except for the artifacts that might be buried under overburden or tailings.

9. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

9.1 AIR QUALITY

Following project termination and reclamation, local and regional air quality will not be significantly different than it would have been if the project had not been undertaken. Therefore, no irreversible or irretrievable commitments of air quality resources are foreseeable because of the proposed mining and milling operation.

9.2 LAND USE AND TOPOGRAPHY

Some highwall areas will consist of cliffs, and probably very little vegetation will ever become established. These cliffs will represent only a small portion of the mine pit. These highwalls and any lake in the bottom pit will be an irreversible commitment of the topography and of land use opportunities. Benches in the pit will be revegetated and will be habitat for certain forest species, such as tree squirrels and birds. The land occupied by the reclaimed tailings impoundment will be removed from productive use for the foreseeable future.

9.3 WATER RESOURCES

9.3.1 Surface water

Other than the drainage area of the tailings pond, the Homestake Mining Company Pitch Project does not seem to require any irreversible or irretrievable commitments of surface water resources. The drainage area in Hale Gulch, which is not affected by the tailings pond, will be diverted into the next unnamed watershed. Once the tailings pond is filled and covered by clay and topsoil, runoff from this area will again be available for the water budget of Marshall Creek without any degradation in water quality.

9.3.2 Groundwater

The open-pit mine will irreversibly alter the groundwater flow in the vicinity of the Chester Fault zone and will destroy several springs. Near-surface groundwater movement down Hale Gulch may be blocked because of the tailings dam. The tailings impoundment in Hale Gulch, although buried and sealed by clay, must be monitored under present state license conditions and regulations to ensure that local groundwater is not contaminated. Groundwater consumed during milling, or discharged from the mine during operation, will be irretrievably lost from the area but will be replaced by precipitation.

9.4 MINERAL RESOURCES

Other than the uranium that will be mined, no irreversible or irretrievable commitment of mineral resources from the site is expected.

9.5 SOILS

9.5.1 Mine

The productivity potential of reclaimed soils differs from that of the original resource and is a commitment of the soil resource. The productivity of the acres committed to highwalls and the potential water body will be lost, although this loss may be compensated partially by increased productivity in the surrounding area.

9.5.2 Mill

Under present reclamation plans, the development and use of 28 ha (69 acres) of the project site for the tailings pond may be considered as rendering this land unavailable for further productive use.

9.6 VEGETATION

Removal of vegetation during construction and operation commits the applicant to the reestablishment of satisfactory vegetative cover when mining is concluded. This reclamation activity will involve substantial human and financial resources for an undetermined period of time.

Research and current reclamation projects of this nature indicate that vegetation can be reestablished in the area (see Appendix J). Therefore, project activities will not result in an irreversible or irretrievable commitment of the site vegetation.

9.7 WILDLIFE

Mining and milling activities will essentially preclude the use of 458 ha (1131 acres) of land by wildlife for the duration of the project. Ultimately, species of wildlife will return when suitable habitat is restored. However, short-term loss of some wildlife species will occur. Aquatic species may suffer a short-term loss but should repopulate the affected streams after project completion.

9.8 COMMUNITY

Any destruction of archaeological or paleontological sites or materials will be an irreversible loss of the resource to the extent that the artifacts or fossils are not recorded and/or salvaged in an appropriate manner. If any sites are found, their loss for future study by improved methods is irretrievable.

10. ALTERNATIVES

10.1 ALTERNATIVES TO PROPOSED MINING AND RECLAMATION PLAN

The prospector and miner have a statutory right under the 1872 Mining Laws and the Forest Service's 1897 Organic Act to enter upon National Forests for prospecting and mining purposes. The applicant has filed an operating plan (36 CFR Part 252) for the Pitch Project that has been approved by the U.S. Forest Service (FS). The MLRB granted the applicant a Development and Extraction Mining permit on 19 April 1978 in compliance with the Colorado Mined Land Reclamation Act of 1976. A bond is required to ensure completion of land restoration by the applicant and to monitor the tailings disposal area as required by Colorado regulations and expected license conditions.

10.1.1 Regulatory alternatives

10.1.1.1 No action

"No action" on the mining and restoration proposals is not an option under existing Federal and State laws.

10.1.1.2 Defer action

Final action on the mining and reclamation plan may be deferred for proper causes, which can include, but are not limited to, the following:

- modification of the proposal to correct administration or technological deficiencies,
- new design to minimize environmental impacts,
- aquisition of additional data to provide an improved basis for technical or environmental evaluation, and
- further evaluation of the proposal and/or alternatives.

The preparation of this Environmental Statement has effectively deferred certain other administrative action on the project since the Forest Service Environmental Analysis Report was approved 25 March 1976. The Colorado Mined Land Reclamation Board permit was issued 19 April 1978. The limitations of the approved operating plan currently in effect are found in Appendix D.

This Environmental Statement, prepared to implement the requirements of the National Environmental Policy Act of 1969, addresses all of the impacts of the project as discussed in the Foreword.

10.1.1.3 Reject the mining and reclamation plans

Rejection of the proposed full-scale mining and reclamation plans for the Pitch Project would result in no further environmental impact on the project site, subject to modification by natural processes. Large-scale open pit mining operations have been in progress on the site since 1969.

Any proposed activity that does not meet the prescriptions of applicable law and regulations, including the potential for environmental impact that could be reduced or avoided by adoption of a different plan of action by the applicant, could be cause for rejection; de facto rejection without specific legal basis is not an option.

10.1.2 Mining alternatives

Selection of a mining method adaptable to recovering a mineral resource is based upon (1) the spatial characteristics of the deposit (size, shape, attitude, and depth); (2) the physical (or mechanical) properties of the mineral deposit and surrounding rock; (3) groundwater and surface-water conditions; (4) economic factors, including grade of the ore, comparative mining costs, and desired production rates; and (5) environmental factors, such as the preservation of the surface overlying the mine and the prevention of air and water pollution. Of these factors, the spatial characteristics of the deposit and the physical (or mechanical) properties of the mineral and surrounding rock technically and economically limit the methods that can be employed to mine it. Previous mining on the site has demonstrated that only open pit mining is a viable method of mining these uranium deposits under the existing state of technology and the existing geologic conditions in the area.

10.1.2.1 Open pit mining

The open pit method is most effective and most used where ore bodies are at or near the surface and where there is ample suitable location for disposal of overburden within the economic constraints of haul distance. The earth surrounding the ore body is removed to expose the ore. As the ore is mined at depth, the overburden and middle waste are removed, creating a depression or pit. The ultimate limit of depth of an open pit mine is an economic limit. The limit is that point at which the cost attributable to a ton of ore plus the company's profit per ton of ore is equal to the net market value of that ton of ore.

10.1.2.2 Solution mining

In situ leaching involves the drilling (from the surface) of injection and recovery wells into the ore body. An acidic or alkaline solution is pumped down the injection wells into the ore-bearing strata; this solution dissolves the uranium minerals which can be reached through the pore spaces in the rock. The uranium-containing leach solution is then recovered by pumping it to the surface through the recovery wells. The dispersal of the leaching solution and/or contamination of the groundwater is the primary environmental impact risk. Uranium deposits, which are small, isolated, and too deep to be mined economically by other methods, may be recovered by in situ leaching under the following general conditions:

1. The ore is generally horizontal and is underlain by relatively impermeable stratum.
2. The ore is in a saturated stratum below the static water table.
3. The fluid transmissivity and storage capability of the ore-bearing formation and the mineralogy of the ore are known.
4. A maximum recovery of the acidic or alkaline leach solution is possible (a primary impact of concern involves an incomplete recovery of the leachate).

The Pitch Project ore occurs in shales, siltstones, and dolomites that do not have the permeability necessary for good in situ extraction. The ore bodies would make recovery of leach solution unreliable. In situ leaching is considered an undesirable alternative at the Homestake site with little potential for mining a major portion of the ore bodies and a strong potential for permanently contaminating local groundwater.

10.1.2.3 Underground mining

At the Pitch Project, uranium ore mainly occurs in a zone approximately 122 m (400 ft) wide. Abundant faults and widespread brecciation have tended to separate the ore into pods that are distributed randomly throughout the mine site. Depth to the ore bodies varies from surface to over 213 m (700 ft) deep.

Because the ore is widespread and randomly concentrated, more extensive shafts, drifts, and crosscuts would be required than when mining a continuous ore body. In addition, because of the faulted and fractured character of the host rock, excessive artificial support measures would be required to provide for employee safety. The applicant estimates safety provisions would reduce ore recovery by 21% when compared to open pit mining. Moreover, past experience at the underground mine previously operated on the site documents difficulty in maintaining standards for ventilated air (ER, p. 10-7).

It is considered that increased employee hazard, lower ore recovery, and the reclamation plan proposed by the applicant for the open pit alternative would make underground mining a poor alternative to the proposed open pit mining.

10.1.3 Reclamation alternatives

The basic goal of reclamation for any alternative is the same, that is, return as much of the land as possible to uses equal to or exceeding current capabilities. After evaluating various approaches to this goal, the studies indicate the best solution at this time to be the proposed reclamation plan. The opportunity remains to improve upon this proposal as new knowledge and experience are acquired.

The proposed reclamation plan is based on a certain set of circumstances, for example, an open pit, particular location of mill site, tailings, roads, and an estimated time frame. Any other alternative would have to assume a different set of circumstances.

10.1.3.1 Mining reclamation alternatives

As concluded above, the only viable method for recovering the maximum amount of the ore is open pit mining. There are different configurations by which this can be done, for example, reduce highwalls to 3:1 instead of 1.5:1 or 2:1, backfill the entire pit (include the tailings), backfill partially, etc. The basic conclusions relating to reclamation of these different strategies are (1) the basic reclamation will be the same for each strategy stated; (2) the reclamation goal will be achievable; and (3) reclamation costs are secondary to mining and tailings management costs.

The FS and the Colorado Mined Land Reclamation Board review proposed reclamation procedures and consider alternatives as the project proceeds. As such, present proposals have been accepted but will be modified as deemed desirable to improve both environmental protection and reclamation. (See Appendices D, J, and K.)

10.2 ALTERNATIVE SITES FOR MILL AND MILL TAILINGS DISPOSAL FACILITIES

The following criteria were used in selecting a suitable site for the Pitch Project mill:

- topographical considerations, including reasonably flat surfaces upon which facilities could be constructed with minimum alteration of terrain, land with suitable drainage characteristics and not subject to flooding, a site on an uphill gradient from the tailings disposal area that would allow tailings slurry to be gravity fed, and a relatively accessible area with limited public exposure;
- no known ore beneath mill location;
- clear title to land, if possible, allowing the applicant to control sufficient surface area;
- adequate subsurface support to prevent building foundation problems; and
- minimization of the distance between the mill and the mine.

Similarly, the major considerations involved in selecting the optimum tailings disposal site included the following:

- The chosen site should have topographic characteristics that provide maximum storage capacity with minimum embankment height and volume.

- The size of the drainage area above the tailings reservoir should be minimized.
- Minimization of seepage control requirements should be considered.
- There should be available onsite clayey material for sealing purposes.
- Proximity to natural and man-made areas that would be affected by construction, operation, and possible failure of the tailings disposal facilities should be of paramount concern.
- There should be no known ore beneath tailings disposal site.

The overriding consideration for selecting a mill site was the selection of an appropriate, nearby, environmentally acceptable tailings impoundment.

10.2.1 Alternative mill sites within the Pitch Project area

Utilizing the above criteria for mill site selection, two alternative mill sites within the Homestake Mining Company Pitch Project area were evaluated. Both of the mill sites considered by the applicant are located on the ridge dividing the drainage basins of Indian and Marshall creeks (Fig. 10.1). The site selected (Site 1) was chosen because it was geographically closer to the mine and because its higher elevation allowed the mill slurry to be gravity fed via a pipeline system to any of the nearby areas selected for tailings disposal.

The land requirements and the process emissions are essentially independent of the location of the mill. The terrain, vegetative cover, and hydrology are very similar for the alternative sites investigated; therefore, the environmental impacts for the two mill sites evaluated would be approximately the same. However, locating the mill at Site 1 would necessitate the installation and operation of a tailings slurry pipeline system that is longer [approximately 1.6 km (1 mile)] than the pipeline required if the mill were located at Site 2. This increased pipeline length increases the probability of environmental damage if the pipeline system were to fail.

10.2.2 Alternative tailings disposal sites within the Pitch Project area

Five sites for mill tailings disposal facilities were investigated. Four of the sites are located within the Homestake Mining Company Pitch Project area; the fifth site is situated at the Gunnison mill site near the city of Gunnison, Colorado. The Gunnison alternative was rejected primarily because of the increased potential for environmental damage as well as excessive transportation and dam construction costs. (This alternative is discussed in greater detail in Sect. 10.4.)

The disposal site selected (Site A) is located on a downhill gradient approximately 1.6 km (1 mile) from the proposed mill site. Because the alternative tailings disposal sites are located in the same general sector of the Pitch Project area, the environmental impacts associated with each alternative would be similar. Clayey materials are available at all sites, with each site possessing small, similar drainage basins. The proposed tailings disposal site was selected because the topography was such that the embankment needed to impound the tailings would be minimized, a factor important in decreasing stability problems, providing enhanced control of seepage, and reducing seepage monitoring requirements. Additionally, the site is located in a relatively secluded area.

Based on the applicant's criteria, the proposed mill and tailings disposal sites chosen were reasonable selections. Additional site selections will be discussed in detail in Sect. 10.4.

10.2.3 Alternative mill and tailings disposal sites outside the Pitch Project area

After considering a number of factors, the alternative of siting the mill outside the Pitch Project permit area was rejected primarily because of topography problems (locating and purchasing land with suitable characteristics for mill construction and tailings disposal), unavailability of surface control, and increased distances from the mining activities (greater possibility of airborne contamination and greater ore-processing costs) (ER, Sect. 10, p. 15).

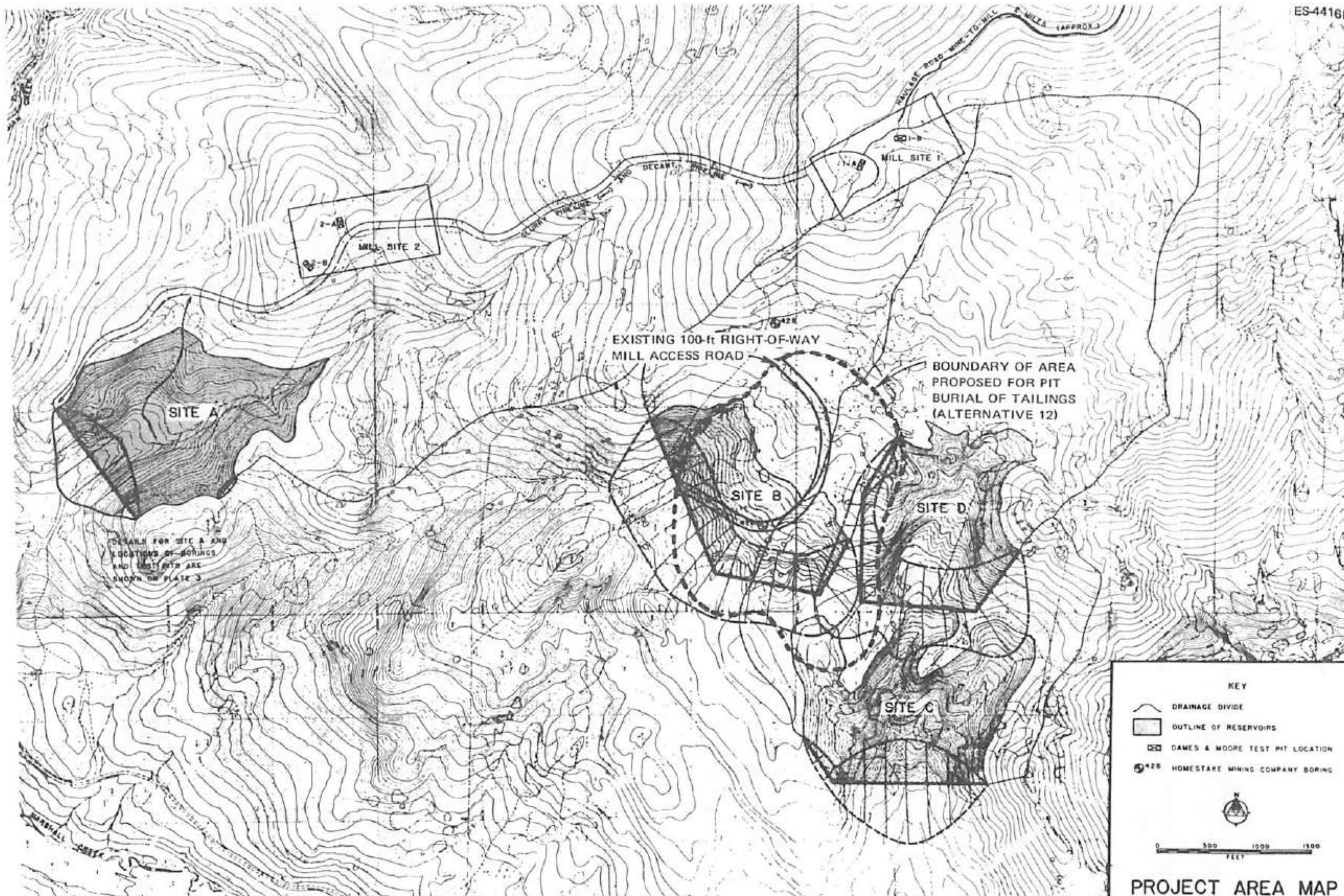

Fig. 10.1. Project area map. Source: ER, Appendix A, Plate 2.

The applicant evaluated the following alternatives: (1) milling ore at an existing ore processing facility (see Sect. 10.5); (2) mining and milling the ore at the Pitch site and offsite tailings disposal at an abandoned mill area located near Gunnison, Colorado (see Sect. 10.4.2, Alternative 7); and (3) locating the mill and tailings impoundment in Section 36, T.48N, R.5E, NMPM. in Saguache County (land adjacent to and southwest of the Pitch permit area).

Although the applicant has applied for a conditional extension of a mining lease for the Section 36 property (which is State property), the alternative of locating the mill and tailings disposal facilities on this land was rejected by the staff for the following reasons:[1]

1. Marshall and Indian creeks are joined in Section 36; therefore, the tailings impoundment would have to be placed closer to the stream channels.

2. Surface-water diversion problems would be increased (compared to those at the Hale Gulch) because the drainage basin is large.

3. Seepage problems from the tailings area might increase because the thicknesses of the relatively impermeable volcanics at Section 36 are significantly less than the thicknesses observed at Hale Gulch.

4. The Section 36 location would increase the ore haulage distance from the mine and increase the amount of land disturbed by construction. Additionally, the haulage road would also cross a stream channel.

5. The Section 36 site would be more accessible to the public and could be seen by travellers on the Marshall Creek road.

Although there are several environmental advantages that can be derived from siting the mill and tailings disposal area on land other than within the Pitch Project permit area (e.g., reduced surface disturbance of forest land and elimination of potential tailings storage impacts, including groundwater contamination, radon gas emanation and gamma radiation, windblown dusts, and restriction of land use), these benefits may be offset by equivalent or more deleterious impacts at alternative locations. The possibility of locating the mill and disposal facilities at alternative offsite locations was investigated, and the staff concluded that no net environmental advantage would accrue for several reasons.

1. Due to the topography of the land in the vicinity of the permit area, minimal potential exists for locating a mill and tailings impoundment other than on a watershed that eventually leads to a river system. The watershed east and west of the Continental Divide drains to the Colorado and Arkansas rivers respectively.

2. Within any reasonable ore transport distance from the project site, regardless of altitude, disposal problems similar to those encountered at the Pitch site would have to be solved. The base of the proposed tailings impoundment is at an elevation of about 2800 m (9200 ft). All runoff from the proposed mill site would drain to this impoundment. The elevation of Sargents, approximately 8 km (5 miles) away, is about 2580 m (8450 ft), and the elevation of Gunnison, 43 m (27 miles) away, is about 2300 m (7600 ft). To the east by road are Monarch pass at 3630 m (11,898 ft) and Marshall pass at 3300 m (10,846 ft). After crossing either pass one finds that the elevation decreases to 2150 m (7050 ft) at Salida. Within these limits, a potential altitude reduction of only about 610 m (2000 ft) is possible.

3. The applicant has proposed locating the tailings impoundment on a 1.0 km^2 (0.4 sq mile) natural drainage with no permanent flow. The applicant proposes to use a canal to divert runoff from 0.75 km^2 (0.3 sq mile) of the natural drainage area involved around the tailings impoundment. The remaining 0.25 km^2 (0.1 sq mile) would be used for tailings disposal during the lifetime of the project. It is unlikely that at other practical offsite mill locations a satisfactory impoundment site utilizing as little land would be available. Any impoundment, wherever located, would then be covered with nearly impermeable clay, overburden, and topsoil and revegetated in a manner deemed acceptable to the State of Colorado for the protection of public health and safety. The impoundment dam and lining design would have to be evaluated and approved by cognizant agencies of the State of Colorado.

4. The mined ore would have to be transported over the public highway system in heavy trucks, which would increase the accident potential for careless automobile drivers as well as increase the use of scarce petroleum resources.

10.3 ALTERNATIVE MILL PROCESSES

In typical ore-processing facilities, uranium is removed from the ore and "... concentrated to an intermediate, semi-refined product often referred to in the industry as 'yellow cake' ...."[2] In general, yellow cake is produced by the milling of uranium ore via the following procedure: (1) ore preparation (involving primarily the crushing and grinding of the ore), (2) leaching, (3) separation of pregnant leach liquids from waste solids (tailings), (4) concentration and purification of the uranium by extraction from the pregnant solution, (5) precipitation of the uranium from the leach solution, and (6) drying and packaging. The specific manner in which each of these steps, singly or in combination, is accomplished varies from mill to mill, depending on differing ore characteristics. Normally, process decisions are based on overall economic considerations, including costs associated with the treatment of air, water, and land pollution problems.

Crushing and grinding of ore are needed to reduce overall particle size to ensure efficient contact with the uranium dissolving reagent. Normally, the ore is moved from stockpiles to the crusher via trucks, bulldozers, or by front-end loader.[3] Conventional crushing equipment usually reduces the size of the ore particles to approximately minus 3/4 in. Control of the moisture level in the feed ore is crucial in the crushing process and generally should be less than 10%. In most mills the crushed ore is stored temporarily in bins before further processing. Grinding is usually accomplished by rod or ball mill with the ore ground to approximately 28 mesh for acid leaching and to approximately 200 mesh for alkaline leaching.[3] The Pitch Project mill will utilize a crusher to reduce the ore particles to minus 3/4 in. mesh size, with about 544 metric tons (600 tons) of the crushed ore being transferred daily from a fine-ore storage bin to the grinding circuit. The grinding mill will operate in a closed circuit with a classifier and will utilize a wet process, operating at approximately 68% solids, with the classifier overflow at about 35% solids.

The leaching method chosen for removal of the uranium from the ground ore is heavily dependent on the chemical properties of the ore. Ores containing low levels of basic materials (primarily lime) are usually leached with sulfuric acid. An alkaline leach reagent (normally sodium carbonate-bicarbonate solution) is usually used when the lime content of the ore is high. Acid could also be used to leach ore of this type, but larger quantities of acid would be required, significantly increasing process costs. Because the carbonate mineral content of the Pitch ore is high, the applicant has chosen to employ a leaching process utilizing sodium carbonate and sodium bicarbonate solutions. The slurry product from the grinding circuit will be thickened and pumped to a series of pressurized agitated leach tanks where steam (from a coal-fired boiler), compressed air, and the alkaline leaching solution will combine to dissolve the uranium. Two alternative leaching techniques, alkaline heap and alkaline vat, were rejected by the applicant because tests indicated that uranium recovery rates would be poor if these processes were used. The separation of the pregnant leach solution (which contains over 90% of the uranium in the ore) from waste solids is commonly accomplished by thickening or filtration. The applicant has chosen to achieve liquid-solid separation by employing a multistage, horizontal belt, vacuum filtration circuit. The pregnant liquor from the first filtration stage will go to a clarification section where a thickener and sand clarifier will remove solids that passed through the filtering circuit into the pregnant solution. The clarified pregnant solution will go to the pregnant solution storage area and then to the precipitation section.

The milling process generally concludes with the recovery of the uranium from solution by chemical precipitation. When alkaline leach processes are used, the uranium is normally precipitated as a sodium diuranate by adding caustic to clarified carbonate-bicarbonate solutions to increase the pH to approximately 12.[2] An alternative procedure precipitates the uranium as UO_2, utilizing hydrogen reduction (used only in Yugoslavia).[2] At the Pitch mill, yellow cake will be precipitated as sodium diuranate by adding sodium hydroxide to the clarified solution. Impure yellow cake will be sent to a purification section to be redissolved in sulfuric acid, reprecipitated with ammonia, and washed with ammonium sulfate to remove additional sodium. The purified uranium concentrate will then be sent to the drying and packaging section. Satisfactorily pure yellow cake from the caustic precipitation step will bypass the purification stage. The drying, storage, and packaging sectors will be isolated and enclosed in an area that is maintained at a negative air pressure. The drier and packaging area emissions will be removed by fans and treated to remove particulate matter.

The milling methods proposed by the applicant are conventional, fully researched procedures and are as environmentally sound as other processing combinations. Further developments, such as changes in the characteristics of the ore or unexpected changes in the relative costs of reagents, may result in the applicant's initiating changes in the process. When such changes are suggested, the environmental impacts associated with their implementation will be assessed and the relative merits of each viable alternative reexamined by the Colorado Department of Health.

10.4 ALTERNATIVE METHODS FOR TAILINGS MANAGEMENT

10.4.1 Introduction

For the purposes of this section, tailings management is defined as the disposition of the tailings and waste leach solutions following extraction (separation) of the uranium-bearing solutions. Engineering techniques to control pollutants from tailings storage, both during operational and postoperational stages of a milling project, have been demonstrated. The unique characteristics of each facility must be identified, and then appropriate environmental controls must be applied. Alternatives considered by the applicant[4] as well as alternatives considered for other mills have been examined in preparing this section.[5-7] Alternatives presently available, or feasible (i.e., potentially available with existing technology and within legal constraints), are described in Sect. 10.4.2 and evaluated in Sect. 10.4.3. A list of additional alternatives for tailings management and treatment that were considered and rejected is presented in Sect. 10.4.4.

Each alternative tailings management plan has been evaluated against the following set of performance objectives designed to ensure that potential public health hazards that otherwise could occur in the operation of the project are avoided or minimized.

Siting and design

1. Locate the tailings isolation area remote from people such that population exposures would be reduced to the maximum extent reasonably achievable.

2. Locate the tailings isolation area so that disruption and dispersion by natural forces are *eliminated* or reduced to the maximum extent reasonably achievable.

3. Design the isolation area so that seepage of toxic materials into the groundwater system would be eliminated or reduced to the maximum extent reasonably achievable.

During operations

4. Eliminate the blowing of tailings to unrestricted areas during normal operating conditions.

Postreclamation

5. Reduce direct gamma radiation from the impoundment area to essentially background.

6. Reduce the radon emanation rate from the impoundment area to about twice the emanation rate in the surrounding environs.

7. Eliminate the need for an ongoing monitoring and maintenance program following successful reclamation.

8. Provide surety arrangements to ensure that sufficient funds are available to complete the full reclamation plan and provide for ongoing monitoring and maintenance as required by Colorado regulations.

10.4.2 Viable alternatives for tailings management

Alternative I: Burial at head end of natural valley (tailings covered with clay cap, overburden, and topsoil)

This alternative consists of constructing an above-grade tailings impoundment by damming the head end of a natural valley (Hale Gulch, Site A) approximately 1.6 km (1 mile) southwest of the proposed mill site (Fig. 10.1). As proposed by the applicant, the tailings disposal area would be sized to contain 544 metric tons (600 tons) per day of tailings produced during 25 years of mill operation. The tailings dam and reservoir would be constructed in stages, each stage having a capacity to hold wastes produced during four to six years of mill operation. The applicant estimates that approximately 14 ha (35 acres) would be required for the first stage and 2 to 4 ha (5 to 10 acres) in each succeeding expansion. The vertical core of the retention dam would be constructed of compacted clay, with the initial dam being sized to accommodate four to six years of tailings. This dam would be approximately 26 m (85 ft) high with a freeboard allowance of 4.6 m (15 ft) to contain a probable maximum flood, and an additional freeboard allowance of about 1.5 m (5 ft) for wave protection. To provide for 25 years of mill operation, the final embankment would be approximately 43.3 m (142 ft) high, with a tailings capacity of approximately 4.5×10^6 metric tons (5.0×10^6 tons). The applicant estimates that the tailings dam and reservoir would cover approximately 28 ha (69 acres) of surface area if the mill were to operate for 25 years; the total affected acreage would be approximately 70 ha (174 acres).

Based on considerations of such criteria as slope and surface-water diversion, the dam design will minimize erosive conditions on the embankment (i.e., gullying, water sheet, and wind erosion). For the long term, the only current proven means of eliminating these erosive conditions is by providing a vegetative or riprap cover on the embankment. The applicant has proposed a vegetative cover and has initiated a testing program to determine its feasibility. Immediately following the final dam lift, the embankment will be seeded. During the remaining operating phase (approximately four to six years), the vegetation will be monitored. Where the use of vegetation as an erosive deterrent has not prevented surface deterioration, riprap will be utilized. If erosion continues to be a problem, riprap will be installed over the entire embankment.

The applicant has proposed to line the floor of the tailings storage area with a minimum of 0.6 m (2 ft) of compacted clay to minimize the seepage of liquid waste from the impoundment area. The pond liner and foundation material will be designed in accordance with current engineering practices for preventing piping. The final design must be submitted to the Colorado State Engineer Office for approval. Because there will be a small thickness of alluvium (<15 ft) beneath the clay liner, differential settlement is not expected to be severe enough to compromise the liner integrity. In addition, the tailings solution will be alkaline and will probably result in swelling the clay liner, thereby making it self healing. The applicant's consultant estimates that the maximum seepage from the impoundment area when filled and after a probable maximum precipitation would be approximately 55 m^3/day (10 gpm). Without a probable maximum precipitation, seepage was estimated to be about 28 m^3/day (5 gpm).[8]

The staff estimated the combined seepage through the core wall and the bottom of the impoundment to be a maximum of 49 m^3/day (9 gpm), assuming a pond size of 28 ha (69 acres), an average pond depth of approximately 11.3 m (37 ft), and a clay permeability of 10^{-8} cm/sec (approximately 0.01 ft/year). The actual seepage rate from the impoundment is expected to be less than the maximum calculated figure because the fine mill tailings produced by the alkaline leach process should begin to seal further the bottom of the pond during the early years of mill operation,[9] and no consideration is given to the resistance to flow of the settled tailings or the underlying tuff. In addition, the impoundment would be slowly filling over a 25-year period. A suitably designed drain consisting of clean, fine-to-coarse sand would be placed on the downstream side of the embankment core to collect seepage coming through or under the dam. This seepage, if contaminated, will be collected in a sump and pumped back into the tailings retention area. Contaminated seepage, if detected in the groundwater monitoring wells, would be returned to the tailings retention area by pumping these wells.

The tailings would be deposited by closely spaced spigots along the dam slope, forming an exposed beach of tailings sands. The tailings sands would be saturated with spigotted tailings liquid, thus minimizing any potential for adverse environmental impacts on offsite areas caused by windblown sands and dusts. If windblown tailings begin to affect the local environment adversely, the applicant will be required by license condition to control release of airborne particulates from tailings by use of a water sprinkler system, chemical stabilization, covering with soil, or other equivalent means.

During the operational phase, surface water would be routed around the disposal area, and the entire disposal area would be fenced.

Reclamation would commence after cessation of mill operations and as soon as the tailings area has dried sufficiently to allow the movement of equipment over the pile. The tailings would be capped with compacted clay obtained from local deposits, with this cover being graded and shaped to prevent the impoundment of surface rainfall. To reduce radon gas emanation and gamma radiation from the tailings to acceptable levels, the slimes portion, which will contain the majority of the radionuclides, would be covered with 1.2 m (4 ft) of compacted clay; 0.6 m (2 ft) of compacted clay would cover the sands portion. The clay cap would then be covered by 1.5 m (5 ft) of mine overburden waste material and 23 cm (9 in.) of topsoil. The clay cap will be designed so that it will not be damaged by differential settlement of the tailings. Under prevailing climatic conditions, the clay cap is not expected to develop shrinkage cracks as a result of drying out. The area would be revegetated and, where necessary, fertilized and mulched. The applicant has proposed to seed the tailings area with a mixture of shallow-rooted grasses and forbs selected to minimize the probability of root penetration into the tailings. (Refer to Sect. 3.1.3.3 for a breakdown of amounts and types of species to be included in the seed mixture.)

The reduction of the gamma radiation that would result after an application of overburden is dependent on the degree of compaction and mass stopping power of the overburden. As shown in Appendix H, the 2 m (6 ft) of overburden and topsoil alone, excluding the clay cover, is estimated to reduce the gamma radiation from the tailings pile to approximately 0.015 millirems per year above the background radiation dose of about 110 millirems per year attributed to the radionuclide content of the soil.

The radon emanation from the uncovered surface of the slimes and sand portions of the tailings is estimated to be 904 $pCi/m^2 \cdot sec$ and 288 $pCi/m^2 \cdot sec$ respectively. The covering scheme proposed by the applicant [0.6 m (2 ft) of compacted clay over the nonslimes and 1.2 m (4 ft) of compacted clay over the slimes areas followed by 1.5 m (5 ft) of overburden, and 23 cm (9 in.) of topsoil] is estimated to reduce the radon emanation rate from the nonslimes section to approximately 2.0 $pCi/m^2 \cdot sec$, which is 2.4 times the background radon emanation rate of 0.83 $pCi/m^2 \cdot sec$ estimated for the proposed tailings area. For the slimes section, the covering is calculated to reduce the radon emanation rate to approximately 0.2 $pCi/m^2 \cdot sec$, or essentially background level. If the proposed reclamation plan were modified so that the clay cap over the tailings area would be a uniform thickness of 1 m (3 ft) and then overlain with 1.5 m (5 ft) of overburden and 23 cm (9 in.) of topsoil, the surface radon flux over the slimes and nonslimes sections would be 1.12 $pCi/m^2 \cdot sec$ and 0.35 $pCi/m^2 \cdot sec$, which are less than twice the estimated background emanation rate. See Appendix G for calculations and assumptions used to derive the above figures.

After the overburden layer is placed over the entire tailings surface, work would begin on a spillway to be located in the saddle on the southeast side of the impoundment area. This spillway will be constructed of high-strength, reinforced concrete, approximately 0.46 m (18 in.) thick. It will be large enough to pass a probable maximum flood (136 m^3/sec; 4800 cfs) with a probable cross section of 46 m (150 ft) wide by 1.5 m (5 ft) deep. A concrete cutoff will also be constructed in a trench beneath the spillway to eliminate the possibility of seepage or erosion under the spillway. This cutoff will consist of a concrete wall approximately 0.46 m (18 in.) thick extending several meters down from the center of the spillway. The top of the dam will be left high enough to divert runoff to the spillway and prevent any runoff flow, including the probable maximum flood from topping the dam. It should be noted that the total drainage area of Hale Gulch above the proposed dam is 1.0 km^2 (0.4 square mile).

Once this reclamation plan is complete, the diversion ditch will be allowed to fill with silt and revegetate naturally. After this occurs, runoff in Hale Gulch will flow gently across the stabilized tailings pile, through the spillway, and into an existing unnamed drainage south of Hale Gulch and eventually into Marshall Creek.

This reclamation plan was developed to eliminate the need for long-term maintenance of the deposited tailings. The proposed spillway will eliminate the possibility of erosion cutting back into the tailings; also, because the elevation of the spillway will be higher than the highest level of tailings, erosion cannot cut through the overburden or clay cap to expose the tailings. As water flows down Hale Gulch changing from the natural slope of about 10% to the

0.2% slope, deposited sediment will form a delta over the stabilized tailings. Sediment buildup should continue until the slope over the stabilized tailings approaches the natural slope, thus burying the tailings under several additional meters of earth. Therefore, rather than the risk of exposure of the tailings increasing with time, this proposed reclamation plan should cause the risk to decrease with time.

Present Colorado regulations and expected license conditions would require that a monitoring and maintenance program be established following reclamation to ensure stability of the tailings.

With the topsoil, overburden, and liner thicknesses proposed by the applicant, the estimated total cost of Alternative 1 is about $7.8 million (1977 dollars) over the 25-year life of the project. The reclamation portion of this cost is estimated to be $1.9 million. Additional costs would be the loss of the tailings retention site [approximately 28 ha (69 acres) of surface area] for other uses because the area under present Colorado regulations would be permanently restricted. Minor costs would be temporary noise and dust generated by the cover construction activities.

A major benefit of the proposed program will be a high degree of protection for the buried tailings from wind and water erosion. In addition, there will be a reduction in gamma radiation and radon release to acceptable levels.

The reclaimed tailings impoundment area will not be aesthetically intrusive because the natural contours of Hale Gulch will merge smoothly into the nearly flat, revegetated surface of the impoundment, and the exposed surface of the dam has a slope no greater than much of the local terrain. Furthermore, the existence of surrounding hills will form a protective barrier against wind erosion.

Alternative 2: Burial at head end of natural valley (tailings covered with overburden and topsoil)

With the exception that no clay liner would be used to cover the tailings, Alternative 2 is the same as Alternative 1. The tailings would be covered with sufficient overburden and topsoil to reduce the radon flux and gamma radiation to acceptable levels. The pile would then be revegetated with appropriate plant species.

To reduce the radon flux from the slimes section of the tailings to twice background (1.66 pCi/$m^2 \cdot$sec) would require a uniform cover of overburden and topsoil approximately 7.7 m (25.2 ft) thick, assuming a 0.23 m (0.75 ft) layer of topsoil. The applicant estimated that a 1.2-m (4-ft) cover of overburden over the tailings pile would cost approximately $1,112,000 [assuming 25 years of mill operation at 544 metric tons (600 tons) per day]. Therefore, utilizing a layer of overburden instead of a combination of clay and overburden to reclaim the tailings area and to reduce the radon flux to an acceptable level would increase reclamation costs from approximately $1.9 million to about $7.0 million.

Because the tailings would not be covered with a relatively impervious cover, as would be provided by a layer of compacted clay, surface water may percolate through the tailings pile, increasing seepage through the clay liner on the bottom of the impoundment area. However, because the overburden area would be very thick, potential problems by penetration of plant roots into the tailings pile would be eliminated.

Alternative 3: Burial at head end of natural valley (disposal area lined with synthetic materials)

Alternative 3 is the same as Alternative 1 except that no clay liner would be installed beneath the tailings retention area, and no compacted clay core would be installed within the dam structure. To prevent seepage from the tailings impoundment, a synthetic liner of CPE (chlorinated polyethylene) would be installed on a sand base on the bottom of the retention area and on the upstream face of the dam.

Artificial liners, if installed without damage and properly maintained, would eliminate the possibility of adverse environmental impacts caused by seepage from the tailings impoundment area. Synthetic liners have been reported to fail because of subsoil settlements, puncture by rocks, splitting at seams, or entrapped air bubbles;[10] however, the probability of failure can be greatly reduced by careful placement and use of liners procured from reliable manufacturers.

The tailings pile would be covered with a layer of compacted clay, overburden, and topsoil of the same configuration as proposed for Alternative 1. Therefore, the reduction in radon emanation and gamma radiation would be the same as estimated for Alternative 1. Additionally, stabilization of sands and dust and revegetation of the pile area would proceed as described in Alternative 1.

The placement of the CPE liner over the bottom of the disposal area and on the upstream face of the dam would bring the total cost to approximately $11.54 million.

Alternative 4: Burial at head end of natural valley (covering tailings with a synthetic cap

Alternative 4 involves covering the dried tailings with an artificial liner, such as asphalt or PVC plastic, to control radon emanation and gamma radiation and to prevent percolation through the stabilized tailings pile. Overburden would be placed on top of the cap to hold the liner in place, with the pile being contoured, shaped, fertilized (if necessary), and revegetated with appropriate plant species. The bottom of the retention area would be lined with 0.6 m (2 ft) of compacted clay (the same as for Alternative 1).

Adverse environmental impacts resulting from airborne contaminants from the tailings (including radon gas emanation) would be significantly reduced following complete placement of the cap. A 5-cm (2-in.) layer of asphalt would reduce the radon flux from the tailings by a factor of 10,000. However, gamma radiation will penetrate these artificial covers, with the surface flux being dependent upon the thickness of the overburden over the liner. Therefore, sufficient overburden and topsoil would be required to reduce gamma radiation to the natural background level, to prevent plant root penetration into the tailings, and to minimize erosion problems.

The major hazards involved in this alternative are the limited life of the artificial liner, probably in the range of 20 years to a few hundred years, and the risk of the soil cover slipping off or being eroded away. Although the short-term benefits of Alternative 4 would meet the desired objectives, the long-term viability of this system is questionable.

Alternative 5: Depleted mine pit burial

The applicant has investigated the possibility of disposing of the tailings in an open pit mine (the south pit). Because the ore blend designed for milling precludes accelerating the mining schedule of a single pit, the applicant contends that a temporary tailings storage area would be required. This impoundment area would have to be sized to contain approximately six years of tailings. If the temporary tailings retention area were installed at the Hale Gulch site (Site A), it would cover about 14 ha (35 acres), with the dam being approximately 26 m (85 ft) high. The temporary tailings retention area would also require a clay liner, monitor wells, dust control, and a runoff diversion ditch to ensure environmentally safe operation. Tailings slurry and decant return pipelines between the mill and the tailings retention area would still be necessary. The same seepage problem would exist as with Alternative I, decreased by the difference in dam height. Because a retention dam is utilized in the temporary retention area, there would be the same small risk of accidental tailings release due to embankment failure.

Once mining operations in the south pit end, the pit walls below the grade elevation of the mine would be excavated to reduce the slopes from 1:1 to 3:1. Additional overburden dump areas would be required for the disposal of 4.9×10^6 m^3 (6.5×10^6 bank yd^3) of intact waste rock produced in this operation. As the tailings would be stored below the expected final water table, the pit bottom and side walls would be lined with clay. The applicant doubts that a reliable liner can be constructed over the highly faulted formations in the pit[1] as does the staff (private communication from the Oak Ridge National Laboratory to the Nuclear Regulatory Commission, 30 January 1978). If groundwater pressure breaches the clay liner, percolates into the tailings, and again enters the surface environment as spring flow at higher elevations, contamination of Indian Creek could occur. The present contaminated flow from the old Pinnacle Mine is an example. A slurry pumping system would be built between the pit and the mill. This slurry transport system would have to operate at high pressure (the mill is at a lower altitude than the mine pit), and this condition would increase the risk of an accidental release of tailings slurry.

After construction of the south pit tailings site, the tailings in the temporary pond would be pumped to the pit. Contaminated soils and materials would be hauled to the tailings area in the south pit. The temporary pond area would return to its original contour and be revegetated with appropriate plant species.

After the completion of mill operations and as the tailings reach sufficient dryness to allow the movement of equipment over the pile, it is proposed that the pile be covered with layers of compacted clay, overburden, and topsoil of the same configuration as proposed for Alternative 1 [1.2 m (4 ft) of compacted clay over slimes or 0.6 m (2 ft) compacted clay over sands, 1.5 m (5 ft) overburden, and 23 cm (9 in.) topsoil]. Therefore, the radon gas and gamma attenuation estimates would be the same as for Alternative 1. The area would be revegetated with appropriate plant species.

Potential long-term disadvantages stem from the fact that the mine pit is located on a steep mountainside and that it intersects two tributaries which empty into a perennial stream. The natural water table is very close to the surface at this location.

It is doubtful that dewatered tailings would remain dry after the pit is abandoned. Diversionary canals would fall into disrepair, and the tributaries would return to their natural channels, creating deep gullies as they cross the tailings pit.

It would be difficult to maintain the area of the mined-out pit at its original contour. The mine is located on a steep-sided wall of a valley that may have been glaciated during Pleistocene time. Much of the rock to be removed from the pit is competent. The backfill would be poorly consolidated and saturated, conditions which are ideal for landslides and rapid erosion. In short, the steepness of the slope could not be maintained once it was underlain by backfill. Over the long term, erosion to the tailings surface and transport of tailings by further erosion could occur.

It is not technically feasible to construct a clay liner around the highwall of the open pit. To stabilize the liner, one would have to reduce its outer slope to 3.0:1 (according to the applicant). There are two methods by which the slope may be reduced, but neither of them is appealing. In one method the bedrock highwall slope would be reduced (as suggested by the applicant) after mining is completed. This method could be accomplished only by cutting through the adjacent drainage divide that separates the Indian and Marshall creeks drainage basins, physically removing the ridge crest. The second method requires the construction of a wedge-shaped clay liner that thickens substantially toward the bottom of the pit. The latter method requires a volume of clay that is probably not available onsite and that substantially reduces the capacity for tailings storage. Failure of the clay liner would probably result in dispersion of tailings fluid along fault and brecciated zones in the wall rock.

The estimated cost of Alternative 5 is about $17.5 million, which includes about $6.8 million for construction operation and reclamation of the temporary tailings retention area. Included in these costs is increased energy consumption required for pumping tailings from the temporary retention area and the mill up to the south pit.

Alternative 6 : Pit burial — solidification of tailings

In this option, mill wastes are fixed with cement, asphalt, or other material to form a solid, less leachable product for disposal. The wastes could then be stored in a specially dug pit or temporarily stored at a landfill site and eventually stored in a mined-out pit (if the pit were suitable for tailings storage). In all cases, the material would be stored above the water table. The applicant would reclaim the disposal area by covering the material with mine waste rock, overlain with a layer of topsoil to establish a vegetative cover.

Portland cement could be utilized to fix either the entire tailings solids or the slimes only. If all the solids are fixed, the liquid effluents could be treated by copperas to remove radium and allowed to evaporate in a dam/pond retention area.[9] A minimum of 1 part cement to 20 parts tailings would be required for solidification; with strength, leaching resistance, and cost increasing as the ratio of cement to tailings increases (ref. 9, p. 43). The 1:20 cement to tailings mixture could be pumped, if necessary, via a slurry pipeline to a disposal site.

Waste solutions and dewatered slimes could be fixed in asphalt, with the final product containing approximately 60% slime solids (ref. 9, p. 42). When first mixed, the product would be fluid and could be shipped via a pipeline to a disposal site. The major advantages of solidifying tailings in asphalt are (1) leaching resistance is high and (2) radon emanation is substantially reduced because asphalt is an effective radon diffusion barrier.

Other major advantages of solidification are (1) the problems associated with windblown tailings, sands, and dust would be eliminated, (2) the majority of tailings could be stored in a remote location and, (3) the need for a retention dam could be eliminated or its size substantially reduced.

Although this alternative eliminates potential windblown dust, this effect can also be achieved by other means (see condition 7j, Summary and Conclusions). Short-term leaching resistance is high, but no long-term data are available, so disposal in a clay-lined pit above the water table would be required as in other proposals. Radon release is reduced, but not eliminated, and cover proposals similar to other alternatives would be required. No decrease in total waste volume would be realized over other proposals.

Technology concerning this alternative is not well established, and long-term permanence of solidification has not been demonstrated. Furthermore, the technique utilizes large quantities of cement (presently in short supply), asphalt (a petroleum product), or chemical fixants (energy intensive to produce).

Although environmentally desirable, solidification of tailings is expensive. Moreover, this procedure would essentially preclude future recovery of minerals. The applicant investigated the costs of solidification for asphalt, cement, and Calcilox, the trade name of a commercial fixant. Relatively large quantities of the materials (30 to 60 tons per day) would be required. The respective costs for concrete, asphalt, and Calcilox tailings treatment over the life of the project were estimated to be \$39.5, \$36.5, and \$48.2 million.

Alternative 7: Utilization of old tailings site near the city of Gunnison

The applicant investigated the possibility of transporting the tailings from the proposed mill on the Pitch Project area to an old mill site located near the city of Gunnison, Colorado. A tailings retention area similar to the applicant's proposed Hale Gulch configuration would be utilized. The area would be fenced, lined, and capped with compacted clay, with the clay cover being overlain with soil and seeded with appropriate species, and a monitoring program would be established.

The major environmental advantages of instituting this alternative are (1) the potential for environmental damage caused by locating the tailings disposal area within the confines of the Pitch Project permit area would be eliminated and (2) the overall land surface disturbed by the project would be decreased by 28 to 30 ha (69 to 75 acres). However, the reduction of environmental impacts at the Pitch Project area would be more than offset by additional adverse impacts at the Gunnison Mill site. The major environmental disadvantages associated with the implementation of this alternative are (1) the potential for groundwater contamination would be enhanced because the Gunnison site is located on the Tomichi Creek drainage system and underlain by permeable materials;[2] (2) the chance of health damage to the local population caused by windblown tailings, seepage, enhanced radon gas emanation (higher than background), or by retention dam failure would be greatly increased because the disposal site would be moved from a sparsely populated, remote area to a location near a population center (the population of Gunnison in 1976 was 6000); and (3) because the tailings would have to be transported approximately 63 km (39 miles) by truck, the probability of accidental dispersal of tailings to the local environment would be increased.

Assuming the cost of shipment to be approximately 10¢ per ton-mile, the cost of transporting the tailings (over the lifetime of the project) would be approximately \$19.4 million. The costs of constructing the retention dam and impoundment area, as well as reclamation costs, were not estimated by the applicant.

Alternative 8: Disposal of low-moisture tailings by burial in an unlined area at the head of a natural valley

This alternative involves altering the proposed milling procedures so that low-moisture tailings would be produced. After the final washing stage in the filtration circuit, the filtered what is moisture content

cake would be removed and transported (by conveyor or by truck) from the mill area and deposited in an unlined, aboveground disposal facility. The applicant estimated that the filtered tailings would contain approximately 25% liquid, compared to an estimated moisture content of approximately 64% for the tailings slurry that would otherwise be produced by the milling process. Employing this method of tailings disposal would mean that a tailings reclaim water system, with return of the tailings decant water to the mill for reuse, would only be utilized when precipitation or runoff water was available.

A relatively flat area would be required for tailings retention, with a containment dam that should prevent erosion or sliding of the deposited tailings. To evaluate the alternative, the applicant analyzed the consequences of storing the tailings at the proposed Hale Gulch site. As suggested by the applicant, the bottom of the impoundment area would not be lined with compacted clay, and (depending on the outcome of seepage analysis) the applicant contends that because the tailings would be relatively "dry" a clay core for the retention dam may not be required. Surface water would have to be diverted around the impoundment area, and the area would be fenced. The tailings pile would be covered with a layer of compacted clay, overburden, and topsoil of the same configuration as proposed for Alternative 1. Therefore, the reduction in radon emanation and gamma radiation would be the same as that estimated for Alternative 1. Revegetation of the pile area would also proceed as described in Alternative 1.

The major advantages of implementing this alternative are (1) because low-moisture tailings would be stored, seepage control problems should be reduced (there should be no standing head of water on the tailings surface); (2) the potential for retention dam failure should be lessened (however, this problem should be mitigated for any tailings disposal alternative by choosing sites where the probability of dam failure is minimized and by adequately diverting surface water around the disposal area); and (3) the tailings could be stored in a remote location.

The major disadvantages associated with the implementation of this alternative are

1. The relative dryness of the tailings and the desirability of maintaining a low-moisture content to control seepage increases the difficulty of preventing wind dispersal of dusts and sands from the tailings surface. The use of water to control dusting would have to be minimized. A chemical crusting agent and wind fences could be used to minimize dust dispersion.

2. By not using a reclaim water system, soluble constituents remaining in the tailings cannot be recovered. With a reclaim water system, it is possible to recover approximately 50% of the soluble uranium left in the tailings and approximately 30% of the sodium carbonate reagent.[11]

The estimated cost for Alternative 8 is $8.8 million. Future recovery of minerals in the tailings should be relatively easy.

Alternative 9: Disposal of low-moisture tailings in an unlined depleted mine pit

This disposal alternative involves a combination of Alternatives 5 and 8. The filtered tailings would be stored in a temporary land disposal site for about eight years (until the south pit was mined out) and then transported to the pit for disposal. The applicant did not consider disposal in the north pit area because of the longer mining period required to complete the open pit and underground mining operations. To provide sufficient capacity for 25-year mill tailings storage, the south pit would have to be enlarged or a dam structure would have to be installed at the 10,320 foot elevation of the south pit (in evaluating this alternative the applicant did not include construction of a dam structure across the daylight elevation of the south pit). Filtered tailings would be hauled to the pit from both the mill and the temporary tailings disposal site after mining has been completed. Because the installation of either a clay or an artificial liner would be difficult and is of questionable value, the bottom and sides of the pit would not be lined.

After termination of all milling operations and removal of all tailings from the temporary disposal site, the tailings surface would be reclaimed by installation of a clay cap, a mine waste layer, and topsoil of sufficient thickness to reduce radon gas emanation and gamma radiation to acceptable levels. The area would be revegetated with appropriate plant species.

A retaining dam would have to be constructed for the temporary tailings impoundment. Also, a runoff diversion ditch, monitoring wells, and provisions for dust control would be needed to ensure environmentally safe operations. The area would be returned as nearly as possible to its original contour and revegetated with appropriate plant species.

The major benefits derived from implementing this alternative disposal method would be (1) reduction of the total land requirements because the temporary tailings retention site in Hale Gulch would be returned to its original use, (2) elimination of a partially above-grade tailings pile, (3) elimination of plant penetration problems into the tailings if the cover thicknesses can be significantly increased by enlargement of the pit, (4) decreased probability of long-term disturbance of tailings because no retention dam would be required to store the tailings in the pit, and (5) reduced seepage control problems at the temporary storage area because of the low-moisture condition of the tailings.

The primary drawbacks associated with implementing this alternative waste management system are:

1. Some of the tailings would have to be handled more than once, and the increased transportation distances involved (compared to Alternative 1) increase the probability of accidental dispersal of wastes.

2. Because a pit liner would be of dubious value due to the faulted nature of the mine, no liner would be installed. It is expected that the "water regime" level in the mined-out pit will rise to the daylight elevation of the mine (10,320 ft) so that the tailings would become saturated with water. The soluble constituents in the filtered tailings (Alternative 8) could present problems with groundwater quality around the pit if the tailings were to be returned to the pit for disposal.[11]

3. The mine waste that was to be backfilled into the south pit area and the extra 5.9×10^6 m (6.5×10^6 yd) of material that has to be excavated from the south pit to permit storage of the total mill tailings would have to be placed on surface mine dumps and reclaimed, increasing the land area required for mine dumps.[11]

4. Placing the tailings into the pit may prevent possible future resource recovery from the pit walls and bottom.

The total estimated cost for this alternative is $20.3 million.

<u>Alternative 10: Burial of slurry tailings near the head end of a natural valley in a lined area with a drainage system to reduce seepage through the liner (tailings covered with clay cap, overburden, and topsoil)</u>

This alternative would consist of an above-grade impoundment constructed by damming the head end of a natural valley (Hale Gulch, Site A). The alternative would be identical to Alternative 1, except that a graded filter with perforated collection pipes would be installed above the 0.6-m (2-ft) clay liner to facilitate drainage and removal of the tailings liquid, thereby reducing the seepage through the liner. The construction of the impoundment, the deposition of tailings, and final reclamation would be the same as discussed for Alternative 1.

The drainage system would consist of a 1.5-m (5-ft) thick granular filter with perforated 10-cm (4-in.) and 15-cm (6-in.) plastic collector pipes that would feed to a central collection structure at the upstream base of the embankment. The liquid collected by the drain would be recycled to process or pumped back into the impoundment area in a manner designed to promote evaporation.

The filter material would allow seepage of liquid from the tailings to enter the collection system but would retain sediment within the impoundment. The collection pipes would be located so that seepage into the filter bed would be captured, thereby reducing the buildup of fluid head on the liner. The amount of seepage through the liner theoretically would be reduced to an estimated maximum rate of less than 5.5 m^3/day (1 gpm) during the life of the impoundment. Collection of seepage from the bottom of the impoundment also will serve to increase the rate of consolidation of the tailings. The system would be designed for seepage associated with a probable maximum flood and could accommodate a peak flow of approximately 545 m^3/day (100 gpm). Normal operating flows would be less than this value.

Prior to final reclamation, a lined evaporation pond would be constructed in the tailings impoundment area to dispose of the postoperational seepage. The size of the pond would depend on the amount of seepage being collected and might occupy as much as 2 ha (5 acres). Collected seepage would be pumped into the pond and allowed to evaporate until the seepage slowed to a negligible rate. After evaporation is complete, any solids remaining in the evaporating pond would be returned to the tailings impoundment, which would be undergoing reclamation as in Alternative 1.

The applicant estimates that approximately 0.5 million cubic yards of specially graded filter material would be required; most of this material would have to be imported. A small amount of the material could come from the mine waste, but blending and sizing would be required. The advantage of this alternative over Alternative 1 is a reduction in seepage from the tailings impoundment.

The applicant estimates that this alternative would cost approximately $10.3 million more than Alternative 1, as indicated below.

Expenditures	Cost ($$10^6$)
In-place filter material	9.68
Collection and pumping system	0.22
Evaporation pond	0.10
Engineering and quality control	0.30
Total	10.3

The staff considers it unlikely that installation of the filter system would be this expensive. With the relatively steep slope of the impoundment sides and assuming little hydraulic head drop across the tailings, the staff opinion is that no more than 4 ha (10 acres) of filter bed, placed in the relatively flat area of the base of the dam, would serve as an adequate drain.

The staff considers this a viable method of tailings disposal. If the filter drain does not perform as expected, conversion to Alternative 11 could be easily implemented or the system could be operated as described in Alternative 1.

Alternative 11: Disposal of low-moisture tailings by burial in a lined area near the head end of a natural valley (tailings covered with clay cap, overburden, and topsoil

This alternative involves altering the final stages of the proposed milling process so that low-moisture tailings would be produced. With this alternative, the filter cake would be removed after the final washing and transported (probably by truck) in low-moisture condition from the mill area and deposited behind an embankment in Hale Gulch.

It is estimated that the low-moisture tailings will contain approximately 25% liquid. Because of this low-moisture content, the need for returning decant water back to the mill is eliminated; however, there will still be a need for a liquid return system to transport to the mill precipitation and runoff that could collect in the tailings disposal area.

The tailings disposal facility would consist of an upstream or central core embankment at the head end of Hale Gulch. The storage area would be lined with a minimum of 0.6-m (2-ft) thick compacted clay liner. The tailings dam and reservoir would be constructed in stages, each stage having a capacity to hold wastes produced during four to six years of mill operation. Approximately 14 ha (35 acres) would be required for the first stage and 2 to 4 ha (5 to 10 acres) in each succeeding expansion. The vertical or upstream core of the retention dam would be constructed of compacted clay. The dam initially would be approximately 26 m (85 ft) high, with a freeboard allowance of 4.6 m (15 ft) for a probable maximum flood and an additional 1.5 m (5 ft) to accommodate possible wave action, assuming a probable maximum flood event occurred. To provide for 25 years of mill operation, the final embankment would be approximately 43.3 m (142 ft) high, with a tailings capacity of approximately 4.5 x 10^6 metric tons (5.0 x 10^6 tons). The tailings dam and reservoir would cover approximately 28 ha (69 acres) of surface area if the mill were to operate for 25 years; the total affected area would be approximately 70 ha (174 acres).

For reclamation, the tailings pile would be covered with a layer of compacted clay, mine overburden, and topsoil. The configuration of these materials would be the same as proposed for Alternative 1, and therefore the radon emanation and gamma radiation would be the same as that estimated for Alternative 1.

Seepage would be restricted to those times of the year that water (precipitation or runoff) accumulates in the disposal area. Water seeping from the reservoir during these periods will contain a lower concentration of contaminants than the slurry decant water. The potential for a retention dam failure during normal operation would be lessened because the embankment would not be subjected to a sustained hydraulic head for any length of time. Following an unlikely probable maximum flood event, the flood water would be removed within two years, which would be the amount of time required to utilize the excess water in the milling operation.

A disadvantage of this alternative is that maintaining a low-moisture content of the tailings to control seepage increases the difficulty of preventing wind dispersal of dust and sand from the tailings surface. The staff recommends that the dewatered tailings be placed on the side slopes in a manner such that at least 6.1 x 10^4 m^3 (50 acre-ft) of water can be impounded without reaching the deposited tailings level. If after further drying the physical properties of the tailings allow maintenance of a stable slope, the staff recommends that consideration be given to implementing disposal in the upper end of the impoundment and, as the tailings stabilize at final design grade level, reclamation of such area be completed.

If this scheme proves practicable, proper choice of dewatered tailings placement and reclaimed surface slope would allow installation of an embankment to the unlikely probable maximum flood after only a few years of project operation. Then, only direct precipitation and snowmelt in the unreclaimed areas would accumulate against the dam, and mill use would maintain this at low levels.

If a probable maximum flood occurs before diversion can be implemented, 3.2 x 10^5 m^3 (260 acre-ft) of water could enter the impoundment and slurry large quantities of unstabilized tailings. The result would be temporary operation as in Alternative 1.

The estimated cost for this alternative is $13.1 million, including the costs of transporting the low-moisture tailings to the disposal area, the spreading of the tailings with a crawler-type tractor, and the return of the direct precipitation or runoff back to the mill.

Alternative 12: Disposal of low-moisture tailings in an excavated pit

This alternative would consist of burial of low-moisture tailings by a cut-and-cover method in an area shown in Fig. 10.1. This site is located across a drainage basin divide. A diversion structure would be provided so that any surface runoff from the site would be from direct precipitation on the site under most conditions. In the unlikely event of a probable maximum flood, design considerations would have to include containment of up to 9.8 x 10^4 m^3 (80 acre-ft) of water falling on the site and provision for the diversion of an additional 9.8 x 10^4 m^3 (80 acre-ft) at rates up to 33.9 m^3/sec (1200 cfs) around the site to prevent erosion and transport of uncovered tailings. Areas on both sides of the access road passing through the site would be used for tailings disposal. The low-moisture tailings would be produced and transported as discussed in Alternative 11. Burial pits at the site would be excavated in stages, with some of the initial overburden being used to construct dikes for the control of surface-water runoff and the remainder being stockpiled on the site. The base on the staged excavations would be to an elevation no closer than about 3.0 m (10 ft) above the maximum water table. Each stage of the excavation would have the capacity for wastes produced from one to two years of mill operation. After the initial excavation, stripped overburden would be placed and compacted over the previously deposited tailings in a manner similar to a strip mining and reclamation scheme. With this procedure, wind dispersal of dust and sand from the tailings surface might be more easily controlled than in Alternative 11, with reclamation proceeding simultaneously with the disposal operations.

The excavated pits would vary in depth, ranging from approximately 3.0 to 22.9 m (18 to 75 ft), depending on the depth to the water table. To maintain stable walls, the excavated pits would have a slope angle of 2:1 (horizontal to vertical).

The low-moisture tailings would be spread and compacted by a tracked vehicle and brought up to an elevation of 1.5 m (5 ft) below the original ground surface. When the tailings reached this elevation, they would be covered with the overburden material taken from the site, which is predominately clayey. This clayey overburden would be spread on top of the tailings at an average thickness of 6.1 m (20 ft), and would eventually cover an area of approximately 42 ha (105 acres). The cover operation would proceed at approximately the same rate as the subsequent excavation.

The site has been explored, and clay has been found to be the predominate material to the depths of the proposed excavations. For additional control of any seepage from the pits, the top 15 cm (6 in.) of the bottom and sides of the excavation would be scarified and recompacted before deposition of the low-moisture tailings. This precaution will reduce the possibility of seepage occurring directly into any fissures or cracks in the natural materials.

Seepage from this naturally clay-lined pit would be negligible if water is not allowed to pond in the excavation. If practicable, any water accumulating in the pit would be transported to the mill. Water entering the pit should be only from direct precipitation because drainage away from the disposal area can be provided by utilizing the excavated overburden to provide temporary dikes and drainage control. Cover materials placed over the disposal area would be graded to provide drainage away from the site and along both sides of the haul road through the site.

The reduction of the gamma radiation that would result after an application of overburden is dependent on the degree of compaction and mass stopping power of the overburden. No quantitative estimates have been made on the amount of gamma radiation from the covered tailings pile. It is expected, however, that the proposed 6.1-m (20-ft) thickness of compacted, clayey overburden would reduce the gamma radiation and radon emanation to levels that would be at least equivalent to that of the reclamation cover proposed for alternatives at the Hale Gulch site. Consolidation of the tailings would be expected to occur primarily during the operational phase of the disposal pits.

There is capacity at this site for approximately 3.3 million tons of tailings, which would indicate an active service life of approximately 17 years. Approximately 33 ha (82 acres) of surface will be required for the 17-year service life. Surface reclamation will require approximately an additional 10 ha (25 acres).

Reclamation of the disposal site would include grading to blend into the natural contours of adjacent areas and restore the natural drainage from the site. The restored drainage paths would be located in areas that would not be underlain by buried tailings. Riprap would be used in some portions of the restored drainage paths to control erosion and sediment transport. The hills surrounding the site will provide a protective barrier against wind erosion and help to preserve the long-term stability of the reclaimed site.

The major advantages of the alternative are that

1. No major drainage path would be blocked.
2. Seepage from the disposal area would be minimal.
3. A haulage road has already been constructed to the mill.
4. The haulage road distance would be shorter than that in other alternatives.
5. A retention dam may not be required.
6. Potential wind dispersal of dust and sand from the tailings surface would be minimized.
7. Reclamation can proceed incrementally as the tailings are deposited and covered.

The disadvantages associated with this alternative tailings disposal system are

1. The quantity of disturbed area per unit of tailings disposal capacity is increased.

2. The disposal capacity of the site has been estimated at 17 years production of tailings, rather than 25 years for the other alternatives; for 25 years of operation, a second disposal site would be required.

3. Fluctuations in the water table may further reduce the storage capacity at the site. Monitor wells are installed to measure water table fluctuations and will provide information for design changes. The storage capacity at the site would likely be reduced by changes in design.

4. Diversion and retention barriers to control the maximum precipitation event without erosion and transport of uncovered tailings onto the watershed have not yet been considered.

5. No depositional environmental reclamation situation, such as that available in Hale Gulch, appears possible. Long-term erosion resistance will require careful design and may pose potentially serious maintenance problems.

The total cost for this disposal system is estimated at $5.83 million, including the cost of transportation of the tailings from the mill to the disposal site. This site and method of tailings disposal appear to be a viable alternative, but too little information is available at this time to make a positive judgment.

10.4.3 Evaluation of alternatives

Alternative 1 is the option proposed by the applicant for tailings management. Although there may be possible drawbacks associated with this alternative, measures are proposed to minimize all known potential environmental impacts. By designing the dam to withstand a major earthquake (Mercalli VIII), the probability of this failure mode is essentially eliminated. In addition, the applicant proposes to minimize seepage by installing a clay core within the dam and by lining the pond area with clay. The clay liner should be at least 0.6 m (2 ft) thick and carefully constructed for this alternative to be environmentally acceptable. The staff's opinion is that if the clay liner is carefully installed no excessive seepage will occur. A uniform cover over the pile of 1 m (3 ft) of compacted clay, 1.5 m (5 ft) of overburden, and 23 cm (9 in.) of topsoil would reduce radon gas from the tailings to less than twice the background level and would decrease gamma radiation to essentially background level.

The percolation of groundwater through the tailings pile and subsequent seepage would be minimized by the clay cover, which would act as a perching layer to divert precipitation from the tailings layer. Long-term maintenance and monitoring would not appear to be required because of contouring and vegetative stabilization of the impoundment area. Study conclusions are that the site selection, coupled with the design and construction features of the tailings impoundment system at the head end of Hale Gulch, will provide effective confinement of the tailings discharged during operation of the mill. Moreover, following implementation of the reclamation plan, the impoundment system will provide the assurance of high resistance to natural erosive forces of wind and water over the long term.

With the exception that surface water might percolate through the tailings pile, increasing seepage through the clay liner on the bottom of the impoundment, the environmental effects of implementing Alternative 2 are essentially the same as those for Alternative 1. The primary disadvantage of Alternative 2 is that a very thick layer of overburden and topsoil would be required to reduce radon gas emanation and gamma radiation to acceptable levels. Alternative 2 offers no significant additional benefits in comparison to Alternative 1.

If properly installed, the placement of a synthetic liner (Alternative 3) on the bottom of the retention area and in the upstream face of the dam would eliminate seepage from the tailings impoundment. However, a liner constructed from clay is preferred when compared to artificial liners; clays exhibit cation exchange capabilities and can adsorb considerable quantities of radioisotopes.[9] Also many clayey soils contain cations, such as calcium or iron, which will form insoluble salts with the sulfate ion, thereby halting migration of sulfate.[9] Finally, there is more room for error in the installation of a synthetic liner, and a clay liner is expected to have a longer life.

The installation of an artificial liner (asphalt or plastic) over the tailings pile, as proposed in Alternative 4, would significantly reduce radon emanation from the pile and would prevent any percolation of surface water through the tailings. However, an overburden and topsoil layer of at least the thickness proposed for Alternative 1 would have to be placed over the liner to reduce gamma radiation to an acceptable level and to prevent eventual penetration of plant roots through the liner and into the tailings. Also the possibility exists that the cover may degrade, erode, or slip. When compared to Alternative 1, there are no significant additional benefits to be gained by implementing Alternative 4.

Alternative 5 is unacceptable because the south mine pit is not amenable to safe and reliable below-grade disposal. The mine will be in highly faulted formations and will be below the natural water table. Consequently, the clay liner may fail, allowing seepage of groundwater through the tailings. In this regard there is greater risk of groundwater contamination with this alternative than with Alternative 1. The use of a temporary tailings pond and a complicated slurry pumping system adds further costs and environmental risks. These effects and risks outweigh the advantage offered by this alternative — the elimination of a retention dam.

Although Alternative 6, pit burial and solidification of tailings, eliminates potential windblown dust, this effect can also be achieved by other means (see condition 7j, Summary and Conclusions). Short-term leaching resistance is high, but no long-term data are available, so disposal in a clay-lined pit above the water table would be required similar to other proposals. Radon release is reduced, but not eliminated, and cover proposals similar to other alternatives would be required. No decrease in total waste volume would be realized over other proposals.

Technology concerning this alternative is not well established, and long-term permanence of solidification has not been demonstrated. Furthermore, the technique utilizes large quantities of cement (presently in short supply), asphalt (a petroleum product), or chemical fixants (energy intensive to produce). Thus, the staff considers that the environmental advantages are not balanced by the excess costs when other environmentally sound, cheaper alternatives are available.

Alternative 7, which involves locating the disposal area at the old Gunnison Mill site, would shift the environmental impacts associated with tailings disposal from the Pitch Project area, which is located in relatively remote Forest Service System land, to an area that is relatively highly populated. The possible adverse environmental impacts at the Gunnison site (groundwater contamination, tailings dust dispersal, and increased probability of accidental dispersal caused by trucking accidents) outweigh any benefits that might be derived.

Alternative 8 is the same as Alternative 1, with the exception that low-moisture tailings would be buried in an unlined disposal area. The major area of concern is whether a relatively impervious material, such as compacted clay or an artificial liner, needs to be placed on (or in) the retention dam and on the bottom of the impoundment to ensure that this alternative possesses significant environmental advantages over Alternative 1. The major advantage of Alternative 8 is that seepage control problems could be reduced. A detailed analysis of tailings transport and seepage, assuming no liner on the bottom of the disposal area, needs to be completed before this alternative could be considered viable.

Alternative 8 has been removed from consideration because Alternative 11, which includes a liner, and Alternative 12, disposal of low-moisture tailings in an excavated pit, achieve the same objective.

Alternative 9 offers short-term environmental improvements when compared to Alternative 5 because low-moisture tailings would be stored. However, because tailings would be placed in an unlined open pit below the water table, the same long-term deficiencies as Alternative 5 would be suffered and thus is unacceptable.

Alternative 10, if the drainage systems operate properly, offers the environmental advantage of minimizing potential seepage through the bottom of the impoundment by reducing the hydraulic head and increasing the rate of consolidation of tailings. All of the features of Alternative 1 would be retained. Draining liquid would be available for mill use, and except for the unlikely probable maximum flood event, less than 5.5 m^3/day (1 gpm) of seepage would be expected.

Alternative 11, the disposal of dewatered tailings in the same impoundment as in Alternative 1, provides the advantage that potential seepage could only occur when snow melts or when precipitation runoff accumulates in the disposal area. The mill would utilize up to 493 m^3 (0.4 acre-ft) per day of ponded water when available. All of the water from an inch of rainfall would be removed within two weeks. No significant water accumulation problems should occur except in the unlikely event of a probable maximum flood, after which ponded water would require about two years for removal. If dewatered tailings become structurally stable (equivalent to excavated soil) within a reasonable time frame, it may be possible to fill and reclaim the upper levels of the impoundment while maintaining a central water collection site at the base of the impoundment dam. If this can be done, Alternative 11 becomes environmentally attractive. A disadvantage is the difficulty of controlling wind dispersal of dust from large exposed areas of dry tailings surface causing increased radon release. All of the features of Alternative 1 will be retained.

Alternative 12 is the disposal of dewatered tailings using cut-and-cover methods in an area shown in Fig. 10.1. Burial pits would be excavated in stages, and removed overburden would be used to construct dikes for surface runoff control. The tailings would not be placed deeper than 3 m (10 ft) above the groundwater table on top of a compacted natural clay base. Any collecting precipitation or snowmelt would be removed for use in the mill circuit. Full pits would be reclaimed by covering with previously removed clayey overburden. The proposal is environmentally attractive in that only two or three years of tailings waste would be exposed at any one time, thus minimizing dust dispersion and radon emissions. As pointed out previously, however, a number of technical issues related to this alternative are as yet unresolved.

The staff concludes that the proposed tailings management plan presented as Alternative 1 meets the performance objectives developed by NRC and adopted by the Colorado Department of Health and is therefore considered to be acceptable.

Alternatives 10 and 11, which are essentially the same as Alternative 1 except that they include means for decreasing the inventory of tailings solution in impoundment, have additional environmental advantages, but the cost-benefit balance is questionable.

Alternative 12 has a few unresolved technical issues including accurate determination of the groundwater table and the development of a reliable method for preventing long-term erosion at the proposed disposal site. If these issues can be resolved satisfactorily, however, this alternative may prove to be the most economically and environmentally desirable plan.

The Radiation and Hazardous Waste Control Division of the Colorado Department of Health is responsible for designating a tailings management plan that is authorized in accordance with the issuance of a Radioactive Materials License for the milling operation.

10.4.4 Alternatives considered and rejected

Table 10.1 lists some of the additional alternatives considered and rejected.

10.5 ALTERNATIVE OF USING AN EXISTING MILL

Existing alkaline leach mills capable of treating ore from the project are located near Canon City, Colorado [159 km (99 miles)], Grants, New Mexico [641 km (398 miles)], Moab, Utah [423 km (263 miles)], and LaSal, Utah [372 km (231 miles)]. Except for the mill in Moab, these existing mills have limited capacity for accepting additional ore. Transportation of the ore to any of these existing mills would result in substantial energy consumption. Considerable accident risk to the public would result from the trucking of large quantities of ore over poor roads for many years.

Shipping costs and toll milling fees would raise the economic cutoff grade of the ore. The applicant estimates that 1.6 x 10^6 metric tons (1.8 x 10^6 tons) of ore representing 1.2 x 10^6 kg (2.7 x 10^6 lb) of U_3O_8 or 60% of the uranium reserves in and around the Pitch Project would be economically unrecoverable (ER, p. 10-5). This alternative would also result in the loss of 150 temporary construction jobs and 70 permanent jobs. The environmental costs of ore processing would be transferred to the mill receiving the ore. Benefits would be the reduction of total land requirements for the project.

Table 10.1. Alternatives considered and rejected

Alternative	Reason for rejection
Location of mill and temporary tailings area adjacent to mine; tailings disposal in mine pit	Lack of topographically suitable mill site; temporary tailings pond would be located very close to Indian Creek headwaters. Suitability of mine pit for tailings is questionable[a]
Neutralization of tailings by acid	Counter-productive action since solubility of most metals and radionuclides of concern would be increased relative to alkaline leach conditions[b]
Precipitate radioactive and toxic elements to bottom of the tailings pond and consider top of tailings as cover	Technology not developed (would require a selectively permeable bottom liner)
Install drains below pond to collect and discharge to a local waterway	Technology not available to allow seepage water treatment sufficient to attain water which is environmentally and legally acceptable for release

[a]Communication from the Oak Ridge National Laboratory to the U.S. Nuclear Regulatory Commission, January 30, 1978.

[b]R. E. Blanco et al., *Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low as Practicable" Guides – Milling of Uranium Ores*, Report ORNL/TM–4903, vol. I, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1975.

10.6 ALTERNATIVE ENERGY SOURCES

10.6.1 Fossil and nuclear fuels

10.6.1.1 Introduction

The use of uranium to fuel reactors for generating electric power is relatively new historically. Coal was the first fuel used in quantity for electrical power generation. Coal use was reduced because of the ready availability and low price of oil and natural gas, which are cleaner burning than coal and easier to use. Uranium fuel is even cleaner (chemically) than oil or gas and at present is less expensive, on a thermal basis, than any other fuel used to generate electric power. The following discussion concerns the relative availability of fuels for power generation over the next 10 to 15 years and a comparison of the health effects of utilizing coal and/or nuclear fuels as energy sources.

10.6.1.2 Overview of U.S. energy usage and availability

According to the *National Energy Plan*, published by the Carter Administration in April 1977, the United States uses more energy to produce goods and services than any other nation and consumes twice as much energy per capita as does West Germany, which has a similar standard of living.[12] In 1975, the United States consumed approximately 71 quadrillion Btu's (71×10^{15}), or 71 quads (q), of energy, with about 93% of this energy being supplied by three fossil fuels: oil, natural gas, and coal.[13] Approximately 75% of our energy needs are supplied by natural gas and oil; however, because domestic supplies of these valuable resources are limited (about 7% of proved reserves are oil and gas), the amount of oil imported from foreign sources has increased, undermining our military and economic security.[13] Table 10.2 illustrates the disparity between availability and usage of energy sources in the United States.

Despite concentrated efforts to slow down our consumption of oil and natural gas, increase the usage of coal-burning facilities, and further the utilization of nonconventional energy sources, energy demand forecasts indicate that by the year 2000, approximately 43% of our energy will still be supplied by oil and gas, 21% by coal, and only a small percentage (7%) by solar, geothermal, and oil shale (Table 10.3).[14]

Of the 71 q of energy consumed in the United States in 1975, 20 q consisted of electric energy. An estimated 8.6% of this electric energy was generated using nuclear fuels, but within ten years this percentage is expected to increase to 26%. Coal was used for producing 59% of the

Table 10.2. Reserves and current consumption of energy sources

	Percentage of proven U.S. energy reserves economically recoverable with existing (1975) technology	Percentage of total U.S. energy consumption contributed by each energy resource
Coal	90	18
Oil	3	46
Gas	4	28
Nuclear	3	3
Other	0	5

Source: Tetra Tech, Inc., *Energy Fact Book – 1977*, prepared under the direction of the Director, Navy Energy and National Resources Research and Development Office, April 1977.

Table 10.3. Forecast of gross energy consumption for 1980, 1985, and 2000

Fuel	1980		1985		2000	
	10^{12} Btu	Percentage of gross	10^{12} Btu	Percentage of gross	10^{12} Btu	Percentage of gross
Coal	17,150	19.7	21,250	20.6	34,750	21.3
Petroleum	41,040	47.1	45,630	44.1	51,200	31.3
Natural gas	20,600	23.6	20,100	19.4	19,600	12.0
Oil shale			870	0.8	5,730	3.5
Nuclear power	4,550	5.2	11,840	11.4	46,080	28.2
Hydropower and geothermal	3,800	4.4	3,850	3.7	6,070	3.7
Totals	87,140	100.0	103,540	100.0	163,430	100.0

Source: U.S. Bureau of Mines, *United States Energy through the Year 2000*, December 1975.

electric energy generated by combustion of fossil fuels in 1975; oil and gas produced 20 and 21% respectively. Use of oil and gas to generate electric power has decreased about 10% over the last three years, a reflection of high oil prices and gas unavailability.[15]

Current and projected requirements for electric energy (1970-1985) and relative changes in resources used for generation, as estimated in the *Project Independence* report,[16] are shown in Table 10.4. The evidence available at this time indicates that, of the resources currently used in electric-power generation (coal, uranium, oil, gas, and hydro), coal and uranium must be used to generate an increasing share of U.S. energy needs. The supplies of oil and gas available for electric power generation are decreasing, and the United States does not have sufficient oil and gas reserves to ensure a long-run supply.

With increasing energy demands, both foreign and domestic, expectations are that in the next few decades the prices of oil and and gas will increase rapidly as reserves of these two resources become severely depleted. Because of the time lag between initial extraction and consumption of the resource for energy production (three to five years from mine to generation plant for uranium and coal, five to seven years for construction of a coal generating plant, and seven to ten years for construction of a nuclear generating plant), the exploitation of both coal and uranium resources must be integrated with contemporary energy needs. Although coal and uranium resources are adequate for foreseeable energy needs, major expansion of both uranium- and coal-producing industries will be required, as neither of these industries is considered capable of singly supplying future energy requirements.

The determination of availability of uranium in large enough quantities to fuel the projected nuclear generating capacity (for 1985 and beyond) is currently a matter of study.[17] Results of those studies are given in Appendix C, which includes an estimate of reactor installation

Table 10.4. Estimated relative changes in resources to be used for generation of projected electric energy requirements

Fuel resource used	Thermal energy required by years, %			
	1970[a]	1974[b]	1980[b]	1985[c]
Coal	45	45	45	46[c]
Oil and gas	38	34	25	16
Nuclear	2	4[d]	17	26
Hydro, waste, etc.	15	17	13	12
Total quads of energy required	15.6	20	25.5	34

[a] Actual.

[b] Estimated from Federal Energy Administration, *National Energy Outlook*, U.S. Government Printing Office, Washington, D.C., February 1976.

[c] Coal usage must increase 77% by 1985 to attain this level.

[d] Uranium-fueled reactors furnished 9.9% of the total U.S. production in January 1976.

Source: Federal Energy Administration, *Project Independence*, U.S. Government Printing Office, Washington, D.C., November 1974.

through the year 2000 and the relative percentage of total electricity-generating capacity these new installations would represent.

10.6.1.3 Coal production

Congress and the Carter administration have stressed, via passed and proposed legislation, the necessity of future decreases in oil and gas demand to alleviate our dependence on foreign energy sources and to reorient our energy consumption patterns. The *Project Independence* report of November 1974 and the *National Energy Outlook* of February 1976 both proposed that coal production be increased from present levels (approximately 650 million tons per year) to approximately 1.2 billion tons by 1985.[15,16] The major expansion of coal production will likely be in the west (from approximately 92 million tons in 1974 to about 380 million tons in 1985), because of the low sulfur (low air pollutant) content of most western coals. The potential for environmental damage (due to disturbance of generally fragile ecosystems) in the western United States will be increased. Because the major markets for the coal produced will be located hundreds of miles from the western mines, transportation costs will be high, as will the environmental impacts associated with transportation systems. Currently, transportation costs for bringing western coal to the eastern United States account for the major portion of the market price. Also, for a given thermal content, transport facilities for U_3O_8 per year are minimal compared to those for coal because of the much higher energy content of uranium fuel. Approximately 250 tons of U_3O_8 per year are required for a 1000-MW nuclear plant operating at a plant factor of 0.8. Annual western coal requirements for an equivalent 1000-MW coal plant would be more than 3×10^6 tons, or the load capacity of at least one unit-train (100 cars of 100 tons each), per day of plant operation.

10.6.1.4 Uranium fuel production

Estimates presented in the *National Energy Outlook*[15] indicate that 140,000 to 150,000 MWe of nuclear generating capacity will be needed to supply 26% of the total electrical energy used in 1985. The first *Project Independence* report[16] indicated that nuclear capacity could increase to more than 200,000 MWe by 1985. A more recent and lower estimate resulted from lower projections of electricity demand, financial problems experienced by utilities, uncertainty about government policy, and continued siting and licensing problems. The more recent projections of uranium requirements are given in Table 10.5.

Table 10.5. Uranium requirements

MWe operating by 1985	Lifetime U_3O_8 requirements (tons) for specified plant factor	
	0.8	0.6
142,000	960,000	704,000

Source: Federal Energy Administration, *National Energy Outlook*, U.S. Government Printing Office, Washington, D.C., February 1976.

Table 10.6 presents estimates of quantities of uranium available at different recovery cost levels. Assuming reserves recoverable at a cost of production up to \$30/lb of U_3O_8, the Department of Energy (DOE) estimated that in January 1978 the total of all variously known categories of uranium resources was approximately 3.26×10^6 tons.[18] An estimated 6.9×10^5 tons of these resources consisted of known reserves; that is, drilling and sampling have established the existence of these deposits beyond reasonable doubt.[18] Approximately 5.2×10^5 tons of U_3O_8 could be recovered from very low-grade ore and Chattanooga shale for about \$100/lb and approximately 4×10^9 tons of U_3O_8 from seawater for an estimated cost of between \$300/lb and \$750/lb.[19,20]

Table 10.6. U.S. uranium (U_3O_8) resources

Cost category[a] (\$/lb)	Reserves[b] (tons)	Potential resources (tons)		
		Probable[c]	Possible[d]	Speculative[d]
15	370,000	540,000	490,000	165,000
30	690,000	1,015,000	1,135,000	415,000
50	890,000	1,395,000	1,515,000	565,000

[a] Each cost category includes all lower cost reserves and resources.

[b] Reserves are in known deposits.

[c] Probable resources have not been drilled and sampled as extensively as reserves.

[d] Possible and speculative resources have been estimated by inference from geologic evidence and limited sampling.

Source: Department of Energy, *Statistical Data of the Uranium Industry*, Report GJO-100(78), Jan. 1, 1978.

Historically, resources of uncertain potential have become established at an average rate of 7% per year since 1955.[16] If this rate were to persist over the next decade, total reserves would exceed requirements (1,340,000 tons of reserves vs a maximum 960,000 tons required for lifetime nuclear generating capacity rated at 142,000 MWe) by about 380,000 tons. Assuming no transfer of possible resources into the "probable" category, probable resources would still contain 430,000 tons.

Mill capacity in the United States as of January 1978 was 39,210 tons of ore per day. These mills operated at 79% of capacity in 1977. Uranium oxide output was approximately 14,940 tons, including 790 tons obtained by solution mining, heap leaching, and by-product recovery.

A survey of U.S. uranium marketing activity completed by ERDA in May 1977[21] indicated that annual contracted deliveries of U_3O_8 for nuclear-powered electric generation plants (assuming no recycle of plutonium and uranium and 0.20% uranium-235 enrichment plant tails assay until October 1, 1980, 0.25% thereafter) will exceed annual requirements until 1979 (see Fig. 10.2). Contracted imports of U_3O_8 will exceed contracted exports by a considerable margin over the next few years. Through 1990, cumulative contracted imports of U_3O_8 are 47,20 tons (approximately 50% of future contracted imports will come from Canadian sources), compared to

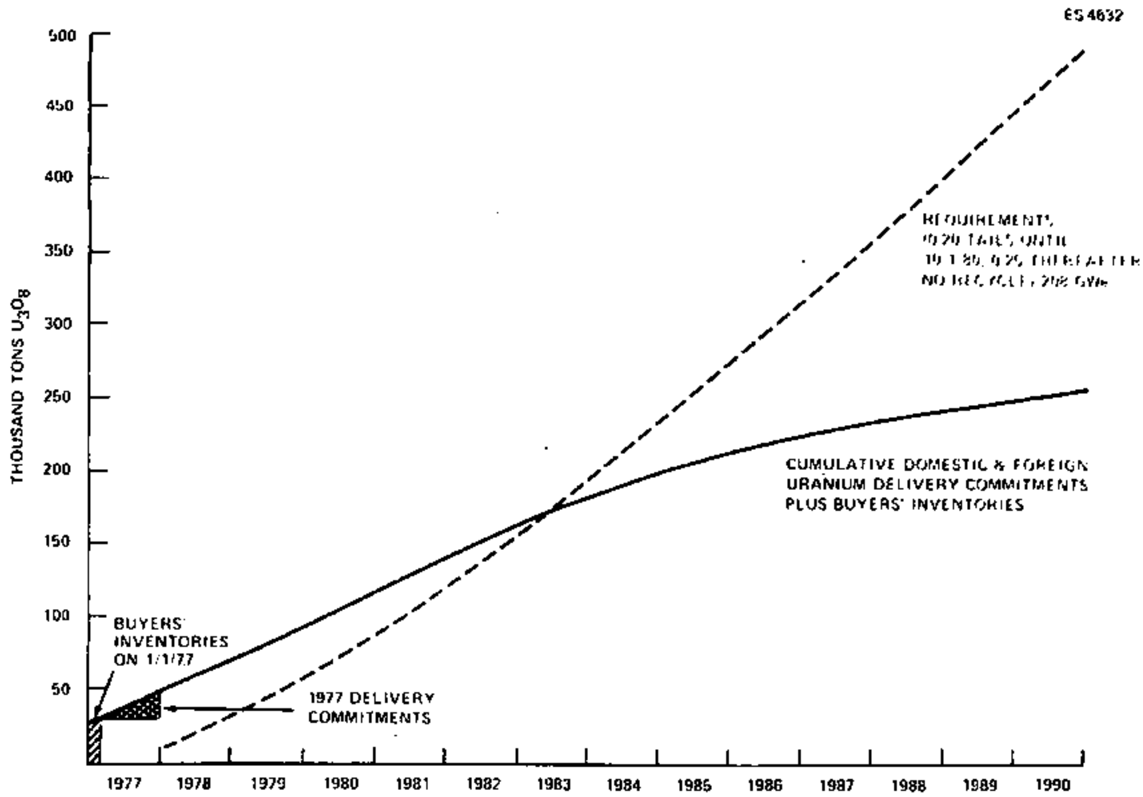

Fig. 10.2. Summary of uranium requirements and delivery commitments as of January 1, 1977. Source: Energy Research and Development Administration, *Survey of United States Uranium Marketing Activity*, Division of Uranium Resources and Enrichment, Office of Assistant Director of Raw Materials, May 1977.

13,500 tons to be exported. Figure 10.2 illustrates total U_3O_8 requirements, domestic deliveries, imports, and exports through 1990.

Cumulative U.S. supplies of U_3O_8 (including domestic and foreign inventories and contract commitments) will exceed DOE enrichment feed requirements until 1983. The gap between cumulative supply and cumulative requirements is expected to be approximately 58,000 tons by 1985 and widen to approximately 233,000 tons by 1990 (see Fig. 10.3).

10.6.1.5 Comparison of health effects of the uranium fuel cycle and the coal fuel cycle

Research conducted by the U.S. Nuclear Regulatory Commission[22] comparing the health effects associated with the coal fuel cycle (mining, processing, fuel transportation, power generation, and waste disposal) and the uranium fuel cycle (mining, milling, uranium enrichment, fuel preparation, fuel transportation, power generation, irradiated fuel transportation, and waste disposal) indicated that increases in the use of coal for power generation may cause the adverse health impacts related to electric energy production to increase. As defined by the study, health effects are stated in terms of "excess" mortality, morbidity (disease and illness), and injury among occupational workers and the general public, where "excess" implies illness and injury rates higher than normal and premature deaths. The estimated excess deaths per 0.8 gigawatt-year electric [GWyr(e)] (i.e., per 1000 MWe power plant operating at 80% of capacity for one year) were 0.47 for an all-nuclear economy (assumes that all of the electricity used within the nuclear fuel cycle is generated by nuclear power) and 1.1 to 5.4 if all the electricity used in the uranium fuel cycle (primarily for uranium enrichment and reactor operation) came from coal-fired plants. Excess deaths for the entire coal cycle varied from 15 to 120 per 0.8 GWyr(e). Mortality estimates are shown in Table 10.7.

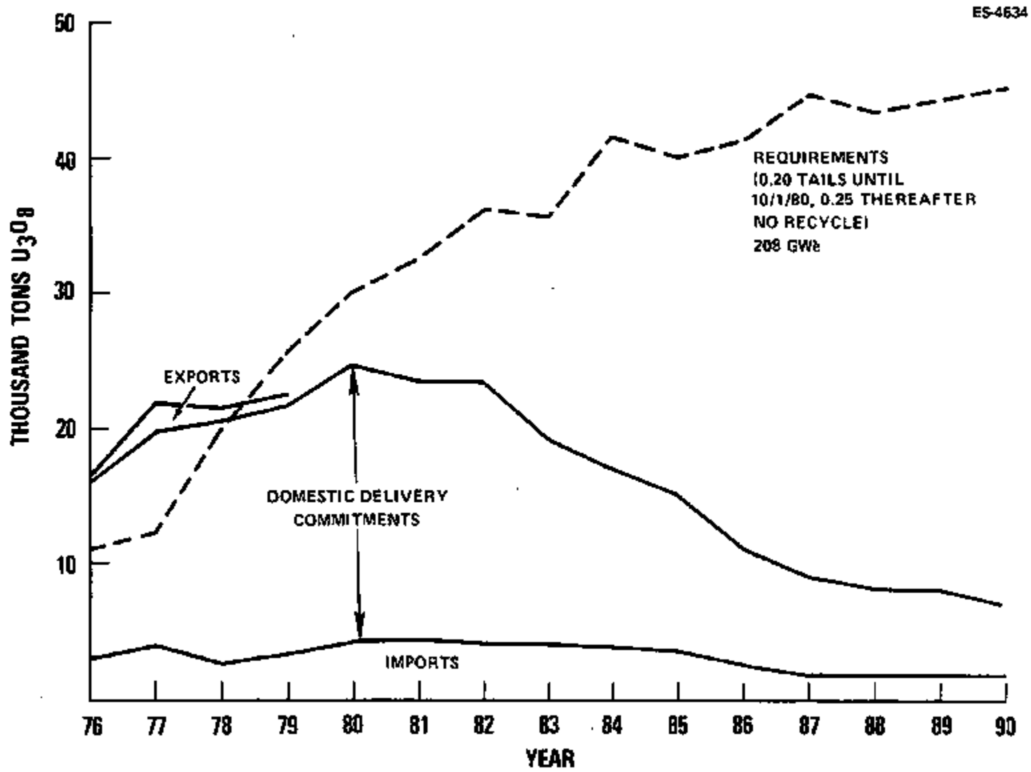

Fig. 10.3. Comparison of U_3O_8 requirements and contracted deliveries plus inventories. Source: Energy Research and Development Administration, *Survey of United States Uranium Marketing Activity*, Division of Uranium Resources and Enrichment, Office of Assistant Director of Raw Materials, May 1977.

Excess morbidity and injury rates for workers and the general public resulting from normal operations and accidents in an all-nuclear cycle were estimated to be about 14 per 0.8 GWyr(e), with injuries to miners from accidents (falls, cave-ins, and explosions) accounting for ten of these occurrences. If all the electrical power used in the uranium fuel cycle originated from coal-fired plants, these rates would increase to approximately 17-24 per 0.8 GWyr(e). The estimated excess disease and injury rate for the coal cycle was 57-210 per 0.8 GWyr(e). Coal-related illnesses among coal miners and the general public and injuries to miners account for the majority of nonfatal cases. Table 10.8 illustrates these comparative illness and injury rates.

Although the adverse health effects related to either the uranium fuel cycle or the coal fuel cycle represent small additional risks to the general public, the study concluded that ". . . the coal fuel cycle may be more harmful to man by factors of 4 to 260 depending on the effect being considered, for an all-nuclear economy, or factors of 3 to 22 with the assumption that all of the electricity used by the uranium fuel cycle comes from coal-powered plants . . ." (ref. 22, p. 13). Additionally, ". . . the impact of transportation of coal is based on firm statistics; this impact alone is greater than the conservative estimates of health effects for the entire uranium fuel cycle (all nuclear economy) and can reasonably be expected to worsen as more coal is shipped over greater distance . . ." (ref. 22, p. 13).

Table 10.7. Current energy source excess mortality summary per year per 0.8-GWyr(e) power plant

	Occupational		General public		Totals
	Accident	Disease	Accident	Disease	
	Nuclear fuel cycle				
All nuclear	0.22[a]	0.14[b]	0.05[c]	0.06[b]	0.47
With 100% of the electricity used in the fuel cycle produced by coal power[d]	0.24–0.25[a,e]	0.14–0.46[b,f]	0.10[c,g]	0.64–4.6[h]	1.1–5.4
	Coal fuel cycle				
Regional population	0.35–0.65[e]	0–7[f]	1.2[g]	13–110[h]	15–120
Ratio of coal to nuclear: 32:260 (all nuclear); 14:22 (with coal power)[i]					

[a]Primarily fatal nonradiological accidents, such as falls, explosions, etc.

[b]Primarily fatal radiogenic cancers and leukemias from normal operations at mines, mills, power plants and reprocessing plants.

[c]Primarily fatal transportation accidents (Table S-4, 10 CFR Part 51) and serious nuclear accidents.

[d]U.S. population for nuclear effects; regional population for coal effects.

[e]Primarily fatal mining accidents, such as cave-ins, fires, explosions, etc.

[f]Primarily coal workers pneumoconiosis and related respiratory diseases leading to respiratory failure.

[g]Primarily members of the general public killed at rail crossings by coal trains.

[h]Primarily respiratory failure among the sick and elderly from combustion products from power plants but includes deaths from waste coal bank fires.

[i]100% of all electricity consumed by the nuclear fuel cycle produced by coal power; amounts to 45 MWe per 0.8 GWyr(e).

Source: R. L. Gotchy, *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives,* Report NUREG-0332, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September 1977.

Table 10.8. Current energy source summary of excess morbidity and injury per 0.8 GWyr(e) power plant

	Occupational		General public		Totals
	Morbidity	Injury	Morbidity	Injury	
	Nuclear fuel cycle				
All nuclear	0.84[a]	12[b]	0.78[c]	0.1[d]	14
With 100% of electricity used by the fuel cycle produced by coal power[e]	1.7–4.1[f]	13–14[b]	1.3–5.3[g]	0.55[h]	17–24
	Coal fuel cycle				
Regional population	20–70[f]	17–34[i]	10–100[g]	10[h]	57–210
Ratio of coal to nuclear: 4.1:15 (all nuclear); 3.4:8.8 (with coal power)[j]					

[a]Primarily nonfatal cancers and thyroid nodules.

[b]Primarily nonfatal injuries associated with accidents in uranium mines, such as rock falls, explosions, etc.

[c]Primarily nonfatal cancers, thyroid nodules, genetically related diseases, and nonfatal illnesses following high radiation doses, such as radiation thyroiditis, prodromal vomiting, and temporary sterility.

[d]Transportation-related injuries from Table S-4, 10 CFR Part 51.

[e]U.S. population for nuclear effects; regional population for coal effects.

[f]Primarily nonfatal diseases associated with coal mining, such as coal workers pneumoconiosis, bronchitis, emphysema, etc.

[g]Primarily respiratory diseases among adults and children from sulfur emissions from coal-fired power plants but includes waste coal bank fires.

[h]Primarily injuries to coal miners from cave-ins, fires, explosions, etc.

[i]Primarily nonfatal injuries among members of the general public from collisions with coal trains at railroad crossings.

[j]100% of all electricity consumed by the nuclear fuel cycle produced by coal power; amounts to 45 MWe per 0.8 GWyr(e).

Source: R. L. Gotchy, *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives,* Report NUREG-0332, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September 1977.

10.6.2 Solar, geothermal, and synthetic fuels

Estimates reported in the *National Energy Outlook*[15] indicate that solar and geothermal sources will each supply about 1% of U.S. energy requirements by 1985 and about 2% by 1990. Supplies of synthetic gas and oil derived from coal will probably not exceed 1% of U.S. energy requirements as of the year 1990. These projections are based on many considerations. The technology exists in all cases but not in a proven, commercially viable manner. The potential for proving these technologies on a commercial scale is great, but timely development will require a favorable market as well as governmental incentives. A maximum of 6% of projected 1990 energy requirements is expected to be derived from solar, geothermal, and synthetic fuel resources combined.

The *National Energy Plan*[12] does not set specific goals for increased use of synthetic fuels or geothermal energy, but does state that, as a possible goal, solar energy will be used in 2.5 million homes by 1985.

10.6.3 By-product uranium

Uranium recoverable as a by-product of phosphate fertilizer and copper production is estimated to be 140,000 tons through the year 2000.[18] These reserves are in addition to the 690,000 tons of $30 uranium available from conventional mining and milling sources.

The following is noted in a report by the National Academy of Sciences:[23]

> Like all by-product commodities, by-product uranium is entirely dependent upon production of the primary commodity, is limited in amount by the level of production of the primary commodity, and is unresponsive to the demand for uranium. By-product uranium could be obtained from the mining of phosphate, copper, and lignite.
>
> Much phosphate is treated with sulfuric acid to produce fertilizer and goes through a phosphoric acid step. Uranium in the phosphate can be recovered from the phosphoric acid. . . . It has been estimated that about 2500 ST U_3O_8 per year could be recovered from Florida phosphate mined for fertilizer.
>
> The Bureau of Mines studied the sulfuric acid leaching of low-grade dumps at 14 porphyry copper mines and concluded that about 750 ST U_3O_8 per year could be recovered. This would be recovered from rocks whose uranium content ranges from 1 to 12 ppm.

The Bureau of Mines thought that other porphyry copper deposits might also be possible sources of by-product uranium.

The staff has studied available data on the potential of uranium production from phosphate fertilizer production[24] and from copper dump leaching, and estimates that production could reach 3000 to 5000 MT (4000-6000 tons) per year from phosphoric acid extraction and 400 to 900 MT (500-1000 tons) per year from copper dump leaching.[24,25] Much effort has been expended to determine the amounts of uranium that might be recovered from coal and lignite. Some uranium was recovered from lignite ash in the early 1960s, but the lignite itself was not a suitable fuel for the process; supplementary fuel was needed for the necessary conversion to ash. No uranium has been recovered as a by-product from the ash of coal- or lignite-fired power plants. Ash samples continue to be analyzed for uranium, but to date no ash containing more than 20 ppm U_3O_8 has been found, and most ash samples contain from 1 to 10 ppm U_3O_8.[25]

10.6.4 Energy conservation

The cornerstone of the *National Energy Plan* is conservation, the cleanest and cheapest source of new energy supply.

> If vigorous conservation measures are not undertaken and present trends continue, energy demand is projected to increase by more than 30% between now [1977] and 1985.[12]

The *National Energy Plan* lists the following consuming segments as being prime targets for energy conservation:

1. transportation,
2. buildings, including residences,
3. appliances,
4. industrial fuel use, and
5. industries and utilities using cogeneration of electricity and low-grade heat.

Part of the *National Energy Plan* will be the utilization of all possible governmental means (tax reduction, incentives, direct subsidy, and legislation and regulation) to change the past relationship between energy production and use of energy requirements in the United States where energy usage is two times higher per capita than in other industrial countries for energy consumption and production and energy use.

The *National Energy Plan* clearly states that both coal and nuclear electrical generation facilities will be needed to meet estimates of U.S. energy requirements through the year 2000, even if the conservation goals of the *Plan* are met. The relative amounts of each energy source used will depend on economic and regional environmental considerations.

10.7 ALTERNATIVE OF NO LICENSING ACTION ON MILL

Among the alternative actions available to the Colorado Department of Health is the denial of a Radioactive Materials License to the applicant. Classifications of these materials are discussed in 10 CFR Part 40.13(b); these classifications are based on Section 62 of the Atomic Energy Act of 1954, which specifically exempts "unbeneficiated ore" from control. Under these regulations Homestake Mining Company could mine the ore at the Pitch Project site but could not process it, should the Radioactive Materials License be denied. Exercise by the Colorado Department of Health of this option would thus leave the applicant with three possible courses of action: (a) mine the ore and have it processed at an existing mill possessing a Radioactive Materials License; (b) postpone the project while attempting to remove the objections that led to the denial of the license; or (c) abandon the project. Alternative (a) has been discussed in Sect. 10.5. Alternative (b) is essentially the applicant's proposal (merely shifted in time), which is the subject of this Statement. Alternative (c), therefore, is the only alternative discussed herein.

If the applicant were not awarded a Radioactive Materials License, the uranium concentrate it intends to produce would not become available for use as fuel in nuclear reactors in so timely a manner as it would if the license were awarded. The relationship of electrical energy produced by nuclear reactors to the total U.S. energy requirements has been discussed in Sect. 10.6.

The yellow cake produced by the Pitch Project will be used as fuel in nuclear reactors that are either operating or under construction. These reactors will produce electric power for sale to U.S. consumers. Lack of fuel would require those reactors short of fuel to reduce their output and could conceivably result in the shutdown of some of them.

The applicant has indicated the effects of losses of local and regional economic benefits that would occur if the Homestake Mining Company Pitch Project mill were not licensed and has also pointed out the environmental costs that would not be incurred should no license be issued. Overall, the benefits accruing from the mill outweigh the costs.

REFERENCES FOR SECTION 10

1. "Responses to comments by Al Hazle (Colorado Department of Health, Radiation and Safety) Regarding Pitch EIS Concerns," (enclosure to letter from Harold A. Powers, Homestake Mining Company, to Ross A. Scarano, U.S. Nuclear Regulatory Commission), 16 January 1978.

2. R. C. Merritt, *The Extractive Metallurgy of Uranium,* Colorado School of Mines Research Institute, Golden, Col., 1971.

3. D. A. Clark, *State-of-the-Art: Uranium Mining, Milling, and Refining Industry,* Report EPA-660/2-74-038, National Environmental Research Center, Office of Research and Development, U.S. Environmental Protection Agency, June 1974.

4. "Responses to the Environmental Review Questions and Requests for Additional Information, Environmental Statement — Pitch Project, Project No. M-5," prepared by Dames and Moore, 28 November 1977 (enclosure to letter from the Homestake Mining Company to the U.S. Nuclear Regulatory Commission, 1 December 1977).

5. U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to the Minerals Exploration Company's Sweetwater Uranium Project, Sweetwater County, Wyoming,* Docket No. 40-8584, December 1977.

6. U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to the Rocky Mountain Energy Company's Bear Creek Project, Converse County, Wyoming,* Docket No. 40-8452, December 1977.

7. U.S. Nuclear Regulatory Commission, *Draft Environmental Statement Related to the Operation of Moab Uranium Mill, Atlas Minerals Division, Atlas Corp., Grand County, Utah,* Docket No. 40-3453, November 1977.

8. Homestake Mining Company, *Preliminary Feasibility Study, Low-Moisture Tailings Disposal, Hale Gulch, with a Summary of Previous Tailings Disposal Alternatives, Proposed Pitch Uranium Project, Near Sargents, Colorado,* prepared by Dames and Moore, Denver, Colo., November 1978.

9. R. E. Blanco et al., *Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "As Low as Practicable" Guides — Milling of Uranium Ores,* Report ORNL/TM-4903, vol. 1, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1975.

10. Ref. 5, p. 10-6.

11. *Environmental Statement, Pitch Project No. M-5* (enclosure to letter from the Homestake Mining Company to the U.S. Regulatory Commission, 31 March 1978).

12. Executive Office of the President, *The National Energy Plan,* Energy Policy and Planning, April 1977.

13. Tetra Tech., Inc., *Energy Fact Book — 1977,* prepared under the direction of the Director, Navy Energy and National Resources Research and Development Office, April 1977.

14. U.S. Bureau of Mines, *United States Energy through the Year 2000,* December 1975.

15. Federal Energy Administration, *National Energy Outlook,* U.S. Government Printing Office, Washington, D.C., February 1976.

16. Federal Energy Administration, *Project Independence,* U.S. Government Printing Office, Washington, D.C., November 1974.

17. Department of Energy, *Latest Estimate of U.S. Uranium Resources,* April 1978.

18. Department of Energy, *Statistical Data of the Uranium Industry,* Report GJO-100(78), January 1, 1978.

19. *Nuclear News*, July 1975, p. 37 [reprinted in *Energy Factbook — 1977*].

20. U.S. Bureau of Mines, *Recovery of Uranium from Low-Grade Resources*, December 7, 1977 (unpublished).

21. Energy Research and Development Administration, *Survey of United States Uranium Marketing Activity*, Division of Uranium Resources and Enrichment, Office of Assistant Director of Raw Materials, May 1977.

22. R. L. Gotchy, *Health Effects Attributable to Coal and Nuclear Fuel Cycle Alternatives*, Report NUREG-0332, Division of Site Safety and Environmental Analysis, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, September 1977.

23. National Academy of Sciences, *Mineral Resources and the Environment. Supplementary Report: Reserves and Resources of Uranium in the U.S.*, Washington, D.C., 1975, p. 106.

24. J. Klemenic and D. Blanchfield, "Production Capability and Supply (of Uranium)," paper presented at Grand Junction, Colo., ERDA Uranium Conference, October 1977.

25. J. F. Pacer, Jr., "Production Statistics," paper presented at Grand Junction, Colo., ERDA Uranium Conference, October 1977.

11. BENEFIT-COST SUMMARY FOR THE HOMESTAKE MINE AND MILL

11.1 GENERAL

The general need for uranium mills is subsumed in the operation of nuclear power reactors. In reactor licensing evaluations, the benefits of the energy produced are weighed against related environmental costs, including a prorated share of the environmental costs of the uranium fuel cycle. These incremental impacts in the fuel cycle are justified in terms of the benefits of energy generation. However, it is appropriate to review the specific site-related benefits and costs for an individual fuel-cycle facility such as the Homestake mine and mill.

11.2 QUANTIFIABLE ECONOMIC IMPACTS

Many monetary benefits accrue to the community from the presence of the project, such as local expenditures of operating funds and the State and local taxes paid by the project. Against these monetary benefits are monetary costs to the communities involved, such as for new or expanded schools and other community services. It is not possible to arrive at an exact numerical balance between these benefits and costs for any one community unit, or for the project, because the distribution of revenues to support services may not be timely or completely consistent with those geographical locations where impacts occur.

11.3 THE BENEFIT-COST SUMMARY

The benefit-cost summary for a fuel-cycle facility such as the Homestake mine and mill therefore evolves to a comparison of the societal benefit of an assured U_3O_8 supply (ultimately providing energy) against local environmental costs for which there is no directly related compensation. For the Homestake mine and mill there are, basically, two uncompensated environmental costs: radiological impact and disturbance of the land. The radiological impact of the Homestake mine and mill is low (Sect. 4.7). The disturbance of the land is also a small environmental impact (Sects. 4.2, 4.5, 4.6, and 8). The mill and tailings ponds will affect approximately 87 ha (215 acres). The mine will affect approximately 304 ha (750 acres). Another 67 ha (166 acres) will be used for roads and reservoirs. Essentially all of the disturbed land will be reclaimed after the mill is decommissioned and, with the possible exception of the tailings burial area, will become available for present uses or for other uses.

11.4 ASSESSMENT

It may be concluded that the adverse environmental impacts and costs are such that the use of the mitigative measures suggested by the applicant and the regulatory agencies involved would reduce the short- and long-term adverse impacts associated with the project to acceptable levels.

In considering the energy value of the U_3O_8 produced, minimal radiological impacts, minimal long-term disturbance of land, and mitigable nature of the societal impacts, the overall benefit-cost balance for the Homestake mine and mill is favorable, and the indicated action is to grant a CDH Radioactive Materials License to construct and operate a uranium processing mill and such other licenses and approvals as are required for mine operation.

Appendix A

SUMMARY OF PUBLIC PARTICIPATION IN THE REVIEW OF THE PITCH PROJECT AND COMMENT LETTERS ON THE DRAFT ENVIRONMENTAL STATEMENT WITH STAFF RESPONSES

CONTENTS

Appendix A

SUMMARY OF PUBLIC PARTICIPATION IN THE REVIEW OF THE PITCH PROJECT AND COMMENT LETTERS ON THE DRAFT ENVIRONMENTAL STATEMENT WITH STAFF RESPONSES

A.1 SUMMARY OF PUBLIC PARTICIPATION IN THE REVIEW OF THE PITCH PROJECT

One of the primary goals of the Forest Service (FS) is to provide an opportunity for public participation. The Homestake Mining Company's Pitch Project has had considerable public exposure and comment. The following is a summary of the public participation related to the Pitch Project.

A.1.1 Phase I Environmental Analysis Report, September 1975–March 1976

During the preparation of the Phase I Environmental Analysis Report (EAR), letters were sent to interested groups and individuals requesting the comments on the Homestake Mining Company proposed actions.

The following received the letter:

- Gunnison City Council
- George E. Means and Sons
- Saguache County Land Use Planning Commission
- Bernard Irby
- Gunnison County Chamber of Commerce
- Gunnison County Commissioners
- Saguache County Commissioners
- Dr. Hugo Ferchau
- Jim Houston
- Dr. John Tarr

Comments received generally reflected concerns for environmental and resource protection.

A.1.2 Phase I Environmental Analysis Report, April 1976–September 1977

Following the publication of the Phase I EAR, a public meeting was held in Gunnison, Colorado, on April 23, 1976, to discuss the project. Gunnison Mayor Rial Lake conducted the meeting. There were 32 persons who attended. The net result was the formation of a Citizens Advisory Committee to provide input into the Homestake Mining Company ER being prepared by Dames & Moore. The Dames & Moore report cited dozens of State, County, and Federal agencies, and individuals consulted during its preparation.

A.1.3 Preparation of Draft Environmental Statement, September 1977–June 1978

When it was determined that an Environmental Statement (ES) was to be prepared, a meeting was held in Denver to organize the coordination procedures between the State of Colorado, Nuclear Regulatory Commission (NRC) and FS. The result over several meetings was the Statement of Understanding (Appendix B), coordinated the review and preparation of the ES.

The DES was published in July 1978 and over 450 copies were sent to individuals, groups, organizations, and agencies for review. Approximately 69 responses were received on the DES and are responded to in the FES.

Three public meetings were held on August 2 and 3, 1978, to discuss the Pitch Project. A panel composed of representatives from the State of Colorado, NRC, and the FS answered questions about the project. One meeting was held in Gunnison; the other two were held in Denver. About 150 people attended the three meetings; 95 questions were answered. The purpose of these meetings was to disseminate or clarify information about the project.

On August 23 and 24, 1978, three additional meetings were held at the same location, that is, Gunnison and Denver. The purpose of these meetings was to receive public comment on the project. A verbatim transcript of these meetings was taken. There were 28 persons submitting verbal or written responses.

A.2 LETTERS RECEIVED AND RESPONSES TO COMMENTS

Pursuant to 10 CFR 51, the DES was transmitted July 14, 1978, with a request to comment, to the Federal, State, and local agencies listed in the Summary and Conclusions section of this Statement. In addition, the FS requested comments on the DES from interested persons by means of a notice published in the *Federal Register* (43 FR 33318) on July 31, 1979.

The comment letters received are listed in the Contents for Appendix A. Each letter is reproduced below. The staff's responses to the issues raised in individual comments are presented in the responses, which are printed adjacent to each comment, and by changes in the text. Specific comments and responses are keyed by numbers in the margins of the letters and at the beginnings of the corresponding responses.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER-78/653

[illegible] 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
U.S. Forest Service
P.O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

We have reviewed the draft environmental statement for the Homestake Mining Company's Pitch Project in Saguache County, Colorado, as requested in your letter of July 14.

General Comments

(1.) References to reclamation throughout the draft statement are vague, and may influence readers to believe reclamation is a relatively short-term event and that "all is well." We believe reclamation of disturbed sites is a long-term and complicated process which can be considered complete only when the site is habitable for organisms that were originally present or that approximate the original inhabitants (National Academy of Sciences, 1974). Although reclamation is completed in steps or by a series of procedures, such as recontouring the spoil and seeding or hand-planting trees and shrubs, a schedule for these procedures should not be presented as a time table for reclamation (table 3-1, p. 3-14). Reclamation is realized when a disturbed site is producing a biomass similar to that existing before development began and may, for example, require up to 100 to 200 years to restore a spruce-fir ecosystem supporting a chicharee squirrel-pine marten association, or to become habitable as an elk calving ground. We propose that these facts be clearly stated in the final statement and that it be made clear that such

RESPONSES

1. The staff agrees with the comment defining reclamation when used in the context that an area is reclaimed. Reclamation is an ongoing process, and rightly may take several decades. However, reclamation begins at the time of the surface disturbance. Roadsides, road cuts, or other areas of surface disturbance will have reclamation actions applied as soon as practicable. Reclamation of the open pit to a viable ecosystem is deemed probable. Restoration to a climax community identical to that presently existing is neither feasible nor planned.

(2.) sites as the open pit cannot be reclaimed. A reclamation table showing how long it would take to restore the various plant and animal associations described in chapter 2 should be included in the final statement.

(3.) Section 2.8.1 on terrestrial wildlife should include enough detail on elk, deer, black bears, and mountain lions to make possible an adequate assessment of probable impacts. Section 4.7.1 is ambiguous and should be expanded to describe the probable effects of proposed action on terrestrial animals, particularly big game, where adequate data is

(4.) available. A development the size of the proposed action would impact these species far beyond the boundary of the project. A data base covering the entire home territory of all far ranging animals is necessary in chapter 2 to permit an adequate impact assessment, which should in part include: What management herd is it? What is the relationship between this herd and other nearby herds? Is the herd at range capacity? What are the management problems (or lack of problems) with the herd? What is this herd's contribution to recreation use? In chapter 4 the analysis should include: In what part of the elks home range would impacts occur? How much of it would be affected? How far away is similar range? Is the alternate range at its carrying capacity? How would the action affect elk hunters and hunting? Would taking the proposed action cause an increase in elk depredations in the Tomichi Creek area where it now occurs? Summation of these facts are needed in sections 4.7.1.1, 4.7.2.1, and 4.10. Several points on elk behavior for consideration in impact analysis follow: When the South Pass (Wyoming) iron mine (similar intensity to the proposed action) was developed in heavily used winter range, the elk abandoned the area. Now they do not come within a mile of the perimeter of the mine complex. Ward found elk avoided light activities such as vehicles on forest roads, campers, fishermen, or small timber operations by allowing about a half-mile buffer zone (Ward, 1973). Other workers have documented similar behavior for elk and other species. The effects of the proposed action should be discussed in similar detail for all appropriate big game species.

(5.) Commendable detail is provided on the disposal methods considered for radioactive wastes; but in view of the uranium tailings problems in Salt Lake City and in several nearby localities, we believe waste-disposal experts should rank the reliability of the various methods. This would allow readers to judge whether the best measure would be taken to protect the environment from radioactive contamination.

walk away by Homestake

2. A reclamation table is not practical because the time required for "reclamation" is not predictable with any degree of accuracy. The important consideration is that reclamation is begun when practical to do so and continued until the area is capable of supporting an established plant cover that can succeed to climax conditions.

3. The ER (pp. 2-219 through 2-244) and the Supplemental ER (pp. 2-150 through 2-172) contain substantial information about terrestrial wildlife. Questions raised by the respondent are answered in those documents.

4. In summary, the effect is considered to be minimal because (1) only 600 to 700 acres of big-game habitat is being removed from use, a small area compared to the tens of thousands of acres available; (2) big-game species will move to a location that gets them out of the line-of-sight of human activity and noise (the next ridge); and (3) when a tolerance of the activity is acquired, they will move back closer as long as cover is available and serves as a buffer.

5. Only in recent years has the subject of uranium mill tailings management received the attention commensurate with the potential hazards attributed to this material. As a consequence, no firm data exist on which the staff can base a reliability ranking of the various methods proposed. However, based on the best judgment of personnel active in this field, the staff considers Alternatives 1, 11, and 12 (with certain limitations) as described in Chapter 10 to be capable of meeting the overall objectives of a tailings management plan. It should be pointed out that the Radiation and Hazardous Wastes Control Division of the Colorado Department of Health will designate the tailings management plan authorized in accordance with the issuance of a Radioactive Materials License for the milling operation.

(6.) A National Scenic Trail has been proposed which would follow the Continental Divide. We suggest that this be recognized in the final statement. Since the area of mining and milling activities is within 2.5 miles of the divide, any adverse effects on the trail should be described.

Specific Comments

(7.) Page iii, item 2: Throughout the report the location of the proposed tailing impoundment is referred to as at the "head end" of a natural valley. Actually, the proposed dam is located about 1 kilometer upstream from the mouth of Hale Gulch into Marshall Creek; Hale Gulch is indicated to be about 3 kilometers long on the USGS topographic map of the Pahlone Peak quadrangle.

(8.) Page 2-13, par. 9: The units of the hydraulic gradient down Hale Gulch is given in feet. Because hydraulic gradient represents the slope of the potentiometric surface, the units should be given as a unit change in elevation over a unit distance--such as feet per mile.

(9.) Page 2-29, table 2.9: Footnote b - Sodium absorption ratio should read sodium adsorption ratio. Footnote c - CEC stands for cation exchange capacity rather than electrical conductivity (EC).

(10.) Page 2-33, sec. 2.8.1.1: Mountain lion, black bear, and pine marten are also known to be present although rarely observed.

(11.) Page 2-37, sec. 2.8.3.1: The greenback cutthroat trout is native to the Arkansas and South Platte River Basins, rather than the Colorado River drainage as stated. The Colorado River cutthroat (*Salmo clarki pleuriticus*), which is listed as threatened by the State, does occur in the Colorado River drainage.

(12.) Page 2-38, sec. 2.8.3.2: The reference to endemic species should be deleted, since, by definition, any species that occurs in an area is endemic to that area. In addition, both the grizzly bear and grey wolf are considered to have been extirpated from the State; thus the occurrence of either in the project area is highly unlikely.

(13.) Page 2-50: We note that archeological sites which may be affected by the construction of the access road are being evaluated for archeological significance. For all sites

6. If this National Scenic Trail is implemented, the project would have no visual impact. Muffled blasting noise, similar to distant thunder, might occasionally be heard. Radiological effects, considering the occupancy factor, would be much less than those calculated for the nearest potential residence (Table 4.3).

7. The area of Hale Gulch above the proposed impoundment is much smaller than the area between the dam and Marshall Creek. Thus, "head end" is considered descriptively correct by denoting the small upstream drainage area.

8. The text has been changed to read "0.05 m/m (0.05 ft/ft)."

9. The correction has been made.

10. During field studies, pine marten were sighted directly, and black bear scats were found, but no direct or indirect sightings of mountain lions occurred. This information has been added in the text.

11. The statement is correct. However, Colorado River cutthroat trout are restricted to two locations in the Colorado River drainage. Neither location is part of the Colorado River drainage, which includes the Pitch Project.

12. The term "endemic" has been deleted from the text.

13. Homestake Mining Company is expected to evaluate all identified sites for which National Register significance has not been determined in advance of project impact upon those sites. This evaluation will be done early enough to allow the Forest Service (FS) to request concurrence in the determination from the State Historic Preservation Officer. Where the site is determined significant, the effect of the project upon the site must be discussed, mitigation measures must be proposed, and approval by the State Historic Preservation Officer on the mitigation must be sought by the FS.

At present, nine sites in the Pitch Project area, one site in the Jay Creek Timber Sale area, one site in the Millswitch Timber Sale area, and Marshall Pass and Marshall Pass Road have been determined to be insignificant and the State Historic Preservation Officer concurrence on this determination is being sought. These sites are as follow: Pitch Uranium Project — 5SH193, 5SH194, 5SH195, 5SH205, 5SH208, 5SH209, 5SH199, 5SH220, and 5SH221; Jay Creek Timber Sale — 5SH293; and Millswitch Timber Sale — 5SH235.

which are found by the State Historic Preservation Officer to meet the National Register criteria, or for those where it is questionable whether the criteria are met, the Forest Service should request a determination of eligibility for inclusion in the National Register from the Keeper of the National Register. Regulations concerning requests for determinations of eligibility (36 CFR 63) were published in the Federal Register on September 21, 1977. If any properties listed in or eligible for the National Register will be affected by the project, the final statement should describe the nature and the extent of the effect and the steps being taken to comply with section 106 of the National Historic Preservation Act and sections 9(3) and 2(b) of Executive Order 11593.

Ten sites located in the Millswitch Timber Sale area near Marshall Pass and Marshall Pass Road have been determined to be historically insignificant but need to be tested to determine their archaeological significance. These sites include 5SH229, 5SH230, 5SH231, 5SH232, 5SH233, 5SH234, 5SH236, 5SH253, 5SH254, and 5SH255.

The Millswitch Timber Sale sites are not readily visible from Marshall Pass Road and those that are visible do not attract much attention. The staff does not consider that the Pitch Project would significantly increase visitation or vandalism of these sites.

(14.) Page 3-10, par. 1: The description of the mining plan is confusing and should be clarified. How will ore below the ultimate pit bottom be recovered?

14. Ore below the ultimate pit bottom will be removed by underground mining methods using an adit or shaft.

(15.) Page 3-10, sec. 3.1.2.3, Rock, line 5: How wide are the benches? This discussion is confusing.

15. The width of the safety benches will vary between 4.3 and 8.5 m (14 and 28 ft), depending on whether the bench heights are 6 or 12 m (20 or 40 ft). The working benches will average 61 m (200 ft) in width.

(16.) Page 3-10, par. 1: This discussion should be expanded to include more engineering detail on the waste dumps. The lifts appear excessive, and drainage-control engineering should be discussed. What considerations have been given to slope stability?

16. Engineering details regarding the waste dumps have been submitted to and approved by the Colorado Mined Land Reclamation Board. The results of studies conducted by the applicant's consultant and approval of Permit Condition No. 2 by the Colorado Mined Land Reclamation Board (see Appendix K) indicate that the lifts are not excessive and that the slope stability is adequate.

(17.) Page 3-12, Underground mining: This section should be more general because the feasibility and details of future underground mining on the site are unknown at this time.

17. This section is a general discussion of probable mining methods.

(18.) Page 3-13, sec. 3.1.3.1: This section should be expanded and correlated with waste-dump engineering.

18. This section applies to general reclamation on the entire project area. Detailed requirements are expected to be included as conditions specified by the cognizant regulatory agencies.

(19.) Page 3-13, sec. 3.1.3.2, par. 3 and 4: There is little engineering detail, and it appears that the slopes on the faces of the benches will approach 45°. If this is true, we doubt that successful reclamation of the benches will be possible.

19. Revegetation on the pit slopes will be difficult and is expected to take a considerable amount of time. Observations of roadcuts where slopes and climatic conditions are similar to those expected in the pit area indicate that natural revegetation will occur over time.

(20.) Page 3-28, sec. 3.3.7: This section should be expanded to include details on tailings, dam construction, and stability analysis, including criteria used for design of the diversion ditches around the tailings disposal area.

20. As stated on p. v, 7(b), "The tailings impoundment dam shall be constructed to withstand . . . an earthquake of Modified Mercalli Intensity of VIII and shall meet minimum specifications contained in the NRC Regulatory Guide 3.11. The design and construction shall be approved by the Colorado State Engineer's Office, Dam Safety Branch, and the U.S. Forest Service." It is the staff's opinion that sufficient detail is included for the purposes of this Statement. Specific engineering details will be submitted to the appropriate regulatory agency for approval.

(21) Page 3-28, par. 1: Does the probable maximum flood refer to the 28-hectare reservoir area or to the 100-hectare drainage area of Hale Creek above the tailings dam? There is concern that the reservoir is not large enough.

(22) Page 3-28, par. 7: The accumulation of radionuclides in the tailings accumulated over the projected life of the mill should be given.

(23) Page 4-5, sec. 4.3.3, par. 2: The Colorado Division of Wildlife recommends that the winter stream flow in Marshall Creek be no lower that 4 cfs rather than 2 cfs as stated. There is also concern about the proposed cut in stream flow during runoff, which may reduce the necessary spring flushing action in the streams.

(24) Page 4-8, last line: Substitute revegetation for reclamation.

(25) Page 4-11, par. 4: Delete sand. Trout build redds and spawn in gravel and rubble, not sand and gravel.

(26) Page 4-14, sec. 4.8.3, line 11: Add elk, deer, and trout. These animals remain closer to the proposed project area year-round than cattle, which are present only several months of the year.

(27) Page 4-18, par. 2, line 3: Add elk and trout.

(28) Page 6-4: The substances to be monitored and the sampling frequency are identified in table 6-1; however, the toxic threshold limits are not identified. We recommend that the table be amended, or a separate table added, to show the threshold levels for each substance monitored that would initiate remedial action. The water quality mitigation statements in sections 6.3.1 (p. 6-3) and 6.3.2.4 (p. 6-5) should also be expanded to give the threshold amounts of pollutants requiring remedial action. We suggest also that a statement be included as to what could be done to mitigate surface- and ground-water pollution if toxic levels of pollutants are reached as a result of the proposed project.

(29) Page 6-8, sec. 6.7.2.4: Beaver dams wash out, entirely or in part, each year with normal or high runoff.

(31) Page 9-1, sec. 9.3.2: The draft statement recognizes that the open-pit mine will irreversibly alter the ground-water

21. The reservoir has been designed and will be operated with sufficient freeboard to accommodate the runoff from a probable maximum flood. The probable maximum flood computed for the tailings dam was developed using the entire naturally contributing drainage area (100 ha) upstream of the centerline of the tailings dam. The drainage area includes that portion upstream of the interceptor ditch. The interceptor ditch is sized to accommodate at least a 100-year flood and will be capable of diverting 3.1 m^3/sec (110 cfs).

22. Utilizing the activity of the radionuclides in the ore feed and the percentages of the radioactivity that will end up in the tailings indicates an accumulation of about 138 Ci of uranium-238 and uranium-234, 7 Ci of uranium-235, 1967 Ci of thorium-230, and 1927 Ci of radium-226 and each daughter over a 20-year period.

23. This matter is discussed in the staff response to State of Colorado comment 10. This diversion will constitute a relatively small portion of the total stream flow and will not affect the "flushing action" during spring runoff periods.

24. The text has been changed.

25. "Sand" has been deleted and "rubble" added.

26. Cattle ingestion of radionuclides and subsequent human exposure through food (beef) are adequate to estimate potential exposures from eating elk, deer, or trout.

27. The additions have been made.

28. The levels at which remedial action will be taken will be determined by State and Federal requirements. It is not feasible to state the toxicity of a given substance that would apply to all types of organisms, and the toxicities of all substances to be monitored are not known. Table 4.1 lists the toxicities of certain trace elements for some species of aquatic organisms, but these values are inconsistent. (See response to State of Colorado comment 12.)

29. Mitigating measures that will be taken to avoid water quality problems are discussed in the responses to State of Colorado comments 9, 15, 18, 19, 20, 27, 31, 53 and EPA comments 3, 21, 22, 25, 26, 29, 36, 38, 39, 40, 42, 44, 45, 51, 52, 56, 57, 59, 60, and 61.

30. No response is required.

31. The groundwater flow pattern in the mine area, including portions of the Chester Fault, will be breached and altered during mining. A return to premining groundwater flow conditions will not be achieved totally due to the physical alteration of the area, but a significant difference between pre- and postmining conditions is not anticipated. Examination of the depth of oxidation does not show any evidence of deep circulation. The information indicates that the Chester Fault serves as a minor flow conduit in the northern and southern extremes of the proposed mine pit. In the central portion of the mine, the Chester Fault serves as a flow dam. The new piezometric map (Fig. 2.6) that has been developed for the existing mine site conditions (see response to State of Colorado comment 20) shows that the groundwater moves toward the west-southwest. This overall

flow in the vicinity of the Chester Fault zone and will destroy several springs. Because of possible deep circulation of ground water within the fault zone and its hydraulic continuity with interconnecting fracture systems, the effects of the altered ground-water flow pattern in the vicinity of the Chester Fault zone on regional ground-water conditions should be assessed.

(32.) Page 10-10, par. 3: We question whether the proposed tailings reclamation plan will indeed eliminate the need for long-term maintenance. Under this plan, flow from Hale Gulch would be diverted to an adjoining drainage over a concrete spillway across a saddle about 300 meters upstream from the tailings dam. As stated, deposition of sediment is likely on top of the covered tailings as the natural slope of Hale Gulch changes from 10 percent to 0.2 percent over the tailings. As sediment begins to build up, the direction of drainage channels above the tailings will become unpredictable. In the long term, flows across the face of the dam will again become a possibility despite the fact that the saddle will initially be lower than the dam. Once flow in the direction of natural drainage becomes reestablished, erosion of the tailings will be inevitable.

References

National Academy of Sciences, 1974, Rehabilitation potential of western coal lands: Study Committee on the Potential for Rehabilitating Lands Surface Mined for Coal in the Western United States, Ballinger Publishing Company, Cambridge, Mass., 198 p.

Ward, Torin A., 1973, Elk behavior in relation to multiple uses on the Medicine BW National Forest West: Assoc. State Game Fish Comm., Proc. 53:125-141, Salt Lake City, Utah.

Thank you for the opportunity to comment.

Sincerely,

(Sgd) Joan M. Davenport

Assistant SECRETARY

flow gradient pattern will be minimally altered, and the groundwater will continue to move from the Precambrian rocks east of the mine area with a slight north-to-south influence from the north, and will continue through the Belden Formation and Paleozoic sediments west of the Chester Fault toward Indian and Marshall creeks.

32. When the tailings impoundment is reclaimed, the slope in Hale Gulch will be changed from 10 to 0.2% to promote deposition of sediment on the tailings. The concrete spillway will act as an ultimate control on the erosion and deposition that is experienced on the reclaimed tailings area. Because the spillway is lower than the top of the reclaimed dam, it will be the drain point or low point in the drainage system upstream from the dam and the point of natural drainage discharge. Over a geologic time frame, water may again flow over the dam face. Because no marked erosion is evident in Hale Gulch at present, the inevitability of tailings erosion appears questionable. Please note that, although the goal is to eliminate the need for long-term maintenance, Colorado regulations require an ongoing monitoring and maintenance program funded by the applicant in the form of a bond.

Oct. 3, 1978

In Reply Refer To:
ER-78/653

Mr. Jimmy R. Wilkins
Forest Supervisor
U.S. Forest Service
P.O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

(1.) This letter is to supplement our review comments of August 31, 1978, on the draft environmental statement for the Homestake Mining Company's Pitch Project. It appears that the project may involve a water exchange agreement between the Bureau of Reclamation (BR) and either the Homestake Mining Company or the Upper Gunnison River Water Conservancy District.

The summary indicates that the applicant has purchased rights to 700 acre-feet of Marshall Creek water from the Upper Gunnison River Water Conservancy District. The district does not have water rights that Homestake Mining Company can purchase. The purchase, as described, is based on an exchange agreement that the district and the Bureau are now negotiating concerning the use of Blue Mesa water. This agreement has not been finalized, nor has NEPA compliance been completed. The Bureau becomes involved as a result of the construction of the Curecanti Storage Unit. Homestake's present plans call for the purchase of exchange storage from Blue Mesa Reservoir. This exchange mechanism should be explained and evaluated so that the environmental statement will provide a basis for any BR actions in this regard.

We ask that you work with Mr. Rinckel, Project Manager, Western Colorado Projects Office, Grand Junction, Colorado (FTS 8-323-0300) to ensure that the Bureau's concerns are adequately met. Additional specific comments for use in preparing the final environmental statement are attached.

Sincerely,

Larry E. Meierotto
SECRETARY

Enclosure

Letter transcribed from xeroxed copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

RESPONSES

1. By the August 24, 1978, decree of the Water Court for Water Division No. 4 in Case No. W-3017, there was adjudicated to Homestake the right to divert a maximum of 8.63×10^5 (700 acre-ft) per year from Marshall Creek for use at the Pitch Project. In June 1977, Homestake entered into an agreement with the Upper Gunnison River Water Conservancy District (the "District") by which the District is to provide Homestake with up to 8.63×10^5 (700 acre-ft) of water per year from the Curecanti Unit Reservoirs for exchange purposes. Water diverted by Homestake from Marshall Creek pursuant to its adjudicated rights for use in the Pitch Project, referred to above, is to be replaced by the exchange water if such replacement is necessary to avoid injury to vested water rights of others.

The rights of senior water users below the Curecanti Unit Reservoirs will be protected from injury due to such diversion by the release of exchange water to the Gunnison River as may become necessary. Senior water rights between the Pitch Project and the Curecanti Unit Reservoirs will be protected by the priority system, and it is anticipated that diversions from Marshall Creek may be curtailed by the operation of that system during portions of the historic irrigation season. Storage of up to 3.7×10^5 (300 acre-ft) of water per year at the Pitch Project will provide a supply of water sufficient to allow the applicant to continue its operations if it is unable to make direct diversions from Marshall Creek. To provide water for direct usage and to fill the Pitch Project storage reservoirs, the applicant contemplates that surface diversions will occur as needed primarily throughout the winter and spring runoff months. The applicant will make diversions of water from Marshall Creek during the historic irrigation season only when and in such manner that will not result in injury to holders of senior water rights.

The plan of operation outlined above is based in part upon providing replacement water for senior water rights below the Curecanti Unit Reservoirs. The applicant negotiated the June 1977 agreement with the District to provide the necessary replacement water and understands that the basic contract between the District and the Bureau of Reclamation (USBR) has not yet been concluded. It is for this reason that the applicant requested the USBR to furnish the replacement water necessary for the operation of the Pitch Project by a direct contract with the USBR until the contract between the District and USBR is consumated. By letter dated May 15, 1978, J. F. Rinckel, Projects Manager of USBR, advised the applicant that its request for the purchase of exchange water from USBR is under consideration. If it becomes necessary to develop an alternate plan, its impacts would have to be fully assessed by appropriate governmental agencies before it could be implemented.

SPECIFIC COMMENTS

(2.) Page 2-19, Surface Water: The surface water is not adequately described. Present uses should be described, and the downstream geographic description should include Tomichi Creek, the Gunnison River, and Blue Mesa Reservoir.

2. Additional material has been added in the text.

(3.) Page 2-21, Water Supply Reservoir: More description of reservoir size is needed. Exchanges should be explained here or elsewhere.

3. Additional information on reservoir size has been added to the text. The proposed exchanges are discussed in the text.

(4.) Page 2-21, Streamflows: Records from a temporary gaging station (April to mid-August 1976) are discussed. This type of a record is of little use in evaluating project impacts or water supply. Flows in the creeks (minimum, maximum, average flows) should be described for wet, dry, and average water-years by correlation with gaged drainages or actual measurements.

4. Assuming that water yields per acre are equal for the drainage basins of Indian, Tomichi, and Marshall creeks and using available data, the staff has added this information in the text.

(5.) Page 2-21, Water Use: Use of Marshall Creek water should include the existing irrigation rights.

5. The proposed diversion will decrease the average annual flow at Sargents by less than 2%. Prior irrigation rights will not be affected.

(6.) Page 2-37, Endangered Species: The Fish and Wildlife Service officially lists only the Humpback chub and the Colorado River squawfish as endangered.

6. This section has been clarified.

(7.) Page 4-3, Ground Water: Support for the statement that none of the spring discharge in the vicinity of the mine reaches a perennial stream should be included or referenced.

7. The statement is based on personal observations by the staff.

(8.) Page 4-5, Surface Water: It is stated that the Colorado Division of Wildlife has recommended minimum streamflows in Marshall Creek between Tank 7 and Indian Creeks. The location of Tank 7 Creek should be indicated on the map. There is no indication whether or not Homestake has made a commitment to operate its diversions in this manner. Also, because of downstream senior water rights, Homestake cannot guarantee streamflows in the creek much beyond its diversions. There is no analysis of preproject and postproject streamflows in Marshall Creek in the report, nor any analysis of effects on Tomichi Creek, the Gunnison River, or Blue Mesa Reservoir. These impacts should be addressed in the final environmental statement.

8. The location of Tank 7 Creek has been added to Fig. 2.9. Additional streamflow information has been added in Sect. 2.4.2.2. Potential impacts have been addressed in Sect. 4.3.3.

(9.) Chapter 5: No mention is made whether or not Homestake is committed to recommended streamflows and to limiting diversions to spring (high) flow periods.

9. This matter is being negotiated with State of Colorado agencies.

(10.) Chapter 10, Alternatives: Alternative water sources are not discussed. A contract with the Upper Gunnison River Water Conservancy District is mentioned in the proposal although it is not adequately described. It should be pointed out that this contract is dependent upon a water exchange from Blue Mesa Reservoir. On July 21, 1978, Homestake wrote the Bureau concerning a direct contract for Blue Mesa water (by exchange). This alternative should also be included and assessed in the final statement. Another alternative open to Homestake would be to acquire existing private irrigation water rights and convert them to industrial uses. This alternative and its impacts should be assessed.

10. There are no alternatives to water use. Present proposals are discussed in response 1 above. The only other potential alternative is stated in this comment.

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
650 CAPITOL MALL
SACRAMENTO, CALIFORNIA 95814

REPLY TO
ATTENTION OF
SPKED-W

6 September 1978

Mr. Jimmy R. Wilkins
USDA Forest Service
P.O. Box 138
11th & Main Street
Delta, Colorado 81416

Dear Mr. Wilkins:

The Draft Environmental Statement for Homestakes Mining Company's Pitch Project, dated 14 July 1978, was sent to the Corps' Omaha District for review and comment. However, since the proposed project is within the area under jurisdiction of Sacramento District, Corps of Engineers, Omaha District referred the report to our office for appropriate response.

We have reviewed the Draft Environmental Statement, and the work as proposed will not conflict with flood control or other programs within our jurisdiction.

Thank you for the opportunity to provide our review comments.

Sincerely yours,

for Joseph D. Countryman
GEORGE C. WEDDELL
Chief, Engineering Division

No response is required.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333
TELEPHONE: (404) 633-3311

September 7, 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
U.S. Department of Agriculture
Forest Service
P. O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

We have reviewed the draft environmental statement for the Homestake Mining Company, Pitch Project, on the Gunnison National Forest. We are responding on behalf of the Public Health Service.

Plans to restore the mined area with respect to air and water quality for human health considerations appear to be adequate. It was noted that the disposal area (69 acres) to be used for mill tailings will remain unfavorable for further productive use. However, we were pleased to note that the Colorado Department of Health, Radiation and Hazardous Waste Control Division, will be be involved in selecting the most environmentally acceptable method of tailings disposal.

1. Paragraph 5.2.2 on mill accidents, page 5-8, refers to a recommended 69,000 mg/m^3 level for prolonged human exposure to ammonia. This is a 1963 reference and the current standard is 34,800 mg/m^3 with the National Institute of Occupational Safety and Health recommending that this be retained but limited to a 5-minute sample.

2. In Table 2.6, water from the Pinnacle Mine portal cannot be identified as Station GW-3 except by noting the high values for radioactivity. This station is first identified in section 6.3.2.2 on page 6-5.

3. As stated in paragraph 3.2.8.5, some chemicals used in chemical toilets might interfere with proper operation of the septic tanks. The advice of the Colorado Department of Health should be obtained in this regard.

4. It is assumed that one transportation route to be upgraded (paragraph 8.2) is the road between Sargents and Poncha Springs over Marshall Pass. The new routes to be constructed and their justification are not listed.

RESPONSES

1. The text has been changed.

2. Identification was provided in Sect. 2.4.1.3. For further clarification, a footnote has been added to the table.

3. The Colorado Department of Health has the responsibility for such installations.

4. The only portion of the Sargents-Marshall Pass-Poncha Springs road to be improved is about 7.2 km (4.5 miles) of the road from Sargents to the mill and mine access road. New roads to be constructed are access roads to various facilities, such as the mill and tailings pond and mine haul roads.

Thank you for the opportunity of reviewing this document. We would appreciate receiving two copies of the final statement when it is issued.

Sincerely yours,

William H. Foege, M.D.
Assistant Surgeon General
Director

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER COLORADO 80295

SEP . 3 1978

REF: 8AH-WM

Mr. Jimmy R. Wilkins
Forest Supervisor
Grand Mesa, Uncompahgre and
Gunnison N.F.
U. S. Department of Agriculture
P. O. Box 138
Delta, CO 81416

Dear Mr. Wilkins:

According to our responsibilities under Section 309 of the Clean Air Act, as amended, enclosed are the Environmental Protection Agency's comments on the Draft Environmental Statement (DES) (USDA-FS-R2-DES (ADM)-FY-78-03) related to the proposed operation of Homestake Mining Company's Pitch Project, Gunnison National Forest, Colorado. While our comments cover many areas of concern, there are several points on which I want to place particular emphasis.

Given the complex geologic structure associated with the Pitch Project site, we are troubled by the limited knowledge of groundwater and stream flow characteristics evidenced in the DES. Yet, rather positive conclusions are reached concerning the volume of dewatering effluent, formation of a lake in the post-mining stage and the Company's ability to handle surface or groundwater problems which the Project may impose.

We are equally concerned with the reclamation plan presented in the DES. Radioactive elements previously entombed within geologic formations at the site will be technologically enhanced by the milling process and can easily contaminate the environment if perpetual vigi-
(A.) lance is not observed. In this case, a unique situation has been imposed by man--the creation of a monumental radioactive uranium mill tailings disposal site for millions of tons of waste, high in a mountain watershed area. The combined wear and tear from periodic fires; chemical action; waterflow cutting action on steep slopes; alternating freezing, heating, drying, wetting; wind action; and, seismic activities are forces that we feel the Company's plan takes lightly, particularly in view of the potential radiological hazards these wastes can inflict for many milenia. Another apparently disregarded impact

RESPONSES

A. The Colorado Department of Health, Radiation and Hazardous Wastes Control Division, has the responsibility for selecting the most environmentally acceptable method of tailings disposal within the present economic and engineering state of the art. All of the potential problems mentioned have been thoroughly considered in the evaluation of the tailings management plans proposed, and the staff has determined that long-term stability of the impoundment is reasonably assured. As a further precaution, a bond will be posted to ensure surveillance and required maintenance of the tailings disposal site caused by unforeseen circumstances. The staff agrees that normally excessive grazing would remove vegetative cover and could contribute to erosion. However, considering the final grade and the depositional character of the reclaimed tailings surface, little erosion is expected to occur under any vegetation condition. With the recommended cover of 0.9 m (3 ft) of compacted clay, 1.5 m (5 ft) of overburden, and 22.8 cm (9 in.) of topsoil plus anticipated deposition, the destructive impacts of burrowing animals in this area is considered to be highly unlikely.

recognized from previous reclamation projects at former uranium mill sites is the destructive effects of burrowing and grazing animals.

(B.) Before this project can proceed, there appears to be little doubt that a Section 404 permit (under the Federal Water Pollution Control Act of 1972, as amended--Public Law 92-500) will be required for construction of the diversion structure along Marshall Creek. We have noted this in our Comment #2 pertaining to Table 1.1 on Page 1-4 of the DES.

In accordance with EPA procedures adopted to rate the adequacy of environmental impact statements, the DES for the proposed Pitch Project will be listed in the Federal Register in Category 3, meaning that EPA rates the DES as inadequate and that additional information is required for the Final Environmental Statement (FES) according to our enclosed detailed comments.

Sincerely yours,

Alan Merson
Regional Administrator

Enclosure

FOREST SERV. DELTA
REC'D
SEP 21 1978

B. See specific comment 2 below.

EPA REGION VIII

SPECIFIC COMMENTS ON

DRAFT ENVIRONMENTAL STATEMENT (DES)

(USDA-FS-R2-DES(ADM) FY-78-03)

FOR

HOMESTAKE MINING COMPANY'S

PITCH PROJECT

RESPONSES

1. Page V, Item 7: Any approval, permit or license issued for the Pitch Project should be subject to a condition which may allow implementation of conclusions of the forthcoming NRC Generic Environmental Impact Statement (GEIS) on uranium milling.

1. The FS and agencies of the State of Colorado (an agreement State) grant approvals, permits, and licenses for the Pitch Project. Pertinent sections from the GEIS on uranium milling will be applicable.

2. Page 1-4- Table 1.1: This table should contain reference to the Corps of Engineers' Section 404 permit. Apparently Homestake Mining Company has inquired of the Corps of Engineers for the need of a 404 permit but no formal application has been received by the Corps. There appears to be little doubt that a 404 permit will be required for construction of the diversion structure along Marshall Creek (flow: 4-55 cfs). If construction of sediment ponds occurs in Indian Creek, a 404 permit may be required (flow 4-7 cfs). Even if Indian Creek does not meet the minimum 5-cfs cutoff requirement of a 404 permit, precedent exists for EPA to review, under Section 404, activities which are integrally related to a larger project for which a Section 404 permit is required. (The reference of Section 404 is from the Federal Water Pollution Control Act of 1972, as amended--Public Law 92-500.)

2. With respect to the diversion from Marshall Creek, by letter dated May 2, 1978, the applicant submitted plans of its proposed diversion to the U.S. Army Corps of Engineers for review and requested a determination of whether or not a "404 permit" is required. By letter dated May 30, 1978, the Corps indicated that, because no fill is to be placed below the ordinary high water elevation of Marshall Creek, a permit will not be required, provided all work is performed in accordance with the plans and criteria previously submitted.

With respect to construction of the sedimentation pond, an individual 404 permit is not required provided certain conditions, set forth in 33 CFR 323.4-2(b), are satisfied. Because the average annual flow at the sedimentation pond construction site is less than 5 cfs and applicable conditions will be satisfied, a nationwide permit has already been issued. It will not be necessary to obtain an individual permit. Because a 404 permit is not required for the diversion from Marshall Creek, the precedent referred to in the comment is inapplicable because a 404 permit is not required for any aspect of the project.

3. Page 2-6, Section 2.4.11: The DES states that because of the limited number of wells tested, coupled with a relatively complex geologic structure, information about the groundwater regime at the site is incomplete at this time. This fact is troublesome given the high potential for the Pitch Project to adversely impact groundwater quantity and quality and it indicates incomplete knowledge and understanding at this point in time. Yet, rather positive conclusions are reached concerning the volume of dewatering effluent, formation of a lake in the post-mining stage, etc. In addition to making

3. Additional knowledge of the hydrogeologic regime at the tailings disposal site has been developed. It is derived from analysis of data from 21 wells and water-level measurements from four piezometers. In addition, data regarding geology and groundwater were derived from more than 500 exploratory holes drilled by the applicant at the mine site. Examination of all of the above data has resulted in the revision of Fig. 2.7 and development of the potentiometric surface map for the mine area, Fig. 2.6. (This matter is also discussed in the response to State of Colorado comment 20.) The geology of the mine area is complex because of the north-south trending Chester, West, and lesser

parallel faults, as well as east-west trending faults, predominantly the Erie. The results of independent analyses conducted by Envirologic Systems, Inc., and a consultant strongly indicate that a lake will form in the mine pit upon the cessation of active mining (see response to State of Colorado comment 20). Flow into the ultimate mine pit is expected to be in excess of 1000 m^3/day (190 gpm) with possible flows up to 2700 m^3/day (500 gpm).

a commitment to treat the dewatering effluent if discharge to Indian Creek is necessary, preliminary design of the treatment system should be presented in the Final Environmental Statement (FES), including type of treatment, effluent limits, location of system, etc.

4. Page 2-8, Figure 2.5: The figure is essentially illegible, making it impossible to locate the sampling stations.

5. Page 2-12, Table 2.4: The recorded water levels on selected dates in the monitoring wells during September 1976 to January 1977, represents a very limited record and fails to document changes in water levels as a result of the important spring recharge. Additional groundwater recharge data is needed.

6. Page 2-13, Section 2.4.1.2, Groundwater regime at the proposed waste dumps: An appropriate number of groundwater wells should be drilled, tested, and sampled in the area of the waste dump sites.

7. Page 2-14, Figure 2.7: This figure shows the locations of the test wells in Hale Gulch which are to be used for monitoring, but there is no frame of reference to show the actual location of the tailings pond. It would also be helpful to have the depth of each hole shown on the figure.

8. Page 2-15, Figure 2.8: The locations of the groundwater sampling stations (GW-1 to GW-7) are not shown in this figure.

9. Pages 2-16 through 2-18, Tables 2.5 and 2.6: What is the explanation for the high TSS concentrations in the groundwater samples listed in Table 2.5? Why isn't the pH included in Table 2.5 or 2.6?

What are the units on the isotopic radiological analyses? The caption states milligrams per liter unless otherwise designated. For the radium-226, this would correspond to millicuries per liter which is unreasonable. On the other hand, the uranium does appear to be in units of milligrams per liter. The radiological analyses appear questionable. Isotopic ratios have no consistency even in the same well for successive samplings. No indication of quality assurance, such as replicate, results is given.

A more complete description of the analyses is needed in the text.

When necessary, excess mine water will be treated for removal of radium and suspended solids. The design of the sedimentation pond has been completed. The pond is designed to contain the deposited sediment over the life of the project, provide an operational retention time of 48 hr for mine dewatering, and totally contain the runoff from a 25-year, 24-hr event (see response to State of Colorado comment 9). The sedimentation pond will be located immediately downstream from the existing pond and will intercept runoff from the waste dumps. Discharges must meet applicable State and Federal limitations and must be in compliance with NPDES permit requirements. Preliminary design of treatment systems is not warranted because treatment will be for specific problems if they occur.

4. This figure has been redrawn.

5. Water level data for wells DM-1 through DM-14 from February 1977 through September 1978 are given in Table 2.4.

6. A monitoring well has been installed downslope from the first waste dump. The Colorado Department of Health will license the waste dumps and impose monitoring requirements.

7. Figure 2.7 has been redrafted (see response 3 above) showing the location of the tailings pond. Surface elevations and groundwater elevations are given. Well depths are reported in the text.

8. The locations of the groundwater sampling stations are shown in Fig. 2.5. The text has been corrected.

9. Suspended solids and turbidity are high because the sampling procedure agitated fine material in the bottom of the well. The pH values, ranging from 7.3 to 8.9, are shown in the Supplemental ER (Tables 2.6-9 and 2.6-12), along with several other parameters that are omitted from the tables in the DES.

The correct units for thorium-230 and radium-226 (pCi/liter) have been added to the tables. Data collected on other proposed mine-mill sites have shown the same wide degree of variability between successive samples. No replicate sample analysis was deemed necessary because the laboratory responsible for analytical services provided the quality assurance. Additional material has been added to the text of Sect. 2.4.1.3.

10. Page 2-19, Section 2.4.1.4: The DES states that the closest domestic groundwater use is at the town of Sargeants, where six wells are being pumped from the alluvium of Marshall Creek. These wells should be located.

Another use of the groundwater along Marshall Creek is subirrigation for hay production.

11. Page 2-20, Figure 2.9: The existing Pinnacle Mine operations should be included in Figure 2.9. The text in Section 2 should describe the existing Pinnacle Mine conditions and wastes.

12. Page 2-20, Section 2.4.2.1., Hale Gulch: The DES refers to Hale Gulch as an intermittent stream. Are any flow measurements available for Hale Gulch and does evidence of baseflow exist? What springs and seeps contribute to this area?

13. Page 2-21, Section 2.4.2.2: Is any stream flow data available for 1977? It is disturbing to note that even though the DES states that long-term discharge measurements are lacking and the Environmental Report states that the data collected during the seven-month period of record are indicative of relatively light precipitation amounts during the period, a longer period of record was not used to determine stream flows. This could have a direct impact on the Corps of Engineers' Section 404 permit.

14. Page 2-22, Table 2.7: Why are no uranium analyses given?

Are the high gross alpha and beta values for Indian Creek due to seepage from the mine and settling pond?

What is the reason for the discrepancy between the TSS range for Indian Creek at the confluence with Marshall Creek indicated in Table 2.7 and that indicated in the text on page 2-21?

Has the impact of the Pinnacle operation on the water quality of Indian Creek been evaluated? It should be discussed in the FES.

15. Page 2-25, Section 2.5.2.2: Does the uranium ore itself contain any significant amount of pyrite? Canadian mills which process ore containing pyrites have problems with acid tailings. The pyrite presence causes acid seepage and subsequent leaching of heavy and radioactive metals from the

10. Table 2.6-4 (p. 2-39) of the Supplemental ER provides the locations of these wells. Groundwater supports subirrigation for hay production along Marshall Creek. It is not directly pumped for subirrigation use.

11. The Pinnacle Mine is not operating. Groundwater monitoring site GW-3 on Fig. 6.1 monitors the discharge from the Pinnacle Mine portal. The quality of this water is reported in Table 2.6. Figure 2.4 also shows the mine location.

The ion-exchange circuit is now dismantled. Most of the buildings remain and are being utilized for storage and some warehousing and maintenance shop usage. Areas utilized by the ion-exchange plant for the processing of yellow cake are presently boarded off and closed to entry. Some ore from Pinnacle mining remains in a stockpile constructed by Pinnacle. Existing waste generated by the previous underground mining of Pinnacle will be disposed of in the proposed mine waste dumps.

12. No actual measurements of flow are available for Hale Gulch, but it has been sampled for water quality during the spring runoff. Hale Gulch flows only during the spring with water primarily from snowmelt. Base flow is discussed in Sect. 2.4.1.2 and springs are shown in Fig. 2.4.

13. The flow monitoring program was not fully maintained from November 1976 to November 1977, and thus only limited and random data are available for that time period. Extrapolated flow estimates have been added to the text.

The 404 permit is discussed in the response to EPA comment 2 above.

14. Uranium values were provided in Tables E-7, E-9, and E-12 of the ER but were omitted in Table 2.7 of the DES as inconsequential. Uranium and lead-210 values are presented in the revised Table 2.7.

The old mine area and the discharge from the closed Pinnacle Mine appear to contribute a significant amount of alpha and beta radioactivity to Indian Creek. At SW-4, immediately upstream of Indian Creek's confluence with Marshall Creek, alpha and beta values drop to about one-half that observed below the mine, probably caused by dilution from Little Indian Creek (Fig. 2.9). The mine discharge is estimated to contribute 16-45% of the gross alpha and 23-65% of the gross beta. Uranium, radium-226, magnesium, calcium, and bicarbonate concentrations in Indian Creek are also considerably higher downstream of the mine discharge than upstream, which further underscores the effect of the discharge on Indian Creek water quality (ER, Supp. Table 2.6-12; ER, Fig. 2.6-11). The discrepancy between the suspended sediment values stated on p. 2-21, Sect. 2.4.2.4, and the total suspended solids values in Table 2.7 reflects two different types of data collected at different times, using different sample collection techniques.

15. The average concentration of pyrite (FeS_2) in the uranium ore is less than 3%. Because the Pitch mill is an alkaline milling process, no problem is anticipated with pyrite conversion to acid, due to the neutralizing capacity of the tailings liquid.

tailings. Since the mill process is basically a carbonate leach, is there sufficient pyrite content to affect the tailings pH?

16. Page 2-26, Section 2.5.2.3: The DES states that the open pit will be excavated into unstable, altered rock and that "flowing ground" and extreme pressures along the fault zone have presented serious problems to previous underground mining. How will the proposed open pit and underground operations specifically deal with these unstable conditions?

17. Page 2-33, Section 2.8.1.1: Do bears frequent the project area? Does the study area include the entire project area? During a site visit in September 1977, a Homestake representative told EPA representatives of a individual being apprehended for attempting to trap bear illegally in the project area.

18. Page 2-38, Section 2.9: It is doubtful that fallout contributes a significant radiation dose. If fallout is to be specifically identified, its specific contribution should be identified.

19. Page 3-1, Section 3.1.2.2: The DES states in Section 3.3.4. that during mill operation the ore will be stored on clay pads with a surrounding water collection system to control and minimize potential soil contamination. What measures are being taken for the ore being stockpiled before mill operation. Is monitoring planned?

20. Page 3-10, Section 3.1.2.3: Every effort should be made to segregate and retain topsoil for later reclamation programs. Use of low-grade waste rock may utlimately cause toxicity or radioactivity problems. If topsoil can be hauled to the waste dumps presumably it can also be set aside.

21. Page 3-11, Section 3.1.2.4: It is our understanding that current plans call for dump lifts to be as great as 240 feet. This should be reflected in the FES. The DES refers to the formation of underdrains in the natural drainages beneath the dumps by natural segregation of the larger material. It is doubtful whether this process will form an underdrain which will not clog with fines. The DES goes on to state that any overburden containing toxic materials in concentrations considered harmful to plants will be buried below the surface of the dump and away from underdrains. What type of operational overburden testing program does Homestake plan to implement and what tests will be undertaken to determine potential leachate quality (i.e., water quality impacts)?

16. The old mine workings were located in extremely unstable ground near the Chester Fault zone. As a result of the excavation of these unstable formations during open pit mining, support problems encountered in the previous underground operation will be eliminated. The pit walls will be established in more competent rock formations adjacent to the Chester Fault on the east and west sides. Where the Chester Fault intersects the pit walls, the design angle of the pit will be altered to provide the desired safety factor.

17. The bear referenced in the question was intentionally attracted to the area by placement of meat and garbage. Normally, bears are not seen on the site and are not considered as frequenting the project site. The study area does include the entire project area.

18. Based on the discussion presented in NCRP Report No. 52 (1977), the annual dose attributable to fallout is estimated to be 1.0 millirem per year.

19. The operational monitoring program will be implemented at the time of licensing.

20. When topsoil is encountered on workable slopes and in sufficient thickness to justify storage, it will be stockpiled and used in reclamation. A soil thickness of only about 5 to 8 cm (2 to 3 in.) generally exists, and this grades rapidly into rock particles within less than 0.3 m (1 ft) of the ground surface. Tree roots in the heavily timbered areas complicate topsoil removal, and steep mountain slopes over part of the mine site will make heavy mobile equipment operations hazardous.

21. Natural segregation will inhibit clogging because fine material will remain near the top of the dumps and coarse material will settle near the bottom. To verify that the underdrains do not clog, piezometers will be installed in the waste dumps. Precipitation and runoff originating above the waste dumps will be directed away from the underdrains, and very little water will flow through the underdrains because no springs or streams will be covered by the dumps. Only precipitation runoff and snow will provide infiltration water.

Through extensive rotary and core drilling programs conducted during the exploration and development phases of the operation, the applicant has determined the location of overburden deposits containing sufficient concentrations of toxic materials to be harmful to plants, and these deposits will be buried below the surface of the dump and away from underdrains. There is no reason to assume that the overburden in areas of higher uranium content will contain higher

Since uranium ore pockets containing 15% uranium will be encountered, it seems reasonable that the overburden in these areas will have significant quantities of uranium and radium-226 contaminants that will require special considerations much the same as tailings wastes. This should be evaluated in the FES.

Any burial of pyrite should be considered from an acid draining problem viewpoint as well as from a plant toxicity viewpoint.

levels of radionuclides. The Colorado School of Mines Research Institute performed leaching studies on both barren overburden and low-grade waste material. These studies resulted in projected minimal changes in water quality associated with the development of the dumps. Their conclusion was that waste dump water quality would be similar to or better than present quality at sample point SW-1.

The Colorado Department of Health will require an ongoing monitoring program of the mine waste dumps. Details will be provided in the license.

22. Page 3-11, Section 3.1.2.5: The DES states that truckloads with less than 0.02% uranium will be dispatched to the overburden dumps. The Forst Service's definition of "waste" in Appendix D includes tailings (mill effluents) and mineralized mine waste averaging 0.01% or more U_3O_8. Does Homestake have any special plans for disposing of mine waste with 0.01% or more U_3O_8 in the waste dump (for example, sealing with clay)?

EPA Florida phosphate studies have indicated a health concern associated with land contaminated with as little as 5 pCi Ra-226 per gram of soil. In order to contain the radiological hazard of Ra-226 contaminated overburden from future use or redistribution, the Colorado Department of Health, Radiological and Hazardous Waste Control Division, should place licensing controls on any overburden contaminated with more than 10 pCi Ra-226 per gram of soil over background.

22. Low-grade waste (less than 0.02% U_3O_8) will be disposed of in "pockets" in the waste dumps, away from the underdrain system, and covered by at least 6 m (20 ft) of barren overburden. If the dump construction (see response 21 above) proceeds as planned, the staff considers that leaching and groundwater contamination from this untreated material is unlikely. The State will license and regulate the waste dumps.

23. Page 3-12, Section 3.1.2.5., Underground mining: What is the potential for acid drainage from the proposed underground mining?

23. Because of the high carbonate content of the ore, the potential for acid drainage is not great. As evidence for this statement, the present drainage from the old Pinnacle Mine is alkaline.

24. Page 3-12, Section 3.1.3: The overall reclamation plan is presented with the implication that revegetation will be achieved without great difficulty and land use will be restored within a reasonably short period of time (not quantified). However, considering the elevation(s) of the project site, the harsh winter conditions, and the short growing season, reclamation may be a difficult, lengthy undertaking with a long delay in the return of the land to pre-project uses. The Company should provide an estimate of the time period that will be required for the return of the project land to pre-project uses.

Evidence should be presented to substantiate the conclusion that revegetation on raw overburden (in the mine pit area and on the waste dumps) is achievable.

Have the revegetation test plots demonstrated the potential for reforesting the open pit benches and waste dump slopes,

24. Appendix J has been included in the FES describing the approach to revegetation and experimental work and results to date. Early results substantiate the staff position that all areas can be revegetated with native species to a viable ecosystem. More site-specific data must be accumulated before a firm time estimate can be made, but the time scale is years rather than decades. Reclamation of the pit slopes will be difficult, and revegetation will take a considerable amount of time. Experience with roadcuts of similar slopes and climatic conditions indicates that natural revegetation will occur over time. In addition, vegetation studies conducted by Ellison* in the Wasatch Plateau region of Utah describe the early ecesis of trees on materials essentially devoid of soil ingredients. Plant succession in the Rocky Mountains often starts with trees on lithic soils and even on talus slopes.

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*Lincoln Ellison, "Subalpine Vegetation of the Wasatch Plateau," *Ecol. Monogr.* 24: 89-184 (1954).

or revegetating the flat areas of the waste dumps. The first paragraph of this subsection states that all disturbed areas will be revegetated. What plans have been developed for the open pit slopes?

The DES makes references to a 29-acre lake which may form in the northern portion of the pit. What is the basis for questions regarding the formation of the lake? In addition, what is the expected water quality of this lake and is this quality consistent with the proposed post-mining land use? What fluctuations can be expected in the lake's level? How will access be provided for such post-mining uses as livestock watering and recreation? If the lake is formed, what are the estimated levels of toxic and radioactive materials in the water? What is the expected time frame for filling?

The DES states that the southern portion of the pit will be partially backfilled with overburden and waste from the north pit. Does the mining plan specifically call for this or is the statement on page 3-10 correct which states that "If the northern part of the open pit is still being mined after the southern-part is mined out, overburden will be backfilled into the southern pit rather than dumped at the disposal site" (emphasis added)?

25. Page 3-13, Section 3.1.3.1: The DES states that disturbed land within the project area will be graded to blend with the surrounding topography. The proposed plan gives little evidence that grading will achieve anything close to approximate original contour (for example, pit slopes of 1:1 and dump faces of 1.5 - 2.0:1). The DES goes on to state that overburden dumps will be compacted by heavy equipment during dump construction. Given the planned lift dimensions, adequate dump compaction is doubtful.

Runoff from Hale Gulch over the stabilized tailings surface seems undesirable since it may cause erosion and any infiltration may cause further seepage to ground water which in turn may be reflected downgradient (i.e., in spring discharges). During operation of the tailings pond, the pond will serve as a source of contaminants for downgradient water (unless there is 100 percent solution containment).

26. Page 3-13, Section 3.1.3.2: What is the basis for the statement that 12 inches of broken overburden will be sufficient to sustain tree growth on the benches within the pit?

There is a strong likelihood that a lake will form and that the water in the lake will be of good quality. (The projected quality of the lake water, including radioactive content, is discussed in responses to State of Colorado comment 20.) With the exception of the spring runoff period, the lake is expected to have almost no fluctuation in water level. This is evidenced by the fact that groundwater levels within the vicinity exhibit very little fluctuation. (See Table 2.4.) Access will be provided by haulage roads. The lake will begin to fill immediately upon the cessation of dewatering activities and is expected to be completely filled in about nine years.

As indicated in Sect. 3.1.3 and Homestake's application for a Colorado Mined Land Reclamation Permit, the southern section of the pit may be at least partially backfilled with overburden and waste from the north pit. The referenced statement (DES, p. 3-10) is correct.

25. (*a*) The grading will not attempt to restore the land to its original contours but will blend the reclaimed area with the surrounding topography. Some of the natural slopes in the area are more than 1:1, and there are some near-vertical bluffs. (See response to State of Colorado comment 27 for a discussion of dump stability.)

(*b*) A 1:500 slope on the surface of the stabilized tailings area will allow slow runoff across the reclaimed tailings area to the saddle dam, while promoting deposition and reducing erosion. Any water seeping through the stabilized structure will have to penetrate a clay cap on top of the tailings surface, as well as the clay liner on the bottom. Considering these physical barriers and evapotranspiration from the surface, it is unlikely that any appreciable amount of liquid will seep through the cap into the reclaimed tailings area. (Seepage from the tailings pond is discussed in the responses to comment 36 and in Sect. 10.)

26. The basis for the statement results from ongoing test plot programs. (See Appendix J and the reference in response 24 above. Overburden used for cover has been evaluated during the exploration program, and only materials not containing harmful amounts of toxic substances and radionuclides will be used for cover. The applicant has analyzed the content of the overburden. (See response to comment 21.)

Overburden used for cover in the mine reclamation program should be evaluated for toxic material and radionuclide content before use. We doubt that the open-pit mining operation will remove "virtually all radioactive materials from the pit." The 20 feet of cover over any radioactive material left in the pit will probably only slow down slightly any leaching of toxic or radioactive materials.

The effects of tailings pond solutions on the proposed clay liner should be investigated in the laboratory. The compacted clay to be used as a pond liner should be evaluated to determine the effect of possible high acid content of the tailings on its retention characteristics (assuming high pyrite content in the wastes).

27. Page 3-14, Section 3.1.3.4., Table 3.1: The reclamation schedule estimates that total restoration should be achieved in 21-25 years, presumably after which further attention is unnecessary. However, since the radionuclide half-lives associated with uranium production wastes are on the order of thousands of years, why aren't the radiological hazards over the many millenia addressed with regard to the reclamation procedures?

Any project dealing with radioactive materials must be concerned with the long-term implications of the proposal. In this case, we have a relatively unique situation--a permanent tailings deposition area high in a mountain watershed area. The combined wear and tear from waterflow cutting action on steep slopes; alternative freezing-heating, drying, wetting, wind action; and seismic activities are geologic forces that must be considered in view of the long-term containment needs for these tailings.

28. Page 3-15, Section 3.1.4: What "minor problems" have been identified with respect to the chemical analysis of the overburden proposed as a subsoil at the dump?

29. Page 3-15, Section 3.1.5: A copy of the NPDES permit (issued proposed) should be included in the FES.

The DES states that course overburden will be used to fill the natural drainages and/or underdrains. Any course overburden used for fill or any other purposes should be evaluated for toxic and radioactive content. Is selective placement planned or does this refer to natural segregation as mentioned before? Also, runoff should, as much as possible, be diverted around the dumps. What form of treatment

Most of the material with any significant radioactivity will be removed from the pit. The staff expects that water percolating into the pit will be of a quality at least an order of magnitude better than drainage from the old Pinnacle Mine and, after penetrating the added overburden, will present no risk to public health or safety.

Pacific Testing Laboratories performed permeability tests on representative clays from Hale Gulch and Site B, which is the primary borrow source for clay. The tests indicate that the permeability of the clay is reduced substantially by the mill effluent. (See response to comment 36.)

27. If there is proper containment and stabilization, there should be no future radiological hazards. The staff has taken into account all known physical factors that will bear on the long-term stabilization of the tailings area. The structure will be designed to accommodate the forces of the elements, such as waterflow, alternate freezing-heating, drying, wetting, wind action, and seismic activity. Final reclamation will promote further deposition on top of the tailings over time. Colorado regulations required an ongoing maintenance and monitoring program. (See also EPA response A.)

glaciation c-8000 years

28. Organic matter, nitrogen, and phosphorus levels are low. (See Sect. 2.10.1.2 of the Supplemental ER.)

29. A copy of the NPDES permit is available for review at the Colorado Department of Health.

The coarse overburden has been extensively drilled and the cores analyzed for toxic and radioactive content. Overburden to be utilized in the construction of the settling pond dam and/or the fill for the remainder of the haulage road will be selectively analyzed for specific radioactive and toxic characteristics. Overburden used in construction will be selectively placed. Natural segregation will be utilized in filling the natural drainages to provide underdrains for the waste dumps. Runoff from higher elevations will be diverted around the dumps, when necessary. A new pond, which will be constructed on Indian Creek will be provided by the treatment ponds that are to be constructed below the waste dumps?

below the existing pond, is located so that runoff from all three waste dumps will flow into the pond. This pond will be used primarily for settling out suspended solids. Any treatment necessary to meet NPDES requirements will be implemented. (Also, see response to State of Colorado comment 9.)

30. Page 3-21, Figure 3.12: Contrary to the texts of the Environmental Report and the DES, the dewatering effluent is depicted as primarily a discharge to surface drainage and only as an alternate mill process water source. Is this correct? The dewatering effluent should be used as an alternate. This will eliminate or reduce treatment costs and decrease the use of Marshall Creek water. What are the units?

30. Mine water from the open pit will be used in the mill circuit as needed. Only excess mine water that is not used in the mill circuit will be discharged. Prior to discharge, the water will be treated, if necessary, for radium removal and then released to the new sedimentation pond for suspended solids removal. The units referred to in Fig. 3.12 are acre-feet. This figure has been updated. (See response to comment 29 above.)

31. Page 3-24, Section 3.2.4.2: The radioactivity levels (gross alpha and beta) shown in Table 2.7. for Indian Creek compared to Marshall Creek or Hale Gulch already seem to indicate some existing degradation, perhaps due to the settling pond.

The seepage interception system should be described more thoroughly in the FES.

31. See response to comment 14 above.

A description of the proposed seepage interception system has been added to Sect. 3.3.7.

32. Page 3-24, Section 3.2.4.3: The applicant should review the Dalton Pass or Crownpoint Environmental Statements which give estimates for fugitive dust emissions for construction, for unpaved roads, and for aggregate storage. Also, see "Compilation of Air Pollutant Emission Factors," 2nd edition, EPA Publication Number AP-42 (April 1973).

32. As indicated in Sect. 4 (DES, pp. 4-1 and 4-25), fugitive dust emissions from vehicles moving along haul roads were calculated using EPA methods.

33. Page 3-26, Section 3.3.1: Does NPDES permit CO-0022756 include radionuclides?

33. Yes.

34. Page 3-27, Section 3.3.3: See above comment for estimates of fugitive dust emissions from haul roads.

34. See response to comment 32 above.

35. Page 3-27, Section 3.3.4: The statement "Sufficient ore will be stored adjacent to the mill to allow six months of mill operation. Storage of this quantity is necessary because mining activities will be curtailed during the winter . . ." implies an accumulation of water in the open pit over the six months winter period. How will this volume be handled just prior to the resumption of mining activities?

35. Curtailment of mining activities during winter does not necessarily mean that the mining will cease for a full six-month period. Stripping activities will continue on a year-round basis, but ore removal activities may cease during severe winter weather. The stripping will necessitate the removal of accumulated snowfall on a regular basis. Any snow remaining after plowing for stripping will melt and be collected in the open pit sump. Water from the sump then will be pumped to the mill or treated for radium removal, if necessary, and then released to the proposed sedimentation pond.

36. Page 3-28, Section 3.3.7: Are the engineering properties of the "natural" on-site clay adequate for a pond liner? Since the liner is to be made with a mix of on-site and off-site clays, there should be liner tests performed prior to the issuance of the license using a chemical composition similar to that of the waste to be in the pond. The clay liners used on the test should be representative of what is to be used in the final liner.

36. (*a*) The engineering properties of project area clay are well suited for liner material. Tests on representative clays have been performed showing that the permeability of the clay is reduced by mill effluent. Calculated permeability values for these clays are 0.3 cm/year (0.01 ft/year) in mill effluent and 3 cm/year (0.1 ft/year) in fresh water. Over 6.1 million yards of clay are located on the project site. Because only 300,000 to 400,000 yards of clay are needed, the supply is adequate.

Because of the toxic nature of the material, for a long period, there should be discussion as to how long the pump back system will be maintained after the mill is decommissioned. In addition, there should be discussion on the design of the pump back system and its efficiency.

Assuming that 60 gpm leakage occurs from the tailings pond with no other mitigating measures (i.e., pump back) and no pollutant attenuation, what would be the magnitude of the effect on water quality of Marshall Creek given the expected quality of liquid wastes in the tailings pond?

Given the toxic nature of some of the material that will end up in the tailings and a possibility of open fractures in the volcanic rocks underlying the site which could transport contaminants off-site undetected, it would seem advisable to install a leachate collection system under the tailings pond. There is no discussion to indicate that any such systems were considered. Such systems are being installed at some industrial waste sites and would seem appropriate in this area, as this type of waste is very hazardous.

The radon release rate of 234 Ci/yr from the tailings impoundment appears to be under-estimated. Using a radon emission rate of 1.6 pCi/m^{2}sec radon-222 for each pCi/gm radium-226 in tailings and using reduction factors of 25 for 100% saturated tailings and 2 for 15% moisture (EPA-520/1-76-001), an annual release rate of 420 Ci/yr is estimated.

(*b*) The pump-back system will be available as long as required and will be regulated as discussed in Sect. 3.2.4.2. The design of the proposed system is also described in Sect. 3.2.4.2.

(*c*) Only molybdenum, selenium, and gross alpha and beta would potentially exceed proposed stock water standards at the point of entry into Marshall Creek. Because the clay permeability has been demonstrated to be only 10% of the value used to calculate the estimated seepage rate of 327 m^3/day (60 gpm) and because of impurity concentration attenuation, dilution, and mitigation (pump-back), the staff considers any adverse effects on Marshall Creek unlikely.

(*d*) Piezometric data (Fig. 2.7) show no anomalies indicative of such fractures. Such a collection system was considered, but potential benefits are small. (See also added Alternatives 10, 11, and 12.)

(*e*) The assumptions used by the staff to calculate radon release are stated. It is not unusual for such estimates to vary by a factor of 2. Details of the radon-222 release calculations are presented in Appendix E. The calculations utilize a state-of-the-art mathematical description of radon diffusion and data. The results presented reflect specific site conditions.

37. Page 4-3, Section 4.3.1.1., Disruption of Groundwater flow patterns: Disruption of groundwater flow patterns should include discussion of the possible lake formation.

37. Following cessation of mining activities, groundwater patterns within the present area will be similar to the existing condition, in which flow moves to the west from the recharge portion east of the Chester Fault. (For a discussion concerning lake formation, see responses to State of Colorado comment 20.)

38. Page 4-3, Section 4.3.1.2: This section should describe effects on groundwater quality from the mining activity itself. What percentage of overburden to be disposed of in the waste dumps is acidic? The chemical content of waste dump runoff and seepage should be characterized (especially with respect to molybdenum and selenium).

The statement indicates that the pH values of water moving through the waste rock pile will be high and thereby reduce the solubility of some heavy metals. The estimate that pH values will be high is based on the fact that only 5 of 33 layers tested had a pH of less than 7.0. This is not a valid estimate of what will happen when you have a large pile of crushed rock which is a random mix of these layers. It is doubtful that water will drain through the pile at an even rate and some areas may be such that a large amount of heavy metals may be taken into solution. In any case, the solution

38. (*a*) The pyrite content is estimated to be less than 3%. The Colorado School of Mines Research Institute has performed leaching tests on columns of low-grade waste (0.013% U_3O_8) and barren overburden material. Analyses show that molybdenum, selenium, and pH will not be a problem. Concentrations measured during leaching studies are shown below, and more details on these tests and leachate analyses for 40 additional parameters have been supplied to the FS and the State agencies of Colorado.

Leachate concentration
(mg/liter)

Parameter	Bed volume					Material
	I	II	III & IV	V	VI	
Molybdenum	<0.1	0.4	<0.1	0.2	<0.1	Low grade
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	Barren overburden
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	Low grade
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	Barren overburden
pH	7.8	8.2	8.0	7.9	7.9	Low grade
pH	7.8	8.3	8.1	7.7	7.9	Barren overburden

of molybdenum and selenium is not effected by the pH. For these reasons, the waste rock pile should be treated similar to the tailings area. The pile should be lined and have collector drains installed under and in it to retrieve as much of the leachate as possible. There should be a monitoring network in this area to determine if the groundwater is being contaminated, and there should be a contingency plan developed that would enable the operator to deal with contaminants when and if they reach what is considered to be an unacceptable level.

This section also states that sediment dams will be installed on Indian Creek below the waste dumps. What design criteria were used in sizing of these ponds (i.e., sediment storage volume, detention times, effluent limitation requirements, etc.)? The third paragraph of this Section goes on to state that short-term problems are unlikely with respect to waste dump drainage. This statement appears to conflict with statements made in Section 4.7.1.2. (on page 4-8) that a 15-fold increase in TSS (i.e., to over 500 mg/l) can be expected during the initial four to five years of construction and development of the mine and overburden areas. What treatment is planned in the catchment basins in addition to sediment control?

39. Page 4-5, Section 4.3.3., Water Use: The statement "The applicant is planning to use recovered mine groundwater as milling process water . . ." is not in agreement with Figure 3.12.

40. Page 4-5, Section 4.3.3., Suspended Solids: This subsection states that the effectiveness of these settling ponds cannot be predicted. What are the design criteria (e.g., detention time for a given inflow) for these ponds?

41. Page 4-5, Section 4.3.3., Tailing Pond: The diversion of Hale Gulch around the tailings ponds should be thoroughly described (e.g., specific location, design criteria, etc.).

42. Page 4-7, Section 4.7.1: Have provisions been made for fencing the potential lake if water quality is unsuitable for wildlife (and livestock) consumption?

43. Page 4-8, Section 4.7.1.1., Trace Elements: Are the existing high trace element concentrations in Indian Creek generally related to high flow or low flow?

44. Page 4-10, Section 4.7.1.2., Suspended Solids: The DES projects a 15-fold increase in TSS to a maximum of approximately 500 mg/l in the intermittent portion of Indian Creek. Does this estimated increase include the utilization of the

(*b*) The waste dumps are designed to minimize water infiltration (See response to State of Colorado comment 27). However, any water entering and moving through the dumps will follow the underdrain system formed by the naturally segregated coarse dump material. Water entering this drainage system will move as surface flow out the toe of the dump and enter the sedimentation pond. A monitoring well has been constructed immediately downslope from the maximum extent of the north overburden area. Additional wells will be installed at the bases of the remaining overburden areas before they are utilized. Piezometric monitoring wells will also be installed in the dumps (see response to State of Colorado comment 18). Should monitoring wells indicate unacceptable levels of water contaminants from the waste piles, pumping of the wells downgradient of the waste piles will be initiated to intercept the contaminated water. This intercepted groundwater would be returned to the surface for treatment in the sedimentation basin. Over the long term, other mitigating measures may become necessary.

(*c*) A single sedimentation pond will be installed on Indian Creek below the waste dumps. Design criteria for this pond have been added to the text.

The projected 500-mg/liter total suspended solids does not consider treatment of the runoff in the new sedimentation pond. The proposed facility is sized to contain runoff from a 25-year, 24-hr precipitation event and to provide sufficient retention time for the discharge to be in compliance with NPDES permit requirements. If required, treatment will be instituted to remove radium and other toxic materials from the catchment basin overflow. (See response to State of Colorado comment 34.)

39. The applicant will use mine water in the milling process. Figure 3.12 has been modified accordingly. Mine water in excess of that required in the mill circuit will be treated for radium removal, if necessary, and released to the sedimentation pond. Fresh water demands will be met using the fresh water storage pond. (See responses to comment 30 above, State of Colorado comment 42, and EPA comments 30 and 45.)

40. Since this subsection was written for the DES, the applicant has committed to the construction (as soon as State agencies and weather permit) of a new settling pond on the intermittent portion of Indian Creek designed to intercept runoff from the entire mine and dump areas. Pond design criteria and total suspended solids limitations are presented in revised Sect. 4.3.3.

41. The diversion ditch will be designed to divert at least 3 m^3/sec (110 cfs) of runoff (100-year flood). This ditch is not a safety-related item.

It is the staff's opinion that sufficient detail is included for the purpose of this Statement. Specific engineering details will be submitted by the applicant to the appropriate regulatory agency for approval.

42. Should water quality analysis of the lake show that the water in the northern mine pit is not of acceptable quality, the applicant will fence the lake to restrict access by big game and livestock.

43. With the exception of those taken May 19, 1976, and June 28, 1976, all the measurements were taken during the low flow period of Indian Creek. No conclusions can be inferred.

44. No, the 15-fold increase in total suspended solids does not include utilization of planned sediment control facilities. The applicant is committed by its

planned sediment control facilities? If so, the planned sediment control practices are inadequate. In addition, the projected 500 mg/l TSS concentration would appear to violate the proposed Colorado Water Quality Standards (Appendix I) for TSS for cold water biota (i.e., 25 mg/l).

45. Page 4-11, Section 4.7.1.2., Seventh Paragraph: A potential adverse impact of significant proportion is attributed to the mining activity and surface disposal of overburden.

> "In general, increased runoff and erosion from the overburden dump areas will increase TSS and sedimentation--especially in Indian Creek, which could be detrimental to the benthic community and the reproducing trout population in Indian Creek. The applicant indicated that settling basins will be provided above the existing pond if necessary. Although these settling ponds would certainly remove the coarser particles from the runoff, they may not provide adequate retention time to significantly remove the finer sand, silt, and clay particles. Therefore, siltation from the dump areas may adversely impact the aquatic biota in Indian Creek and possibly Marshall Creek and the settling pond, though they will reduce the severity of these impacts, may not be sufficient to adequately minimize the environmental degradation in Indian Creek."

Instead of delaying the construction of settling ponds until a need is demonstrated by biota destruction, the ponds should be constructed before the start of mining activities. Quite frankly, to even consider the suspended solids concentrations (to approximately 500 mg/l) is totally unacceptable. If trout populations are reduced, the cost of restocking (at whatever frequency is required by the State) should be borne by the Company.

46. Page 4-13, Section 4.7.2.2., Operation of mill facilities and tailings pond: Section 3.6.8. of the Environmental Report is referenced for tailings discharge; however, Section 3.6. of the Environmental Report deals with mining activities, not milling activities. Section 5.2.2. of the Environmental Report is referenced for sanitary waste disposal; however, Section 5.2 deals with the radiological impact on man, not sanitary wastes. A more complete description of sanitary waste disposal options and impact of a leach field is needed in the FES.

NPDES discharge permit to a daily maximum of 30 mg/liter total suspended solids and a monthly average of 20 mg/liter in discharge from settling ponds. See revised Sect. 4.3.3.

45. A new, much larger sedimentation pond designed to contain the runoff from a 25-year, 24-hr precipitation event has been designed for the applicant. Total design storage includes 4.8×10^4 m^3 (39.0 acre-ft) of flood storage, 2.3×10^4 m^3 (18.8 acre-ft) of sediment storage, and 8.1×10^3 m^3 (6.6 acre-ft) of mine dewatering storage. The new pond will be built immediately downstream of the present sedimentation pond on the intermittent portion of Indian Creek when State agency approvals and clearances are obtained and when weather permits. The NPDES permit requires the applicant to limit total suspended solids in discharges to 30 mg/liter or less, a concentration that should be harmless to all stream biota, including trout.

46. The corrected reference for tailings discharge is to Sect. 3.3.4.2 of the ER. The reference for sanitary waste disposal is to Sect. 3.5 of the ER. A detailed description of the sanitary waste disposal options and leach field will be included in the final design specifications for construction of the mill. These specifications will meet all Saguache County and State of Colorado requirements.

47. Page 4-13, Section 4.7.3: The statement, ". . . If adverse effects are observed, the applicant will take such additional measures as may be required by the State of Colorado and/or the FS.", is troublesome in that once mining and milling are started, it will be difficult to bring about the implementation of additional abatement actions within a short period of time, particularly if the need is based on the identification and quantification of an adverse impact. In conjunction with requiring additional measures, will the State and/or Forest Service require the temporary halt of project activities until such measures are operational? In other words, will the occurrence of adverse biological impacts trigger the cessation of causative activities until the necessary controls can be designed and constructed or will continued biological degradation be tolerated until the necessary control actions are researched, designed, and implemented?

47. Actions taken to correct unforeseen adverse impacts will be commensurate with the scope of the problems and with the legal authority of the cognizant Federal or State agencies. All measures believed necessary to minimize impacts will be implemented.

48. Page 5-3, Section 5.1.2.2: Unless it is definitely known that the yellowcake is U_3O_8 and not sodium or ammonium diuranate, calculations should also be made for soluble uranium inhalation.

48. The highest organ dose is shown in Fig. 5.1. This result is for insoluble uranium inhaled and deposited in the lungs. The doses from soluble forms of uranium are less than the doses shown.

49. Page 5-5, Table 5.1: The table should be updated to include major slurry releases since 1971 (including United Nuclear - Homestake Partners at Ambrosia Lake and Western Nuclear at Jeffery City).

49. The figure and text have been updated.

50. Page 6-1, Section 6.1.1: In addition to analysis for suspended particulates uranium, gross alpha, and gross beta activities, radon-222 analysis should be conducted during the pre-operational period.

50. Sampling and analysis for radon-222 were performed at six locations (see Fig. 6.1) during the preoperational monitoring program. Samples were collected during June, August, and September 1976 (see Table 6.3 and Supplemental ER, Table 2.9-4, p. 2-208). Additional baseline measurements of radon-222 are planned for 1979 as soon as weather and soil conditions permit.

51. Page 6-2, Section 6.2.1: We do not agree with that part of the mining reclamation plan which provides for the creation of a small lake (in the central part of the open-pit). Considering the remoteness of the mining location and the probable unpleasing appearance of the terrain for some time after the cessation of mining, it is doubtful that any such lake can be expected to become a recreational feature and attraction.

Assuming that there is sufficient ground water and precipitation to form a lake, beneficial use requires adequate water quality and it must be readily accessible. There is no discussion in the DES concerning the actions that will be taken to insure the accessibility of the lake for wildlife and humans. To make a judgement on accessibility, the following information is required:

51. To suggest that treating the lake water or draining it will be unacceptable to the applicant is an unwarranted assumption. The same is true when describing the lake as being "of questionable beneficial value." There is no evidence to support either assumption.

a. The estimated vertical distance between the equilibrium water surface and the "rim" of the pit.

b. Means of access to the pit--established and maintained pathways, etc. Without established access paths, the slope of the pit highwalls suggests that access to a lake might be difficult and hazardous.

The stated commitment to take corrective action(s) if the equilibrium water quality is found to be unacceptable, although possibly well-intentioned, appears impractical.

> "If the water quality is not acceptable, one of the following actions will be taken: (1) treat the water until acceptable, (2) drain the lake, (3) eliminate the problem some other way."

In terms of cost, abatement actions such as treating the lake water or draining undoubtedly will be found unacceptable when the time of such actions are determined. It is conceivable that such actions would have to be undertaken annually for an extended period of time; certainly more than a "one-time" implementation will be necessary. The third action--to eliminate the problem some other way--is no more than a statement of good intention without support. The "wait and see" approach of the lake concept will extend the completion date of reclamation efforts and may well be more costly.

Since a lake, if formed, is of questionable beneficial value and could create costly, long-term abatement actions, the proposed reclamation plan should be rejected. The recommended alternate action is replacement of <u>all</u> waste overburden into the open-pit. Other than this alternate action, what other corrective action is available?

The stated objections to backfilling with sand tailings are valid and sufficient reason for not implementing such an action.

52. <u>Page 6-2, Section 6.2.3</u>: It is stated that the tailings disposal pond area will be restricted as long as required by regulations in effect at the time of reclamation. Does the Company intend to achieve restricted access by fencing or some other means?

Current information indicates it is likely that a lake will form in the open pit and that the lake will fill with water of acceptable quality. This matter is discussed in responses to State of Colorado comment 20. The final access roads into the pit will be left in place to provide access to the lake. The shaping of the land surface will create a lake resembling a glacial circular lake, which is considered by most people to be aesthetically pleasing. Pit-rim elevations with respect to the lake surface, as well as the location of the access road, can be derived from Fig. 3.7 (see responses to EPA comment 24 and State of Colorado comment 20).

Another means of dealing with water quality problems would be to impede access by big game and livestock by fencing the lake.

If the mine pit were completely backfilled, the original reclamation undertaken at the waste dumps would be destroyed when the overburden was returned to the pit. The disruption of dump stabilization would increase the possibility of accelerated soil erosion and water quality degradation, increasing the difficulty of reclaiming the dumps. Final reclamation of the dumps and pit could not commence until all mining activities were completed. The delay in implementing the ultimate reclamation program for more than ten years is a significant disadvantage.

what happens in coal mining - but shorter time span
Time of 10 years not significant in revegetation.
see A-7 - ongoing process
and #27 p A-26

52. Access to the reclaimed tailings disposal area will be restricted by fencing.

When necessary during initial stages of the operation, water runoff from above will be diverted around the overburden dumps by the use of ditches and/or roads. The overburden benches will be sloped back so that rain and snowmelt will be drained to ditches that will carry the water back into the open pit sump. No free-standing water will remain in the dump areas.

It is not clear how sloping the overburden dumps toward drainage ditches in the center of each dump will minimize slippage. With a natural segregation-type underdrain, water from above should be diverted around the dumps and the surface of the dumps should be crowned to promote flow off the dump (i.e., to the sides) and not concentrated to the middle of the dump.

53. Page 6-3, Section 6.3.1.1: There appears to be no plans for monitoring the springs which are in the vicinity of the mine. Since these are discharge points for the groundwater system in the area, it would be advisable to monitor them occasionally. We would suggest that they be sampled at least once a year and analyzed for TDS, pH, and the various heavy metals.

54. Page 6-3, Section 6.3.1.1, Water quality: mine: The proposed leach test for stream sediments will provide useful information on the fate and transport of pollutants entering the streams draining the project. However, equally useful and somewhat less difficult to conduct is the analysis of stream sediment for total metals conduct. This involves the acid digestion of a suitable aliquout of dried sediment material. Such data show the long-term trend at a given station (accumulation of lack thereof) and the total amount of materials available for leaching into the water phase. These analyses should be conducted on an annual basis-- samples collected at the end of the summer season (assumed to correspond to a period of extended low flow).

55. Page 6-4, Section 6.3.2.1: Preoperational groundwater monitoring tests should be conducted to reasonably assess the impacts to the groundwater system during and after the mining operation.

56. Page 6-5, Section 6.3.2.2., Mine: This subsection notes that a monitoring well will be constructed in Indian Creek Valley, immediately downslope from the maximum extent of the overburden disposal areas. Where, specifically, will this well be located? It seems that at least one monitor well for each waste dump would be more appropriate. Is any sampling in the unsaturated zone planned? What measures are available for mitigating groundwater contamination associated with the waste dumps?

57. Page 6-5, Section 6.3.2.2., Tailings disposal area: It seems a bit presumptuous to design a monitoring system for the

53. The springs in the vicinity of the mine will be analyzed once a year for total dissolved solids and pH. If the total dissolved solids and pH fluctuations indicate that significant changes are taking place, the samples will be analyzed for heavy metals.

54. Analyses of stream sediments at selected surface-water monitoring stations on Indian Creek and on Marshall Creek below Hale Gulch will be conducted on an annual basis. The stream sediment sample will be representative of the stream cross section at the sampling location and analyzed for total metals concentration by an acid digestion technique of a dried sediment sample. In particular, cobalt, nickel, molybdenum, arsenic, silver, beryllium, barium, boron, copper, lead, mercury, manganese, and iron will be analyzed to further define the stream sediment bedload.

55. Preoperational groundwater sampling and analyses have been and are presently being conducted on all monitor wells in the vicinity of the open pit mine, overburden disposal area, mill site, and tailings disposal area.

56. A monitoring well has been constructed in Indian Creek Valley immediately downslope from the maximum extent of the north overburden disposal area. Additional wells will be installed at the base of remaining overburden disposal areas when utilization of those areas commences. The wells will be constructed utilizing Johnson well screens or equivalent mechanisms at various depth intervals to sample the groundwater contained in the 46-m (150-ft) holes.

The mitigating measures available are pumping contaminated water out of the wells, altering the drainage at the dump sites, and treating contaminated water as it enters the Indian Creek drainage, that is, at the settling pond.

57. As shown on revised Fig. 2.7, a reevaluation of previous data and interpretation of additional recently acquired data have provided improved knowledge of local groundwater movement in Hale Gulch. There is no evidence of near-surface fractures passing underneath the proposed tailings pond that could allow movement of contaminants offsite.

tailings area with the limited amount of test well data that is apparently available. The information on the geology at the tailings pond site indicates that movement of ground water probably occurs along fractures. The presence of these fractures raises the possibility that contaminants could move off-site via a fracture system that has little or no connection to the fractures that are tapped by the monitoring wells. For this reason, it would seem necessary to better define exactly how the water will move in order to insure that such a possibility is eliminated. In addition, there should be several devices capable of sampling in an unsaturated environment, such as vacuum lysimeters, installed immediately under the liner to obtain early information on the movement of leachate through the liner. The applicant should be required to install more test wells to enable a more exact description of groundwater flow in the area. Then, it will be possible to establish a better monitoring program. The monitoring wells should be of such a size that a submersible sampling pump can be placed in the well to obtain a pumped sample. This will assure that the resulting sample represents the quality of the fractures around the well in question. A requirement that pumped samples be obtained should be a license condition. The final monitoring program should be designed prior to the issuance of the mill permit.

Additional information will be evaluated to further define the groundwater flow patterns prior to final design of a groundwater monitoring network. Existing monitoring wells and those to be constructed will accommodate a sampling pump, which will be used when possible. Vacuum lysimeters can be installed, if required, at certain sites under and around the tailings pond. The exact number and location will depend on the results of additional analyses of data to be obtained. The Colorado Department of Health will determine license conditions after review of the Safety Analysis Report. (See responses to comments 12 and 36.)

58. Page 6-9, Figure 6.1: This map is difficult to read. It should be enlarged and the contour lines removed. The only required features are the surface drainages and the major sites of the Pitch Project (i.e., mine site, mill site, and tailings disposal pond site). It also would be helpful to illustrate the sampling sites by related types on two additional figures: (a) surface water and sediments, aquatic biota, and ground water; and (b) air, soil, vegetation, and terrestrial animals.

58. Figure 6.1 has been revised to improve legibility.

59. Page 6-13, Table 6.4: The operational environmental monitoring program is incomplete and poorly described. The following specific comments are made of Table 6.4:

a. There is no mention of groundwater monitoring associated with the dumps, of a waste dump and pit well stability monitoring program, nor mention of subsidence monitoring program.

b. Locations of all aspects of the operational monitoring program should be specific.

59. Table 6.4 presents the operational radiological monitoring program for the mill. The Colorado Department of Health will require an ongoing monitoring program of the mine waste dumps. Details will be in the license.

(*a*) A groundwater monitoring program for the overburden dumps will be conducted. A monitoring well has been installed in the drainage downslope from the maximum extent of the north overburden disposal area. Baseline data are presently being collected. Additional monitoring wells will be installed at the base of the remaining waste dump areas before they are utilized. Piezometric monitoring wells will also be installed (see responses to EPA comments 38 and 56). Stability programs for the pitwalls and overburden dumps will be conducted. The stability program for the overburden dumps has been approved by the Colorado Mined Land Reclamation Board, Department of Natural Resources. (See Appendix K.)

(*b*) The proposed operational monitoring plan, including sampling locations, is described in Sect. 6.2 of the ER and Supplemental ER. Some locations may be altered as a result of licensing conditions.

c. Based on the statement presented under Section 6.3.2.1. (preoperational groundwater monitoring--page 6-4), the 14 wells constructed in the vicinity of the open-pit mine, mill, and sand tailings disposal area will be monitored during project operations (a continuation of the preoperational monitoring program). Yet, the operational environmental monitoring program presented in Table 6.4 lists only four wells in the vicinity of the tailings disposal area. Considering the uncertainties of the groundwater regime, sampling of all wells should be continued during the operational period (at least for several years).

(*c*) All monitoring wells, DM-1 through DM-14, will be monitored during the life of the project. DM-12 and DM-14 will be destroyed by the mining. DM-14 will be replaced with another well.

d. There should be three surface water stations on Marshall Creek instead of the proposed two: upstream of Hale Gulch, downstream of Hale Gulch, and downstream of the confluence with Indian Creek.

(*d*) Marshall Creek is presently being sampled at the designated three locations. SW-5 is upstream of Hale Gulch, SW-9 is downstream of Hale Gulch, and SW-10 is downstream of the confluence with Indian Creek (see Fig. 2.5).

e. When present, surface flow in Hale Gulch should be sampled monthly.

(*e*) Surface flow in Hale Gulch will be sampled monthly when it exists.

f. At least for the first and/or second year of the operational period, surface water samples should be collected monthly and analyzed for total concentrations of uranium and radium-226. Quarterly composite samples should be analyzed for the dissolved and suspended concentrations of uranium and radium-226.

(*f*) Surface-water samples will be collected and analyzed on a monthly basis during the first year of the operational period. This monthly operational monitoring will continue into the second year of operation or until such time as it can be documented that the quality is remaining constant. Currently, samples are analyzed for total uranium and radium-226. Dissolved uranium and radium-226 analyses will be conducted quarterly.

g. Bottom sediment samples should be collected annually at each surface water sampling station. Samples should be analyzed for uranium, radium-226, thorium, lead-210, polonium-210, and significant trace metals.

(*g*) Bottom sediment samples have been collected and analyzed for radionuclides (see ER, p. 2-264) for baseline data. Sediment samples will be collected annually at the surface-water monitoring stations (SW-1, SW-3, SW-4, SW-5, SW-9, and SW-10) and analyzed for radionuclides (see ER, p. 6-6; also, see response to State of Colorado comment 46).

h. To provide coverage for the entire project area, probably considerably more than five soil stations will be required. The proposed network does not include any on-site stations--particularly around the periphery of the tailings disposal pond; three of the five stations which might be considered on-site are to be located at the boundaries.

(*h*) Seven soil sampling stations as shown on Plate 6.1-1 of the ER were sampled during June, August, and October 1976 and analyzed for radionuclides. Samples will be collected and analyzed quarterly at these stations during the first year of mill operation. Annual soil sampling will be performed at the same stations in succeeding years.

60. Page 7-1, Section 7.3.1: The expected sediment runoff from exposed areas which may increase TSS to an estimated 500 mg/l or greater is unacceptable in terms of water quality standards.

60. The staff agrees that a total suspended solids increase to an estimated 500 mg/liter would be unacceptable. That estimate does not consider treatment in the proposed new sedimentation pond. This pond will control sediment runoff from the waste dump faces and will allow discharge in accordance with NPDES permit requirements. (See response to comments 40 and 44.)

61. Page 7-2, Section 7.3.2: Groundwater quality deterioration in the mine pit and waste dump areas should also be addressed in Section 7.3.2.

62. Page 8-1, Section 8.2: The Pitch Project has a high probability for long-term, adverse impacts to aesthetics (paragraph 2) due to the mining plan which provides for limited backfilling and grading and the utilization of large waste dumps and also due to the questionable success of revegetation efforts.

63. Page 9-1, Section 9.3.2: It should be noted that groundwater degradation may essentially be irreversible.

64. Page 10-3, Section 10.1.3.1: What is the basis (data) for the conclusion that the reclamation goal will be achievable?

We feel that the mining reclamation alternatives are totally inadequate. Such options as pit wall reduction, revegetation alternatives, backfilling, clay caps over radioactive materials, and alternate waste dump configurations and construction practices should be thoroughly discussed.

65. Page 10-8, Section 10.4.2: Was consideration ever given to an artificial liner with a secondary clay liner (as proposed for Cotter's new tailings pond)?

66. Page 10-8, Section 10.4.2., Alternative I: Unless both clay cap and liner are almost completely impervious, we would expect water flow in Hale Gulch to produce continued seepage with resultant spread of contamination.

61. Ongoing studies indicate that there will be little deterioration of groundwater in either the mine pit or waste dump areas. More specific information and discussion are included in responses to comments 3, 24, 37, 38, and 51.

62. The Pitch Project is not visible from any road system in the area. The waste dumps and open pit will not be visible to the general public. The area presently receives very little traffic, most of which is for recreational purposes such as hunting and fishing. The portion of the comment dealing with revegetation is addressed in Appendix J and in the response to comment 64. Matters addressed in this comment are also discussed in responses to comments 24, 25, and 26.

63. Except for the area immediately under the tailings impoundment, the staff estimates that groundwater quality will not be degraded but may be improved, especially with respect to radionuclide content. (See responses to comments 38 and 61.)

64. Refer to Appendix D and Appendix K. The FS and Colorado Mined Land Reclamation Board review reclamation measures proposed and consider alternatives as the project proceeds. As such, the present proposals are accepted but will be modified as deemed desirable to improve reclamation. No detail or discussion of alternatives is required.

65. A liner similar to the one proposed for Cotter Corporation was not evaluated in detail, but it was considered and rejected. It was concluded that an artificial liner would not be significantly superior to the proposed 2-ft clay liner with an interception and pump-back system.

66. See response to comment 36.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL OFFICE
EXECUTIVE TOWER · 1405 CURTIS STREET
DENVER, COLORADO 80202

REGION VIII

September 11, 1978

IN REPLY REFER TO:
8SOQ

Mr. Jimmy R. Wilkins
Forest Supervisor, USDA
Grand Mesa, Uncompahgre and
Gunnison National Forest
Post Office Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

Thank you for the opportunity to review the draft Environmental Impact Statement (EIS) for the Homestake Mining Company, Pitch Project, on the Gunnison National Forest, dated July 14, 1978.

As you know, the Department of Housing and Urban Development's (HUD) assigned responsibility for reviewing other agency EIS's includes consideration of the project's compatability with comprehensive plans for the area and the impact the project is likely to have on an urbanized area.

(1.) We do not believe that you have adequately addressed the impact this project will have on the towns of Salida or Gunnison. Since both Salida and Gunnison are 35 miles from the project site, a more complete evaluation of the impact on each community should be made. This evaluation should include an assessment of the labor market in each town and the impact of selecting project employment from one town or the other.

(2.) In Section 4.9.4 of the draft EIS your assumption that marginal cost is equal to average cost of providing services should be reconsidered. Normally, a sudden demand for services would result from industrial development and a critical examination of actual increases in the costs of such services would appear to be appropriate, rather than to assume average cost.

(3.) After your evaluation is completed, mitigation should be suggested, where appropriate. Mitigation may become evident in several areas such as: concentrated hiring in only one community, determining need for requesting

RESPONSES

1. Unemployment in Chaffee County (Salida) has ranged from about 160 to 250 and in Gunnison County (Gunnison) from about 110 to 185 from 1970 through 1976. It is unlikely that the peak labor force (286 maximum) can be recruited from local labor without some short-term immigration. During mine and mill operation, only about 110 persons will be required besides 40 imported specialists. These 110 persons will probably be local residents. The distribution between Salida and Gunnison will depend on the number of applicants from each town and their available skills. It would appear likely that project-related employment impacts would be equally shared.

2. The need to assess cost for capital improvements of public services, as the difference between average and marginal cost increases, would be due primarily to new capital expenditures. Because it has been projected that significant new capital expenditures will not result from the Pitch Project, it appears valid to assume that marginal cost will nearly equal average cost of providing services.

3. It appears that the best mitigating measure that can be utilized to minimize adverse socioeconomic impacts is to hire local residents to the maximum extent feasible. This will not only reduce unemployment but also the demand for housing and social services. (See Sect. 4.9.7.)

   State energy impact assistance has been requested and obtained for road improvements.

   The applicant does not anticipate providing commuting assistance at this time; however, a number of private individuals in both Gunnison and Salida have expressed an interest in making bus transportation available on a fare basis.

state energy impact assistance, and the possibility of requiring the owner to provide some sort of commuting assistance between available housing sites and the job site.

If we can be of further assistance, please contact Mr. David Le Fevre, Environmental Quality Division, PPE, at (303) 837-3102.

Sincerely,

Raymond D. McKinney
Director
Program Planning and Evaluation

Department of Energy
Washington, D.C. 20545

SEP 13 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
Grand Mesa, Uncompahgre
and Gunnison N.F.
U.S. Department of Agriculture
P. O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

This is in response to your letter of July 14, 1978, inviting the U.S. Department of Energy to review and comment on the Forest Service's draft environmental statement for the Homestake Mining Company, Pitch Project, on the Gunnison National Forest.

We have reviewed the statement and have determined that the proposed action will not conflict with present or known future Department programs. We have no substantive comments to offer on the statement.

Thank you for the opportunity to review the draft statement.

Sincerely,

W. H. Pennington, Director
Division of Program Review
and Coordination
Office of NEPA Affairs

No response is required.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 17107, Denver, Colorado 80217

September 8, 1978

Jimmy R. Wilkins
Forest Supervisor
U. S. Forest Service
P. O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

Thank you for the opportunity to review the draft environmental impact statement for the Homestake Mining Company Pitch Project on the Gunnison National Forest. We have only the following comment on this draft environmental impact statement.

Section 3.1.3, Reclamation Procedures, states that the land will be returned to its present use as "livestock grazing and wildlife habitat," another section says the mill site will return to "rangeland." This could infer that present or comparable communities of native plants will be re-established. The seed mixtures, however, shown in Section 3.1.3.3 contain 80% introduced pasture species. There is no mention of this plant community difference in Section 4.6, "Vegetation." We believe there will not only be a significant change in the landscape but also a great influence in both grazing animals and wildlife through the establishment of these more palatable introduced pasture species. Section 4.6 should address the fact that more productive and more palatable grasses will be available to both wildlife and livestock.

Thank you again for the opportunity to review this draft environmental impact statement. We believe it to be very well done with the exception of the above comment.

Sincerely,

Robert G. Halstead
State Conservationist

RESPONSES

Section 4.6 treats only the environmental impacts of the Pitch Project. Section 6.6 treats mitigating measures and refers to the seed mixture in Sects. 3.1 and 3.3 and to browse species establishment. The pasture species are not expected to remain permanently dominant but will provide short-term soil stabilization. Because natural local species are expected to eventually reinhabit the reclaimed areas, the staff chose not to discuss the short-term improvement in grazing habitat.

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

RESPONSES

August 8, 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
Forest Service
Grand Mesa, Uncompahgre and Gunnison
National Forests
P. O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

This is in response to your request of July 14, 1978, for comments on the draft environmental statement for the Homestake Mining Company Pitch Project, Saguache County, Colorado.

The Council notes from its review that while cultural resource studies to date indicate no properties included in or known to be eligible for inclusion in the National Register of Historic Places will be affected the possibility exists for previously unknown cultural resources to be identified during project construction and that the Forest Service appears to recognize its responsibility pursuant to Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320), should such cultural properties be encountered. Accordingly, we look forward to working with the FS in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800), as appropriate in the future.

The FS plans to cooperate to the fullest extent.

Should you have any questions or require additional assistance in this matter, please contact Brit Allan Storey of the Council staff at P. O. Box 25085, Denver, Colorado 80225, or at (303) 234-4946, an FTS number.

Sincerely yours,

Louis S. Wall
Assistant Director, Office of
Review and Compliance, Denver

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

COLORADO DEPARTMENT OF HEALTH

4210 EAST 11TH AVENUE · DENVER, COLORADO 80220 · PHONE 388-6111
Anthony Robbins, M.D., M.P.A. Executive Director

RESPONSES

September 11, 1978

Jimmy Wilkins
Forest Supervisor
U.S. Forest Service
P.O. Box 138
11th and Main Street
Delta, Colorado 81416

Dear Mr. Wilkins:

After thorough review of the Draft Environmental Statement (DES) for the Homestake Mining Company's Pitch Project I am providing the following comments and questions on behalf of the State of Colorado:

1. Certain steps to evaluate previously identified resources and to assess impacts upon Marshall Pass have not occurred. Copies of two comment letters from the Colorado Historical Society dated March 9 and June 28, 1977 are enclosed. To our knowledge no action has yet been taken in response to these comments. Therefore, it appears that the Draft DES is not in full compliance with the National Historic Preservation Act of 1966, as amended. The Colorado Historical Society requests that consultation be held with the U.S. Forest Service in the manner described in federal regulation 36 CFR Part 800 in order to establish full compliance with this federal law.

   Response 1. The applicant is expected to evaluate all identified sites for which National Register significance has not been determined in advance of project impact upon those sites. This evaluation should be done early enough to allow the FS to request concurrence in the determination from the State Historic Preservation Officer. Where the site is determined to be significant, the effect of the project upon the site must be discussed, mitigation measures must be proposed, and SHPO concurrence on the mitigation sought by the FS. (See also response to DOI, August 31, 1978, comment 13.)

2. Socio-economic impacts appear to have been fairly assessed. However, the applicant should be strongly encouraged to provide bus transportation for its employees from Gunnison and Salida. The availability of such service would help to alleviate pressures for isolated developments along U.S. Highway 50.

   Response 2. The applicant does not now contemplate providing bus service to and from the mine; however, a number of private individuals in both Gunnison and Salida have expressed interest in making bus transportation available on a fare basis.

3. The applicant must apply for water rights to store the runoff from the basin above the water storage reservoirs and the tailings pond. There appears to be no record of any application for these storage rights. Also, if the applicant plans to store this runoff during periods of river administration, a plan of exchange or augmentation may be necessary.

3. The applicant is responsible for acquiring water for operation. The FS has no jurisdiction in awarding water rights. (See also response to DOI, October 3, 1978, comment 1.)

4. The DES mentions the construction of the impervious core of the tailings disposal dam will extend below the alluvial soil, thus causing part of the near surface ground water to move upward to the surface behind the dam or infiltrate into deep rock. During excavation of the core, the ground water will surface and either be discharged into Hale Gulch below the damsite or be used for dust control. Since the ground water is stated as being tributary to Indian Creek, Homestake Mining Company should apply for the water right to use the water and submit a plan of augmentation to make up for the ground water which is tributary to Indian Creek if used during times of river administration.

4. The applicant does not anticipate using the tributary groundwater encountered as a result of construction of the tailings disposal dam at Hale Gulch. Water so encountered will reenter the Hale Gulch drainage. Accordingly, no loss of water to the system of supply for Marshall Creek is anticipated. The responsible State agency will determine permit requirements.

No for Tailings see USDHEW Surgeon General's Office A16

5. The reference to "reclamation" throughout the document may lead the reader to believe all is well with this part of the project. Reclamation of this site to its pre-project condition is extremely doubtful, but would take at least 200 years. The document should so state.

dif "beneficial" in usage

5. Returning the project area to its exact, preproject condition is not to be expected. The goal of reclamation is to restore the area to a condition compatible with preproject uses. After the Pitch Project is completed, the area will be suitable for recreation and grazing and can be expected to blend with the surrounding area. Most of the area will be returned to useful wildlife habitat and recreational uses within a few years (see responses to EPA comments 24 and 64). The staff estimates (Sect. 8.1.6) that conversion to original species communities will require as much as 50 to 100 years.

6. The whole project area is currently being fenced. This fence should be constructed according to Division of Wildlife specifications. As constructed, the fence will pose a barrier to wildlife migration.

6. The entire project area is not being fenced. The fences for cattle containment in a few locations will be designed to permit migration of big-game animals.

7. The project area is apparently to be closed to hunting. The proponent should provide some sort of alternate hunter access to the general area and present a plan for wildlife management and harvest if the closed area acts as a refuge when big game species adapt to the disturbance, and move close to it during hunting season.

7. About 865 ha (350 acres) will be closed to hunting. The applicant will cooperate with the Colorado Division of Wildlife and FS in developing a plan for wildlife management in the project vicinity.

8. It is expected that elk will vacate a large area around the project site. The displaced animals will be forced onto already overcrowded ranges, complicating the States present game damage problem in the Sargents area.

8. Previous observations in northwestern Colorado indicate that elk associated with areas of direct disturbance probably will abandon the immediate area. Elk initially are sensitive to line-of-sight human activity and noise and may move to the next ridge. (See also response to DOI, August 31, 1978, comments 3 and 4.)

9. The Indian Creek settling pond is not discussed in detail in this document. The present pond is far too small to effectively control a cloudburst runoff from the mine site. Any pond should be large enough to hold a 100 year flood.

10. The Colorado Division of Wildlife has recommended that winter stream flows be no lower than four cfs, and summer flows no lower than eight cfs, not two and six, respectively, as stated in Section 4.3.3 of the DES.

11. Pine marten, mountain lion and black bear should be added to the list of game and furbearing wildlife species in Section 2.8.1 of the DES.

12. Table 4.1 of the DES indicates toxicity levels for certain trace elements. Page 4-8 state that a series of toxicity tests are "recommended" and "should be implemented". Such a statement has no place in an E.S. and should be changed to "will be implemented". The applicant should also present mitigation and curtailment procedures to be taken if toxicity limits are reached.

13. The possibilities of placing dewatered tailings in a lined impoundment at the head of a drainage need further evaluation. This might be accomplished by dewatering prior to or after emplacement. The argument for loss of resource due to dewatering does not make sense since uranium was not planned for recovery from the interstitial fluids in the tailings pond under Alternative I.

14. Statements have been presented to the effect that ample clay and other construction materials exist on the site to satisfy the needs of all phases of the project. The location and quantities of these materials have never actually been identified or proven. Since these materials are critical to the dam construction, liner, and final reclamation, we recommend verification of their availability.

9. It is the staff's opinion that sufficient detail is included for the purpose of this Statement. Specific engineering details will be submitted to the appropriate regulatory agency for approval. Sedimentation ponds must meet the requirements of CRS 1973 37-87-105 and 37-87-122. (See also response to EPA comment 40.)

10. The Colorado Division of Wildlife has recommended that diversions from Marshall Creek not reduce streamflows in the reach between Indian Creek and Tomichi Creek below 0.1 m^3/sec (4 cfs) in winter and 0.2 m^3/sec (8 cfs) in summer (Case No. W-3292). The statement in Sect. 4.3.3 that refers to the reach between Tank 7 Creek and Indian Creek is correct (Case No. W-3293). The applicant and the Colorado Division of Wildlife are continuing discussions regarding the manner of diversion and restocking Marshall Creek if the diversion causes a loss of fish life. The applicant plans to operate diversions in a manner that will minimize adverse consequences.

11. See response to DOI, August 31, 1978, comment 10.

12. The applicant had the Colorado School of Mines Research Institute conduct leaching experiments on barren overburden and low-grade waste materials from the site. The conclusions were that projected waste dump water quality would be similar to, if not better than, the present water quality at SW-1 on Indian Creek. Considering runoff additions downstream from the waste dumps, the addition of the new settling pond, and NPDES permit restrictions, the staff considers that the intent of this recommendation has been met by the applicant.

13. Alternatives 10, 11, and 12, all concerning dewatered tailings, have been included in the FES. These alternatives are evaluated in conjunction with other tailings disposal alternatives in selecting the most environmentally acceptable method of tailings disposal within the present economic and engineering state of the art. Any portion of the tailings solution reused in the mill circuit conserves sodium carbonate and bicarbonate and also results in additional uranium recovery.

14. According to a study recently completed, over 6.1 million cubic yards of clay are located on the project site. Because only 300,000 to 400,000 yards of clay are needed, the supply should be adequate. Sand and fine gravel for the transition zone of the tailings pond embankment will be purchased from a local supplier in Gunnison. The remaining construction materials for the dam, roads, and final reclamation will be selected from mine overburden.

15. If the slurry method of tailings disposal is selected, the clay liner is the key to the reduction of ground water contamination. It is stated in the DES that seepage through the liner could be as high as 40 gpm, but that the contamination will be negligible due to the adsorption and retardation effects of the clay liner. Also it is stated that seepage will be collected down-stream of the dam. There is no data presented to show that the clay liner will reduce contamination as claimed or that the seepage path under the liner will allow collection of the effluents below the dam. Due to these problems, it might be more reasonable to increase the thickness of the clay liner to reduce the potential for contamination.

16. Shipment of uranium ore is planned for the time prior to full operation of the mill on site. How much ore is to be shipped per year, by what means, to which processing mill(s) and via what public roads? This information will be needed to assure safety and structural integrity of highway facilities.

17. The plan to construct haul roads from overburden material is described on page 3-15 of the DES but it is not indicated that the material will be assayed to assure an acceptable radioactive content.

18. Wells should be placed in the areas of the proposed waste dumps to evaluate possible impact on ground waters.

19. As the tailings pond will be capable of retaining runoff from a probable maximum flood, the diversion ditches should be capable of diverting such a flood. However, the design capacity of the diversion ditches is not addressed.

20. The report fails to address what the impact of the abandoned pit will be on ground waters and what the quality of any ponded water might be.

21. In Section 4.3.2.2 of the DES the possibility has been mentioned that the sodium content of the liquid waste may reduce the permeability of the clay liner. The actual impact of the tailings waste on the liner should be determined. This seems valuable as seepage rates from the tailings pond are based on laboratory testing of the clays and may be unrealistic of what can be obtained in the field.

15. The engineering properties of the clay located on the project site are suited for liner material. Pacific Testing Laboratories performed permeability tests on representative clays from Hale Gulch and Site 8 that will be the primary borrow source for clay. These tests show that the permeability of the clay is reduced by the mill effluent. Estimated permeability values for these clays are 0.01 ft/year in effluent.

Using this value of permeability and tailings management Alternative 1, the total seepage through the dam and reservoir liner has been estimated at less than 27 m^3/day (5 gpm) for any condition (including probable maximum flood) during the first four years of operation. At the end of 25 years, the seepage rate will still be approximately 27 m^3/day (5 gpm) for normal operations and approximately 54 m^3/day (10 gpm) for a period of several months following a probable maximum flood.

This small amount of seepage will percolate down to the groundwater flowing in the alluvium in Hale Gulch. The hydraulic continuity of the alluvium will be maintained by constructing a filter blanket under the dam. Monitor wells below the dam will indicate if deleterious seepage occurs. Such seepage will be intercepted by a trench to be constructed across Hale Gulch, downstream from the tailing embankment. The trench will extend through the alluvium and at least 0.6 m (2 ft) into the underlying tuff. A perforated pipe, 15 cm (6 in.) in diameter, will be placed in the bottom of the trench. The trench will be backfilled with free-draining sand and gravel. At the low point of the trench, water will collect in a sump, and contaminated seepage will be pumped back to the tailings reservoir. (See response to EPA comment 36.)

16. The amount of ore that may be shipped will not exceed 300 tons per day and will depend upon variable factors such as mine operating expense, transportation costs, market price, and availability of mill facilities elsewhere. The ore probably will be transported by truck, with the routing depending upon the location of the processing mill. After the Pitch Project mill is authorized, the applicant plans to stockpile all mined ore. After approval for the mill is obtained, shipment of ore from the mine is unlikely because the applicant plans to process all ore produced at the site.

17. Approximately 0.9 million yards of overburden material will be used in haul road construction. It will be taken from areas known to contain only background levels of radioactivity. The areas from which overburden will be taken will be identified by utilizing records from the exploratory and development drilling programs.

18. A monitoring well has been constructed immediately downslope from the maximum extent of the north overburden disposal area. Additional wells will be installed at the base of remaining overburden areas when utilization of those areas commences.

19. Under all conditions, the Pitch Project tailings impoundment is designed to retain a probable maximum flood and maintain at least 1.5 m (5 ft) of freeboard at the dam crest (see Appendix A of the ER).

Diversion ditches are not safety related and do not have to contain a probable maximum flood. The diversion ditch for this project is designed to carry a 100-year flood.

20. Increased knowledge of the geohydrologic regime of the mine area is now available (Fig. 2.6). Based on this information, it is likely that a lake will form

22. In Section 4.7.1.2 of the DES the projected 15 fold increase does not take into account NPDES permit requirements which should largely reduce this impact.

23. The list of commentors on page V should include Mined Land Reclamation.

24. In Table 2.11, are plant nutrients measured in plant-available amounts or amounts present in sample?

25. Most current data indicates dump lifts will vary from less than 80 feet to as much as 240 feet. This should be corrected on page 3-11, Section 3.1.2.4.

26. On page 3-12, Section 3.1.3, paragraph 3 references stabilization, reclamation and control of the tailings area based upon regulations in effect at the time. While this statement is correct, the most current methods of tailings management should also be reflected.

27. On page 3-13, Section 3.1.3.1 it is doubtful that compaction by heavy equipment will provide adequate compaction given the maximum lift of 240 feet on the northern dump.

28. On page 3-13, Section 3.1.3.1, will a concrete saddle on the dam provide long-term use or will it require maintenance? Perhaps some other material is more suitable.

29. On page 3-13, Section 3.1.3.1, does the applicant really want to commit to 1:500 on final tailings surface grade? Perhaps a slightly convex or concave surface to provide drainage off the tailings area is more suitable. The point is to prevent accumulation of water in the tailings after reclamation.

30. On page 3-13, Section 3.1.3.2, it is doubtful based upon review of soils and geology information that the overburden dumps and pit will support proposed vegetation.

in the mining pit upon closure and cessation of pumping. The inflow to the pit will be greater than the inflow to the existing mine working, and the outflow will be restricted to the existing groundwater outflow. It is apparent that the faults (Chester and Erie faults) are currently serving as local barriers to groundwater movement. Such barriers will be breached by the mining operations. Fractured rocks in the fault zone will continue to serve as flow conduits.

Following lake formation, the flow gradient will be from the higher permeability formations to the north and east into the lake and from the lake into the low permeability formations to the west. The water quality of the lake that will form in the planned mine pit will be similar to the dominant groundwater quality present in the Precambrian rocks to the east of the Chester Fault, modified in a slight amount by the inflow of water from the Paleozoic rocks located to the north of the mine. Thus, the water would be of a bicarbonate type with a pH slightly greater than 7 and would have a dissolved solids content of probably less than 50 mg/liter to a worst-case situation of slightly in excess of 200 mg/liter. The most probable radionuclide concentrations for the lake are those as monitored by well DM-13, which includes a polonium-210 concentration of 0.7 ± 0.4 pCi/liter, thorium-230 concentration of 0.2 ± 0.4 pCi/liter, uranium concentration of 0.002 mg/liter, radium-226 concentration of 0.0 ± 0.8 pCi/liter, gross alpha concentration of 2.2 ± 1.0 pCi/liter, and gross beta concentration of 5 ± 7 pCi/liter.

After the lake forms, the ultimate water quality will be dependent on many factors such as rainfall, evaporation, freezing, erosion, and eventual biological influences. These factors will act to modify slightly the existing water quality.

21. See response to comment 15.

22. The comment is correct. The suspended solids discharge will be limited by the terms of the NPDES permit.

23. See revised text — Summary and Conclusions, p. v, and Foreword, p. xix, paragraph 4.

24. Potassium and phosphorus values are given as soluble components and are plant-available. Nitrogen values are listed as total nitrogen.

25. See the response to DOI comment 16.

26. Alternative tailings management programs are thoroughly discussed (Sects. 3.3.7 and 10.4.2). The State of Colorado Department of Health, Radiation and Hazardous Wastes Control Division, has the responsibility of authorizing the tailings management program as a condition for issuing a Radioactive Materials License for the milling operation.

27. The Colorado Mined Land Reclamation Board, Department of Natural Resources, reviews applicant proposals to ensure that dumps will meet stability requirements needed for protection of the environment and the public.

28. Of the materials considered, good quality concrete was deemed as durable as any other material that could be selected. It is the staff's opinion that concrete will provide as long-term, maintenance-free operation as other viable alternatives.

29. The 1:500 surface grade was carefully selected to provide the needed drainage and to prevent erosion. This will be a sufficient grade to prevent accumulation of water on the reclaimed tailings surface. If settling occurs, fill will be added to restore the surface grade.

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U.S. Forest Service
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31. Paragraph 5 of Section 3.1.3.2 states that all radioactive materials will be removed from the pit. The next statement says that radioactive material encountered will be covered with 20 feet of overburden to prevent water in the proposed lake from contacting said radioactive material. What is the basis for this statement? Pit overburden will not be sufficient. Only selected materials (clay) may provide desired isolation. In addition, the Mined Land Reclamation Board should have the specifics concerning the proposed cover now, and approvals may hinge upon Forest Service, Mined Land Reclamation, and possibly Health Department reviews.

32. On page 3-14, Section 3.1.3.3 the waste dumps and pit will be made of fractured materials consisting of sandstones, shales, and limestones. Organic content is low, nitrogen is low, as well as other nutrients. It is doubtful that revegetation efforts will be successful.

33. Will forested areas be fertilized? Paragraph 2 of Section 3.1.3.3 makes the statement that fertilizer will be added where it is necessary to achieve lasting growth. Continued fertilization may produce a cover dependent upon fertilization (open pit and dumps in particular).

34. In Section 3.1.5, the recommendation for retention of runoff from the waste piles for a probable maximum flood must be in error, as all other portions of the DES suggest a discharge of the runoff if compliance with state regulatory limits is met.

35. In paragraph 4 of Section 3.1.3.2, what will be the nature of the rock material below the 12 inches of fines?

36. On page 3-15, Section 3.1.4, the methods of disposal as indicated here must be in accordance with the requirements of the Mined Land Reclamation Board Permit.

30. Certain areas within the project will be difficult to revegetate. It is anticipated that, with the use of special treatments such as mulching, addition of organic materials, and well-managed seeding practices, the revegetation plan will be successful. Test-plot information indicates that revegetation will work in the areas of the overburden dumps and pit benches. Continuing experimentation will be utilized to provide the most suitable species and treatments for a successful revegetation effort. (See Appendix J and responses to EPA comments 24, 26, and 64.)

31. The open pit mining operation and subsequent underground operations will remove most of the radioactive material from the pit area.

The lake is expected to form as a result of groundwater flow into the pit. After the pit has been completely mined, groundwater will circulate through material that contains less U_3O_8 than at present. Even without the 6-m (20-ft) cover, water quality is expected to improve. The probable radionuclide concentrations for the lake are indicated by the monitoring data obtained from well DM-13 (see response to State of Colorado comment 20). The final design of the cover must meet the requirements of the FS and/or other appropriate agencies.

32. The test-plot experiments on the material taken out of the open pit indicate that the revegetation efforts will work. Continuing experimentation into vegetation species, as well as fertilization, will allow the applicant to determine what species can be best utilized for successful revegetation. At the present time, materials from the open pit area are being revegetated successfully without amendments. Initially, various amendments can be added to promote growth if required. (See Appendix J and responses to EPA comments 24, 26, and 64.)

33. Current information from the test plots indicates that fertilizer probably will not have to be used for reforestation. The applicant is continuing to experiment with different species of trees, as well as with different treatments in the planting of seedlings. At the present time, seedlings are growing on overburden material removed from the pit without the aid of fertilization. If fertilization is needed, it will be employed during the early stages of reclamation. (See Appendix J.)

34. Section 3.1.5 is in error. A single, large settling pond will be constructed to treat runoff from the entire waste dump area. The settling pond will be sized to contain a 25-year, 24-hr precipitation event. The discharge from the settling pond will be in compliance with the NPDES permit conditions. The text has been changed. (See responses to comment 9 and EPA comment 40.)

35. The material for several feet below the 30 cm (12 in.) of fines will be broken rock, with fine to coarse constituents.

36. The methods of disposal will be in accordance with the requirements of the Colorado Mined Land Reclamation Board's Development and Extraction Mining Permit. The text has been modified accordingly.

37. On page 3-15, Section 3.1.5, past information indicated that large and small sized overburden would be segregated naturally and that large material would fill in the drainages. Paragraph 3 leads one to believe that the larger material is purposely placed in drainages.

38. It should be noted in Section 3.3.9 that the NRC has no long-term care policy after decommissioning of the mill/tailings. Any required actions after that point would be up to the Colorado Department of Health and/or the Mined Land Reclamation Board.

39. On page 3-14, Section 3.1.3.4, Table 3.1 the gross disturbed acreage should be 1131, not 1100.

40. Will deer fencing be utilized in areas that may prove hazardous to wildlife?

41. On page 4-2, Section 4.2.2, the open pit should read 152 acres and the overburden dumps should be 216 acres.

42. Paragraph 3 of Section 4.3.1.2 indicates treatment and discharge of waters in accordance with the NPDES permit. On numerous occasions it is stated that water would be utilized. Which is correct?

43. On page 4-5, Section 4.3.3 if future mitigating measures are needed on the settling basins mentioned, it may require Mined Land Reclamation and the Department of Health, as well as Forest Service, interactions.

44. On page 6-2, Sections 6.2.1 and 6.2.3, the geotechnical programs required in Condition 2, Appendix B of the Mined Land Reclamation Permit (copy enclosed) should be mentioned.

45. On page 6-2, Section 6.2.3, specifically what shrub species are referred to here? Also item 4 under 6.2.3 states that sandstone, siltstone and limestone will promote plant growth and mulches utilized if needed. The applicant should use mulches as a general rule of practice rather than if needed.

37. The materials will purposely be allowed to segregate. The text in Sect. 3.1.5 has been altered.

38. A surety is required by the State of Colorado to guarantee long-term monitoring and maintenance.

39. The 2717-ha (1100-acre) "gross disturbed" area in Table 3.1 applies only to the amount of surface area disturbed during years one through five, not to the total disturbance. Accordingly, the 2717-ha (1100-acre) value in the table is correct. Gross acreage disturbed during the life of the project will be 2793 ha (1131 acres).

40. Yes. The subject of fencing is discussed in the response to comment 6.

41. The text has been revised.

42. Mine water will be utilized in the mill circuit to the extent that it is needed. Mine water not used in the mill circuit will be treated for radium removal, if necessary, and released to the sedimentation pond. All releases from the pond will be in compliance with NPDES permit requirements (see response to comment 12).

43. The statement is correct.

44. This information has been added to the text.

45. The shrub species tested for revegetation potential are listed in Appendix J. The applicant does utilize mulches as a general rule.

46. Have or will analyses of trace element concentrations of the sediments on Indian and Marshall Creeks been/be taken prior to major mining and overburden dumping in accordance with Section 6.3.1.1?

47. On page 6-5, Section 6.5, overburden materials to be used as a topsoil will be treated similarly to topsoil. What overburden materials specifically? When will these materials be stockpiled and where? What quick-growing grasses will be utilized on the topsoil as well as overburden stockpiles?

48. Paragraph 2 on page 6-6 raises doubt that the amount of information known at this point is sufficient to make the statement that reclamation goals are achievable as indicated in Mining and Reclamation Alternatives. (In particular, revegetation of the pit and dumps.)

49. Why is there no mention of Mined Land Reclamation Board approved plans on page 6-b, Section 6.5.1?

50. Under Mining Reclamation Alternatives on page 10-3 the statement is made that reclamation goals are achievable. On numerous occasions throughout the text of this DES it is inferred that the overburden materials will support plant growth. There are also inferences that soils quality, suitability, etc. will be based upon analyses at the time of reclamation. In essence, there is no information presented to prove the overburden materials will sustain vegetation. In fact, soils information presented indicates that while the proposed revegetation medium may not hinder vegetation propagation, it certainly will not assist said revegetation efforts. Section 3.1.4 goes further in indicating minor problems may exist relative to using overburden as a subsoil with regard to inorganic constituents detrimental to revegetation. A test plot program was also presented to Mined Land Reclamation in the Fall of 1977. Why have the specifics of that program not been included in this DES?

In short, it seems rather presumptuous to assume that reclamation goals are achievable based upon the information presented here. Compounded by the fact that no viable alternatives have been presented.

46. Sediment analyses for trace elements from Indian and Marshall creeks will be required. (The text has been changed.) Based upon waste dump leaching tests performed by the Colorado School of Mines Research Institute, it is anticipated that trace elements in Indian Creek will not be a problem. The most effective monitoring for trace elements and other chemicals that may be leached from the overburden dumps is through the water quality monitoring program.

47. The overburden materials to be used as a topsoil are those fine materials that overlie solid rock. As these materials are removed, they will be stockpiled at the tops of the overburden dumps. Revegetation of these stockpiles will be accomplished with the mixture of grasses now being tested. This mixture includes quick-growing species and will be utilized in conjunction with a mulching additive to minimize the potential for erosion. (Refer to Appendix J for a list of these species.)

48. This subject is addressed in the responses to comments 30, 32, and 33 and the responses to EPA comments 24 and 26. More information is contained in Appendix J. The results presented in the revegetation report indicate that the reclamation goals are achievable.

49. This oversight has been corrected.

50. See response to comment 48.

Jimmy Wilkins
U.S. Forest Service
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51. There are numerous statements regarding actions that require Forest Service approval that should also require Health Department and Mined Land Reclamation Board approval. While the staff has not made specific comments concerning the mill and tailings, it reserves the right to make additional comments as new information and further research deem necessary, either through future review of this DES or through amendment to the Mined Land Reclamation Permit.

52. As a footnote to Appendix D on page D-3, it should be indicated that the Homestake Pitch Project bond was approved and the permit thereby signed and issued on April 19, 1978.

53. On page 3-28, Section 3.3.7, the five feet of freeboard on the tailing dam should not restrict the drainage of water off the pile surface after final reclamation.

54. On page 3-1, Section 3.1.1, change from 50 tons of waste per ton of ore to 44 tons of waste per ton of ore. The latter figure was given to the Mined Land Reclamation Board in the original application submitted by the applicant.

55. The potential for acid drainage should also be considered in Section 3.1.2.5, page 3-12.

56. The DES does not recognize that suspended solids, a principal water quality problem of Marshall and Indian Creeks, is attributable to past and future aspects of the Pitch Project.

Page 4-5 of the DES states, "4.3.3 Surface Water Suspended Solids ...."The existing benthic fauna and trout populations in Indian Creek are well adjusted to the occasional high bed and suspended solids loads occurring naturally in Indian Creek."

51. The general responsibilities are discussed in paragraphs 3 and 4 of the Foreword, Sect. 1.2, and Table 1.1. In the interest of brevity, all approving organizations are not always listed for specific actions.

52. The text has been changed.

53. The 1.5 m (5 ft) of freeboard is designed to ensure that drainage will not flow over the face of the main dam. The reclaimed tailings area will be sloped away from the main dam toward the concrete saddle dam. This slope will allow adequate drainage from the surface of the tailings area to control seepage through the cover. The slope is gentle enough to minimize erosion of the surface and will promote deposition of suspended material on top of the reclaimed tailings pile, increasing the thickness of the cover.

54. The last sentence in the referenced section states that there will be 44 (not 50) tons of waste per ton of ore.

55. Because of the high carbonate content of the ore, no acid drainage problem is anticipated. As evidence of this statement, the present drainage from the old Pinnacle Mine is alkaline.

56. Total suspended solids related to future aspects of the Pitch Project will be minimized by constructing a new settling reservoir (see response to comment 9), and discharges will be restricted by the terms of the NPDES permit. The suspended solids loading of Indian Creek is expected to improve once the new settling pond is in operation (see responses to EPA comments 40 and 44).

The Colorado Department of Health's Water Quality Control Division field service has been performing a survey on Marshall Creek and Indian Creek since March, 1978. Results to date from the survey indicate the aquatic community of the Marshall Creek and Indian Creek drainages are not "adjusted" to suspended solids loadings to the streams and that additional negative impacts have occurred during 1977-78. In addition, the raw data indicates much of the suspended solids loadings to Indian Creek is not natural. Field investigations have documented four principal sources of suspended solids to the two streams.

a. During March and April, 1978, Homestake Mining Company bulldozed the snow from the access road up Indian Creek into the stream. As snow melted, vast quantities of solids were introduced into Indian Creek.

b. Road runoff from several locations in 1978 has been documented. Loadings of 3195 and 34860 mg/l suspended solids were entering Indian Creek in March and April, 1978.

c. Tie Camp Creek, tributary to Indian Creek, drains the portion of the project where strip mining activities will be located. A 795 mg/l loading of suspended solids was entering Indian Creek from Tie Camp Creek on April 27, 1978. The solids were traced to the existing pit area.

d. Road Construction. During July, 1978 a D-6 caterpillar was used to "straighten" the Marshall Creek bed to accommodate a wider county road to be used for hauling ore. Saguache County, not Homestake, was responsible for that activity.

All of the above sources have been documented to introduce excessive loadings of suspended solids to Indian and Marshall Creeks comparatively, "natural" loadings of suspended solids to Indian Creek during spring runoff conditions were less than 35 mg/l.

That the aquatic community of Indian Creek is "well adjusted" to the suspended solids (see above) is a questionable statement at best. Water Quality Control Division data and the DES provide information which refute that statement. Page 2-35 of the DES, paragraph 3, states that statistical interpretation of raw data indicate the presence of a "stressed community of benthic invertebrates" in Indian Creek. Sampling by the Water Quality Control Division has revealed a community dominated by a few species of insect larve which evidently can colonize the sandy substrate of Indian Creek. The sedimentation rate in Indian Creek has impacted stream quality. Colorado Division of Wildlife employee, Norwin Smit, compared stream conditions in 1977 to 1978. His visual determination was that upper Indian Creek above little Indian Creek, had incurred a habitat destruction due to sediment in the 12 month period. The DES should be modified to include mitigating programs to reduce the suspended solid loadings.

57. On pages 6-7 and 6-8 the DES calls for "trace element body burden" analysis of brook and brown trout populations at four stations on Indian and Marshall Creeks. The DES calls for analyses of all age class. Such a proposal is totally uncalled for, one which entail a useless slaughter of fish. Baseline data sampling by the Water Quality Control Division has demonstrated metal concentrations to be generally below detection limits. Such a program as proposed by the DES is of no use until some metals increase in water samples is noted.

57. This proposed analysis has been replaced by leaching experiments that, together with water quality analyses, will provide an adequate indirect measure of potential trace element accumulation by trout populations. The text has been modified accordingly.

58. The applicant should be requested to demonstrate how the As Low As Reasonably Achievable (ALARA) concept is practiced not only in the operational program but in the mill design as well. If modest increases in costs could further reduce occupational exposures below the standard then appropriate changes must be made.

59. Since as much as 90% of the occupational airborne hazard in a uranium mill comes from the drying and packaging circuit, we believe the applicant should evaluate, as an alternative, the elimination of this circuit. The yellow cake could then be shipped wet in a Colorado, NRC and DOT approved vehicle. This also would probably eliminate some of the transportation hazards involved with this product.

60. Conduct of all mill employee training and testing programs should be documented by the applicant.

61. Initial and refresher examinations given during employee training should be written.

62. We understand that the applicant has not yet hired any mill radiation safety personnel. Nevertheless a list of minimum qualifications for this position must be given.

63. Effluent stack sampling should be monthly for the first year. There should be especially close control on the yellow cake dryer and on the bag houses.

64. Ambient air samples should be calibrated semi-annually at least. Filters may need to be inspected daily where dust loading becomes a problem.

65. Ground water samples: Liquid discharges to unrestricted areas should be monitored monthly or more often as needed to assess the effectiveness of control measures.

66. Where will control personnel monitoring badges be kept?

58-74. All of these items will be addressed in the Colorado Department of Health review of the Homestake Application for a Radioactive Materials License.

67. Radon daughter sampling should be done monthly at least during the first year of full operations.

68. Will Homestake personnel be trained to respond to off-site transportation accidents?

69. The site and manner of disposal should be specified for radioactively contaminated industrial trash, equipment, construction materials, etc. generated during mill operation. How will radioactive and nonradioactive wastes be segregated?

70. A listing of the applicant's corporate officers has been given to the Colorado Department of Health. In addition, the FES should delineate the corporate line of authority as it relates to the Pitch Project.

71. The line and degree of authority of the Radiation Safety Officer should be stated even if the individual has not been hired.

72. Action levels should be related to radiation levels as well as radioactivity concentrations.

73. Surface contamination in employee lunch and change rooms should be monitored by both air sampling and surface wipe testing.

74. Bioassay procedures will have to be brought into concurrence with the soon-to-be-released NRC Regulatory Guide.

75. Background radon emanation rates should be measured now at the mill and future tailings impoundment sites.

76. A summary of the applicant's past performance in complying with environmental licenses, permits, regulations and laws throughout the United States should be presented in the FES.

75. Radon emanation rate measurements are planned for 1979 as soon as weather and soil conditions permit.

76. See response to comments 58-74.

Jimmy Wilkins
U.S. Forest Service
Page Fourteen, September 11, 1978

77. The quality control procedures for the impoundment construction should be specified. Certified inspection reports should be submitted to the Department at weekly intervals. Plans for a catchment system for seepage below the tailings impoundment should be submitted. Plans for the liner construction in the mine effluent water storage pond should be submitted.

78. We expect that any concerns related to safety and emergency plans will be fully addressed through coordination by the Forest Service with appropriate agencies including the Colorado State Patrol.

79. Periodic monitoring of the access road from the mine to mill will be necessary to measure possible excessive contamination.

This concludes the State of Colorado comments on the DES. All state agencies involved in the review and comment process reserve the right to make further comments or impose further requirements as their permit, licensing, regulatory or statute authority dictates.

For purposes of clarity the Radiation and Hazardous Wastes Control Division will be requesting that the applicant consolidate all previously specified operational health physics and environmental radiation monitoring information into one document to permit completion of the Division's license review.

There will undoubtedly be questions concerning these comments. Please contact this Division for assistance. If we cannot help you we will put you in touch with someone who can.

Sincerely,

Albert J. Hazle
Director, Radiation
and Hazardous Wastes
Control Division

AJH/JLM:els
Enclosures

77. It is the staff opinion that sufficient detail is included for the purpose of this Statement. Specific engineering details will be submitted to the appropriate regulatory agency for approval prior to commencing construction.

78. The applicant is expected to cooperate fully with Federal, State, and local regulatory agencies having jurisdiction over the Pitch Project.

79. The amount of radioactivity contained in the quantities of ore that will fall from haul trucks will be negligible. Annual surveys for potential contamination will be conducted, and, if warranted, appropriate mitigation measures will be implemented. Operational monitoring will be accomplished according to license conditions and applicable Federal and State guidelines.

Copies Sent to:

Harold Powers
Homestake Mining Company
Gerry Trujillo
Michele Feingold
Dr. Tom Vernon, CDH
Bill Auberle, CDH
Peg Little, CDH
Dick Gammell, CDH
Micki Barnes, CDH
Al Whitaker, Division of Wildlife
Dr. Jeris Danielson, Division of Water Resources
Dave Shelton, Geological Survey
Harvey Atchison, Department of Highways
Bob Shukle, CDH
Rade Orell, Mined Land Reclamation
Philip Schmuck, Department of Local Affairs
Arthur Townsend, Colorado Historical Society
John Woodling, Water Quality
EPC members
Paul Smith, EPA

CITY OF GUNNISON

Box 339 Gunnison, Colorado 81230

July 31, 1978

Jimmy R. Wilkins, Forest Supervisor
U. S. A. A. Forest Service
P. O. Box 138
Delta, Colorado 81416

Re: E. I. S. for Homestake Mining Company's Pitch Project

Gentlemen:

The Gunnison City Council wishes to go on record as favoring the acceptance of the Environmental Impact Statement for Homestake Mining Company's Pitch Project. After reviewing the E. I. S. prepared by the U. S. Forest Service, it is our opinion that the possible environmental hazards of this project will be adequately neutralized by the various safeguards required of Homestake, and that the economic benefits for Gunnison and the entire country weigh heavily in its favor.

We, therefore, urge acceptance of the E. I. S. by the various federal, state and local licensing agencies, and urge them to issue the various licenses needed by Homestake posthaste.

Sincerely,

S. J. Sangosti

Santo J. Sangosti
Mayor

SJS:sjb

Home of Western State College and Blue Mesa Reservoir

No response is required.

THE BOARD OF COUNTY COMMISSIONERS
CHAFFEE COUNTY
P.O. BOX 699
SALIDA, COLORADO 81201
(303) 539-2218

No response is required.

August 1, 1978

Forest Service
U. S. Department of Agriculture
Grand Mesa, Uncompahgre and
Gunnison National Forests
P. O. Box 138
Delta, Colorado, 81416

Re: Draft Environmental Statement
Homestake Mining Company's
Pitch Project

Gentlemen:

In view of the urgent need to develop all sources of energy that will make this country less dependent on foreign imports of petroleum, the benefits that will accrue to Chaffee, Gunnison, and Saguache Counties through increased employment, and the real concern for the environment displayed by the Homestake Mining Company in planning the Pitch Project, I wholeheartedly endorse this project and recommend its approval.

While no project of this magnitude can be entirely free of negative aspects, it is my opinion that the benefits to be derived from this project far outweigh the detrimental effects that may arise.

It is unfortunate that the need for energy, food, shelter, etc. cannot be satisfied without some alteration of the natural environment; however, when adequate provisions are made to protect the environment and restore the land. the objectionable features of such projects as the Pitch Project are greatly diminished.

R. C. Tuttle
Richard C. Tuttle
County Commissioner

AUG 1 8 1978

THE BOARD OF COUNTY COMMISSIONERS
CHAFFEE COUNTY
P.O. BOX 699 (303) 539-2218
SALIDA, COLORADO 81201

No response is required.

August 2, 1978

Forest Service
United States Department of Agriculture
Grand Mesa, Uncompahgre and Gunnison National Forests
P.O. Box 138
Delta, Colorado 81416

Re: Draft Environmental Statement--
Homestake Mining Company's
Pitch Project

Gentlemen:

The purpose of this letter is to provide my input on the Pitch Project as proposed by the Homestake Mining Company. Although I have not reviewed the Draft Environmental Statement in detail, I am pleased to note that the Statement is generally favorable to the Project.

Provided that the proper and necessary precautions are taken to safeguard the area I would endorse the Pitch Project.

Chaffee County is not involved in the construction or operation of the proposed Project; however, because of the close proximity of the site, the County will benefit economically from a portion of the work force who will undoubtedly reside in Chaffee County.

I believe that every effort should be made to expedite the delivery of fuel which our nation so sorely requires. The proper implementation of the Pitch Project is a necessary step in providing energy to American consumers.

Sincerely,

Mark E. Vanderpool

Mark E. Vanderpool
Chaffee County Commissioner

MEV/jas

AUG 1 8 1978

SAN LUIS VALLEY COUNCIL OF GOVERNMENTS

box 26, adams state college
alamosa colorado
81102 (303)589-7925
casa del sol, 122 richardson ave

A COOPERATIVE EFFORT OF VALLEY GOVERNMENTS FOR A BETTER COMMUNITY

September 11, 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
Grand Mesa, Uncompahgre and Gunnison N.F.
P. O. Box 130
Delta, CO 81416

Dear Mr. Wilkins:

In reviewing the Draft Environmental Statement for the Homestake Mining Company's Pitch Project, we are concerned with several inconsistencies in the text which bring us to question certain conclusions in the Summary and Conclusion section at the beginning of the text.

The following is a list of such consistencies:

A. Will there or will there not be underground mining?

2.5.2.3 Geological Hazards

"The open pit will be excavated into unstable, unaltered rock. 'Flowing ground' and extreme pressures in the altered Precambian rock along the fault zone presented serious problems to previous underground mining. The open-pit method, however, will avoid the problems associated with support of underground openings."

3.1.2.5 Underground Mining

"Although detailed underground mining plans have not been finalized by the applicant because of a lack of deep drillings, tentative plans are presented, based on drilling to date and past experience from underground mining operations in this area." . . . . . .
"Flatlying ore deposits will be mined by room-and-pillar methods. As the dip increases, stopping will start by driving drifts at an oblique angle to the strike of the rock to control the operating grades within the capabilities of small load-haul-dump units and underground haulage trucks to operate."

CONEJOS Antonito La Jara Manassa Romeo Sanford
COSTILLA Blanca San Luis
ALAMOSA Alamosa Hooper
MINERAL Creede
RIO GRANDE Del Norte Monte Vista
SAGUACHE Bonanza Center Crestone Moffat Saguache

RESPONSES

A. There will be underground mining of ore at the Pitch Project. (See response to EPA comment 16.) The probable location of an underground mine outside the pit boundaries is shown in Fig. 3.5. In addition, small adits and shafts will be used within the pit to recover ore pockets without further overburden removal. The mine pit excavation will remove most of the fault zone where previous mining encountered difficulties (see Fig. 2.6). To ensure mine safety, the mining plan and operations are subject to stringent review by the Colorado Mined Land Reclamation Board, the Colorado Division of Mines, and the U.S. Mine Safety and Health Administration.

5.1.1 Mine Accidents
"The Pitch Project will involve both open-pit and underground mining of uranium ore."

Statements made in the above sections lead us to believe that there will be underground mining and that it will be hazardous to employees. Also, because underground mining is expected to occur under the open pit walls and floor (Sec. 3.1.2.5), this poses a problem for potential waste spillage.

B. What is the potential for wall failure in the open pit?

2.5.2.3 Geologic Hazards
", and the pit walls are designed to minimize the chances of slope failure."

5.2.1 Mine Accidents
"Although the results indicate than an open-pit mine can be developed at this site with dimensions as indicated in Sec. 3.1, the study also concluded that large wall failures were possible, especially failures of the eastern wall.

These above contradicting statements lead us to think that the safety of the open pit walls is questionable and further explanation is warranted.

B. To minimize the possibility of failure of the open pit mine walls, the proposed design slope angles average 42°, which provides a safety factor greater than 1.0 on all faces. These slope angles are subject to design changes based on the results of the applicant's ongoing slope stability program. As stated on p. v, part 7e, of the FES, "A pit wall stability program will be instituted and maintained during the operation of the open pit. This program must be approved by the Colorado Division of Mines."

C. We are concerned with the health, safety, and welfare of the present and future residents in the vicinity of the proposed Pitch Project site. One area which we do not feel has been adequately analyzed is that of radioactive effluent percolating into groundwater.

page:iii Summary and Conclusions: c.
"Although seepage will be minimized by placement of a clay liner, some liquid percolation from the tailings impairment (through the bottom and dam) will enter the underlying strata."

2.4.1.1 General Groundwater Characteristics
"Because of the limited number of wells tested coupled with a relatively complex geologic structure, information about the groundwater regime at the site is incomplete at this time."

2.4.1.2 Groundwater Regime at the Proposed Waste Dumps
"No wells have been drilled at the proposed waste dump sites. The three dumps will cover the upper drainage areas of Indian Creek. Because most of the bedrock in this area dips gently to the south, it is probable that groundwater moves to the south and discharges, in part, along Indian Creek."

C. The Colorado Department of Health, Radiation and Hazardous Wastes Control Division, has the responsibility for selecting the methods to control potential releases from both the waste dumps and tailings disposal areas. Licensing action is dependent upon an environmentally acceptable method of control and disposal of radioactive effluents such that they produce no measurable risk to public health and safety. The actual methods selected will be the most acceptable within the present economic and engineering state of the art.

The applicant is committed to the implementation of mitigating measures to capture any seepage from the tailings pond and pump it back into the reservoir. In addition, a new sedimentation pond will be constructed as soon as all clearances and approvals have been obtained and weather permits. Monitoring wells will be constructed below the overburden dumps. Additional information pertaining to the matters addressed in this comment can be found in the responses to State of Colorado comments 9, 15, 18, 19, 20, 27, 31, and 53 and EPA comments 3, 21, 22, 25, 26, 29, 36, 38, 39, 40, 42, 44, 45, 51, 52, 56, 57, 59, 60, and 61.

Leaching experiments conducted by the Colorado School of Mines Research Institute on overburden and low-grade waste from the site indicate that water from the waste dump will not be significantly different from that presently in Indian Creek.

The groundwater regime at the proposed mine and waste dumps has now been established (Fig. 2.6), and spring recharge (Table 2.4) does not appear to have a large effect.

4.3.1.2 Degredation of Groundwater Quality
"Much of this contaminated groundwater would probably discharge into Indian Creek somewhere below the waste dumps."

4.3.1.3 Groundwater Consumption
"The groundwater regime at the mine site is not well known." . . . . "At present, the applicant does not know the volume of mine water available for the mining and milling operations."

4.3.2.2 Degradation of Groundwater Quality
"As the tailings impoundment fills with wastes, some of the liquids will seep through the bottom and the sides of the impoundment and contaminate the near-surface groundwater" . . . . "Precipitation that infiltrates ore stockpiles at the mill site could potentially seep into the ground and contaminate the groundwater."

6.3.1.1 Environmental Monitoring
", sediment from erosion of the mine area may cause significant impacts on Indian Creek."

The above statements clearly detail that there will be contamination of Indian Creek, and that the applicant has insufficient knowledge about how drainage will effect the groundwater regime. The following statements show how this could be dangerous to those living in the area.

2.4.2 Surface Water
"Indian Creek is a first order tributory to Marshall Creek."

2.4.1.4 Groundwater Use
"The closest domestic use is by the town of Sargents, approximately 8 Km (5 miles) west of the project area. As of April 1976, only six wells were being pumped by Sargents, and all produce from the alluvium of Marshall Creek."

It is our opinion, based on the information presented above, that further groundwater studies appear warranted at the project site to guarantee safety for the residents of Sargents and residents downstream. Detailed mitigating procedures should be employed if the project is approved and stringently enforced by the appropriate agencies.

D. One final area of concern which we do not feel has been adequately addressed in the EIS is the problem of wind at the Project site, which can be a constant occurence in this area. Section 5.1.2.3 examines the effect of a Tornado on the site, but as mentioned, this would be a rare occurence.

Although there is increased knowledge about the groundwater available for milling, only pit development will disclose exact quantities. If some of this water is discharged to Indian Creek, it will enter the settling pond along with dump runoff. The NPDES permit will limit the amounts of sediment, trace elements, and radioactive materials that may be discharged into Indian Creek. These levels will be set to protect the public, and any treatment required to meet these levels will be implemented.

No discharges will be permitted that will pose any measurable risk to public health and safety.

Any conditions imposed on the applicant to achieve this goal will be stringently enforced by the appropriate agencies.

D. Site-specific meteorological data were used to calculate the potential radiological impact offsite. With the exception of radon (gas) and daughter products, little radioactivity will potentially be transported offsite. Sprinkling would not be required except on haul roads to control dust with winds below 30 mph and then only under very dry conditions, which are unlikely in the spring.

Moderately high velocity wind is frequent, and its potential hazard appears great. It would not be possible to contain all radioactive matter on the Project Site with water sprinklers during the Spring when the wind blows with such consistency.

Spillage of a radioactive material could take place in transport and be blown into the atmosphere before sprinklers could be employed to settle it.

In closing, we would like to state that it is the general position of the San Luis Valley Council of Governments to support projects in the area which will increase the tax base, and provide additional jobs. However, this increase in tax base and jobs must be closely weighed in light of any potential hazards posed to residents in or near the area.

For this reason we submit our concerns to you so that they can be alleviated, and that through proper preparation and design there will be no threat to life and property caused by the Homestake Pitch Project. It is also our concern that if the Project is approved, that adequate ongoing inspections be made by appropriate agencies. Finally, it is our concern that once mining ends in the area, that scrutiny of the abandoned site continue with the same diligence as when it was active.

Sincerely,

Terry Hundley
Planning Director

TH/jg

The Colorado Department of Health, Radiation and Hazardous Wastes Control Division, inspects licensed uranium mills annually. Licenses are renewable after five years, at which time a thorough review of operations and impacts is conducted. Scrutiny of the abandoned site will occur as funded by a long-term care agreement entered into by the Department of Health and Homestake Mining Company before a Radioactive Materials License is issued. Regular monitoring and maintenance are provided for by the long-term-care fund.

Gunnison County, Colorado

RESPONSES

Board of
COUNTY COMMISSIONERS

GUNNISON, COLORADO

September 12, 1978

Mr. Jimmy Wilkins
Supervisor
Gunnison National Forest
P.O. Box 138
Delta, Colorado 81416

Re: Homestake Mining Company, Pitch Project,
Draft Environmental Impact Statement

Dear Mr. Wilkins:

Enclosed please find my specific point by point comments which may help you in amending the Draft Environmental Impact Statement on the Homestake Mining Company's pitch project.

The Gunnison County Commissioners and the Gunnison County Planning Commission have both sent into you their substantive overview analyses of this DEIS.

Please review them with a serious eye to the needs of this County, which will be most seriously impacted by the proposed development.

Sincerely,

By: Elaine Lockwood
ELAINE LOCKWOOD
Planning Assistant

Ms. Lockwood is an employee of the Gunnison County Planning Commission. Her comments were reviewed and edited by the Commission and forwarded as a response to the DES. The Forest Supervisor has determined that the Gunnison County Planning Commission response dated September 13, 1978, is the official commenting letter.

Gunnison County, Colorado

Board of
COUNTY COMMISSIONERS

GUNNISON, COLORADO

September 13, 1978

Mr. Jimmy Wilkins
Supervisor
Gunnison National Forest
P.O. Box 138
Delta, CO 81416

RE: Homestake Mining Company, Pitch
Project, Draft Environmental
Impact Statement

Dear Mr. Wilkins:

Attached please find our concerns regarding the Draft Environmental Impact Statement on the Homestake Mining Company's Pitch Project.

Sincerely,

By: ____________________
Dora Mae Trampe, Chairperson
Gunnison County Planning Commission

/pv
encl.

(1.) Representing the Planning Commission of the County in Colorado that will receive the majority of physical impacts and it's share of socio-economic impacts, we view with grave concern the timing of our opportunity to comment on the Draft Environmental Statement of Homestake Mining Company's Pitch Project. It appears the applicatn has already received essentially all necessary permission and the DES has approved the applicant's plan and now we who will be impacted have little input. Only the Colorado Department of Health can insure mitigation and tailings safety.

Our study of the Draft Environmental Statement for the Homestake Mining Company's Pitch Project, USDA-FS-R2-DES(ADM)FY-78-03, convinces us that it is inadequate to serve its legally intended purpose of improving decision making in the management of public lands. As written, the draft EIS is a fair description of what Homestake proposes to do. At least some of the anticipated adverse impacts are analysed in considerable detail. Furthermore, a number of alternatives are addressed which have the potential for mitigating adverse impacts.

The problem with the analysis is that the alternatives are considered in only the most superficial way. Essentially all adverse impacts are in the end judged to be acceptable. The one unacceptable impact seems to be a production cost increase for Homestake. It is our understanding that within the bounds specified by law and regulations, it is the duty of Federal land managers to exercise their authority for the greater public good. It is generally accepted that such management may from time to time impose hardships on particular individuals or groups. The attitude in the Homestake EIS seems to be that hardships to the public are acceptable, but hardships to the company are not. The ultimate hardship to the company would be for the costs of mitigating adverse impacts to be so high that profitable operation would be impossible. Under the law this is not necessarily an unreasonable imposition. It could merely mean that the uranium market is too weak to support a new mine meeting reasonable standards, and that mining should be postponed until the market or technological advances make mining practicable.

In the paragraphs which follow, we will make specific criticisms of various sections of the EIS - focusing on their failure to emphasize the greater public good.

(2.) The greatest environmental hazard posed by the Pitch Project is radioactive and mineral contamination of ground water by seepage from the tailings. The estimated seepage is 48 to 64 acre feet per year (Section 4.3.2.2). Significant addition of suspended solids to Marshall Creek and Indian Creek is also expected to degrade the quality of these streams (Section 4.3.3). Furthermore, there is only a 2 out of 3 chance that the tailings dam will hodl for the 20 years of mining coperation (Section 5.1.2.3). Homestake is to deal with watershed problems as they arise (Section 4.7.3) which virtually guarantees major damage to Indian Creek, Marshall Creek, and perhaps Tomichi Creek. The Forest

RESPONSES

1. Because the Pitch Project is located in Saguache County, it would appear unlikely that Gunnison County would receive a majority of the physical impacts of the project.

The Colorado Department of Health, in cooperation with other State agencies, evaluates project plans to see that State requirements are met. A license must be issued if all State requirements are satisfied.

The FS is required to review mineral development proposals within existing Federal law and regulations. The Environmental Statement clearly points out the authorities and responsibilities of the FS (Sect. 1.2), which do not provide the discretionary latitude suggested by the respondent.

As stated in the Foreword, Section 102(2)(C) of NEPA calls for preparation of a detailed statement on (1) the environmental impact of the proposed action; (2) any adverse environmental effects that cannot be avoided should the proposal be implemented; (3) alternatives to the proposed action; (4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and (5) any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

The staff has prepared this document within these guidelines and believes it to be a fair representation of the effects of the project as proposed and as it will be affected by any viable alternatives and mitigating measures projected to protect the environment.

2. Since the DES was issued, tests have shown that the permeability coefficient of the proposed clay liner decreases by a factor of 10 when exposed to tailings solution. The estimated seepage is therefore 13 to 18 m^3 (5 to 7 acre-ft) per year. The possibility of this decrease in seepage occurring was mentioned in Sect. 4.3.2.2 of the DES.

Section 4.3.3, paragraph 4, addresses the fact that measures will be taken to reduce the potential addition of suspended solids. The applicant is committed to the installation of a new settling pond designed to contain the runoff from a 25-year, 24-hr precipitation event. The pond will provide a storage volume adequate to hold the estimated project-life sediment load at maximum disturbance conditions, thereby controlling the addition of suspended solids to Marshall and Indian creeks. Discharge from the pond will be subject to the requirements of the NPDES permit. (See response to EPA comments 40 and 44 for additional details.)

Service evidently considres this potential impact so minor as not even to be worthy of mention in their Benefit-Cost summary (Section 11.3). They also consider this impact so minor as to render unnecessary souch mitigation measures as dewatering the tailings (Section 10.4.2 Alternative #10), solidification of tailings (Section 10.4.2 Alternative #6), or location of mill and tailings in a safer area (Section 10.2.3) where it could be used later to serve other uranium mining operations in the upper Gunnison Basin. It is interesting to note that in Table 10.1 an alternative is considered to treat tailings seepage before discharging to a local waterway. This alternative is rejected because "technology not available to allow seepage water treatment sufficient to attain water which is environmentally and legally acceptable for release;" but the Forest Service seems to feel it is all right to let this untreatable waste go into the water table as long as no one sees it.

(3.) The analysis considers in great detail the hazard to the off site public (Section 4.8, Appendix E, Appendix F, Appendix G). The hazard here does seem to be minimal except possibly if the tailings dam should break or if the tailings seepage fails to vanish as assumed. The largest radiation hazard, however, will be to the workers. This is dismissed in one small paragraph as being acceptable in other mines (Section 4.8.7). No numbers are given for the actual doses anticipated, or for the cancer deaths expected. Despite the absence of any supporting data or computations for workers comparable to that for the off site public, the Forest Service concludes that "the radiologic impact of the Homestake Mine and mill is low." (Section 11.3) Compared to what?

(4.) The third significant impact will be socio-economic (Section 4.9, pages 4-19 to 4-24). This lengthly analysis has two major defects. Repeated reference is made to Homestake's intention to hire locally thereby minimizing impacts on housing, schools and public services. Since Homestake will be paying wages higher than the local average, they certainly should be able to hire locally; but Gunnison County has low unemployment and significant growth already. Thus new workers will have to be attracted to replace the local hiring, and wages throughout the County will probably be forced up, thereby hurting other segements of the economy. Local hiring will thus not reduce impact problems but will probably make them worse. The second major defect is in the computation of social costs of increased population based on historical per capita budgets. The error here arises because the historical budgets reflect mainly operation and maintenance costs of existing infrastructure, whereas new growth requires additional capital investment to enlarge the infrastructure. These costs are not considered, but must be for a fair evaluation of whether the new growth will be paying its way. The adverse impacts of sudden growth (the boom town syndrome) are well known. Although the Homestake impact will certainly not be so large as to be called a boom, its impact should not be underestimated by erroneous analysis or be brushed off as is done in the summary (Section 11.2).

Section 5.1.2.3 is historical and does not take into account that the tailings dam will be designed to withstand a major earthquake and contain a maximum potential flood. This section has been revised and updated to clarify the small risk associated with dam failure. See also item 7b in the Summary and Conclusions. The staff expects (Sect. 4.7.3) the settling pond (or such other measures as may be accepted by the State of Colorado) to mitigate potential excess sediment loading (see above). The last sentence merely indicates that additional measures will be taken if required. Because this is true, the cost-benefit summary is not affected. Alternatives 11 and 12 have been added, and both consider dewatered tailings disposal. For further amplification of Alternative 6, see response to Gunnison Board of Commissioners comment A.

Dewatering or solidifying the tailings will have no effect on sedimentation in local streams. The staff considered (Sect. 10.2.3) that there was no superior location for the mill and notes that there is no regulatory authority to force either joint or toll-milling projects on other mining operations.

The technological problem in 10.1 relates to the volume and rates that must be handled. Natural evaporation "treats" the tailings liquids and releases water vapor that is legally and environmentally acceptable. Natural chemical processes "treat" the seepage, and the mineral constituents return to their original state over time. The only question is potential exposure before this process occurs. Provisions are made to prevent this exposure.

3. Maximum radiation exposures for both mine and mill workers have been set by regulatory agencies to protect the workers from undue risks. In addition, protection measures to reduce occupational dose are reviewed and revised by the regulatory agencies to keep radiation exposures as low as reasonably achievable.

Because doses to occupational workers are measured and are maintained below Colorado Department of Health and NRC occupational dose limits, no special discussion is warranted in the FES. Normally, individual worker exposure will be less than one-fourth of the allowable limit.

Meaningful numbers for cancer risk per rem of exposure are controversial. With 10^2 cancers per 10^6 man-rems of population exposure and 25% of allowable radiation exposure for a project employee, the individual worker risk above normal expectations would be about 1.25×10^{-6} per year. Total occupational exposure would be about 190 man-rems compared to the calculated public man-rem dose within 80 km (50 miles) of less than 5 man-rems from the project and 33,100 man-rems from natural background.

In Sect. 11.3, "low" is as compared to present regulations and future EPA standards for added radiation exposure to individuals not occupationally involved in the project.

4. Because the total permanent labor force at the Pitch Project will be less than 2% of the number presently employed in Gunnison, Saquache, and Chaffee counties, it seems unlikely that any major economic stress will occur.

The analysis in Sect. 4.9 indicates no additional capital costs will be required in support of the Pitch Project (see State of Colorado comment 2). Therefore, no marginal costs exist.

In Sect. 11.2, the staff has indicated that there may be some imbalance in costs vs benefits in local communities. Local planning units can use the information in Sect. 4.9 to develop mitigating measures for such imbalance.

(5.) Reclamation techniques are layed out without substantiation of the assumption that revegetation will actually work. High altitude revegetation is generally less successful than at lower elevations, and proof that revegetation will occur must be offered by the mining company. Otherwise this constitutes a considerably greater irreversible committment of resources than is estimated in the EIS.

Documentation of Homestake's past performance, the past success of other similar reclamation efforts, and evaluation of current research must be included here, as well as why this technique was chosen over others. Why not backfill the mine pit completely with overburden? Also include documentation that reclamation will leave the land usable for it's current or expected uses (grazing, recreation, etc.).

If the USFS is unsure reclamation will work, they must at least admit it. Stating that it <u>will</u> occur is misleading to the public.

Finally, it is vital that the bond posted to cover the reclamation costs not underestimate what those costs might potentially be, since the outlook on the uranium market is disputed at this time.

(6.) All of the costs and adverse impacts of the Pitch Project must be weighed against its potential benefits. The most significant benefit is judged to be satisfaction of the national need for uranium and the energy it provides (Section 1.7 and Section 11.3). This need is supported in Section 10.6.1 primarily be reference to "Project Independence" a document published in 1974 and now largely discredited because of its heavy content of wishfull thinking. The facts are that major expansion of the nuclear power industry is not occuring, and projections of uranium needs have been revised downward every year since 1974. Before a final decision is made on the issuance of a Radioactive Materials License for the Pitch Project, the need should be reviewed in the light of current data, and the conclusions in sections 10.7 and 11.4 should be reevaluated.

It seems to us that in evaluating the Pitch Project we need to look at two possibilities. If there is no pressing national need for more uranium and the market will not support the costs of full mitigation of adverse impacts, then the Benefit-Cost analysis ends up all on the cost side. If, on the other hand, there is a growing national need for uranium, then more than just the Pitch Project will be needed. We should then be planning for several mines in the upper Gunnison Basin supplying a common mill and tailings operation, and Hale Gulch at the upper end of an important watershed and drainage basin is not the right location. Thus whether there is a national need for uranium or not, the mill and tailings operation as now proposed is not in the public interest.

5. Revegetation can be accomplished. Experimentation to determine the most successful techniques is ongoing (Appendix J). Reclamation will be supervised by the FS and the Colorado Mined Land Reclamation Board, Department of Natural Resources, with the cooperation and advice of other agencies. The proposed plan should not be considered absolute but will be changed as environmentally better methods become available.

No environmental advantage would be achieved by filling the mine pit completely with overburden. (See response to EPA comment 51.)

A bond has been posted with the Colorado Mined Land Reclamation Board to ensure reclamation. The amount of the bond was calculated on a best estimate basis taking into account all factors of the reclamation program.

6. The staff has reviewed the national need for uranium, and this updated information is reported in Sect. 10.6. Nuclear reactors presently under construction will require an expansion of U.S. production of uranium or will require the purchase of uranium from foreign sources.

Uranium produced by the Pitch Project will aid the national balance of payments and provide fuel for reactors presently under construction, enabling the timely delivery of needed electrical power. The conclusions in Sects. 10.7 and 11.4 remain valid.

Mitigation of adverse impacts is considered in depth in this FES. The NEPA states one objective as to "achieve balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities."

The staff considers that the environmental costs for the Pitch Project are more than offset by the electrical power that will be produced from the uranium to be mined and milled. Inadequate electrical production would lower the standard of living and reduce life's amenities for a far greater population than that which will be minimally affected by project operation.

It is the opinion of the staff that no demonstrably better location for the mill exists in the Upper Gunnison Basin.

No regulatory authority exists to require a mining operator to supply ore to a common mill even if environmental advantages could be demonstrated. It is not evident that such advantages exist.

Gunnison County, Colorado

Board of
COUNTY COMMISSIONERS

GUNNISON, COLORADO

September 6, 1978

Mr. Jimmy Wilkins
Supervisor
Gunnison National Forest
P.O. Box 138
Delta, CO 81416

Re: Homestake Mining Company, Pitch Project, Draft Environmental Impact Statement

Dear Jimmy:

The Gunnison County Board of County Commissioners makes the follow'ng comments on the Homestake Mining Company Pitch Project Draft Environmental Impact Statement.

Sincerely,

By: [signature]
Kenneth Watters, Chairman
Board of County Commissioners

/pv
encl.

1. The alternative technique of tailings deposition, which would involve solidification of the tailings in cement (Alt. #6) is dismissed without adequate consideration. The EIS merely labels it "cost prohibitive" and says it is therefore impracticable. On the contrary, "cost prohibitive" is a relative term. Concluding that it is unusable because of cost, without a detailed financial analysis to establish that it actually is impossible for the mine to be developed if this cost is included, is unacceptable.

2. Inadequate cost-benefit analysis is a highly significant shortfall of this EIS. Economic impacts are not really assessed; they are treated in only a very general and vague way. Environmental impacts are not genuinely weighed against the economic value of the mine to the locale. Without substantiation, the EIS summarily asserts that the benefits of the project outweigh it's costs to the public. No detailed analysis is made, and significant environmental losses are dismissed as unimportant relative to the need for uranium.

3. The EIS is written and organized in a confusing manner. Language is highly technical and therefore unsuitable for interpretation by concerned lay people. Great expertise is required to decipher the implications of the analysis of water, air, radiological and revegetation problems. Information tends to be scattered thoughout the book, rather than grouped in one place for each subject. As material unacceptable for reading by the general public, it does not serve the function of providing for suitable public review of the proposed development.

It is apparent that the persons who formulated the EIS are highly skilled scientists who naturally present the information in their own accustomed but erudite language. Furthermore, what is apparent to them may seem a gross assumption to the public, which, lacking technical background, may not see where the flow of reasoning has gone. Perhaps the USFS could solve this problem by employing a writer to review the technical input and produce a readable, cohesive document, and to uncover such problems as discontinuous areas where conclusions are not sufficiently documented to show a clear, continuous line of thought.

Cumulative effects of various environmental hazards, such as increased radiation, water contamination and air pollution, are not clearly considered. It is difficult to discern, for example, the cumulative effects of various water pollution sources on the surrounding waterways.

4. An on-site inspector, not in the employ of the Homestake Mining Company, must be present continually during construction to see that all specifications of the tailings pond design are met, and during reclamation, to see that this also occurs as approved.

5. Steps for mitigating potential impacts are presented without due consideration to alternative methods. For example, there are various methods for cleaning effluent particles from exhaust air, but the technique which <u>will</u> be used is the only one presented in any given instance. The reader is unable to make a comparison.

6. The report states throughout that various effluents will be brought to state and federal standards, but conforming to standards may still mean degredation. (Note: what are the standards of air quality to be followed?) While pollution control regulations may dictate certain standards, actual environmental losses - degredation - must be considered in evaluating cost/benefit of the operation. This means that more stringent standards must be utilized in individual cases. This is necessary to make the licensing action consistent with environmental/economic tradeoffs beneficial to the public good.

Potential degredation must be considered for each effluent (i.e., water, gases, ash, particulates), and cumulatively. Possible mitigation measures to prevent degradation should be evaluated and relative costs considered.

RESPONSES

1. The staff regrets the superficial treatment of Alternative 6 in Sect. 10.4.3. Further discussion of this alternative has been added to the text. In summary, additional costs of $7 to $36 per ton of tailings would be required depending on whether chemical, asphalt, or cement fixation were used. Burial of the solid tailings would still be required to prevent radon release. In addition, relatively large quantities of cement (presently in short supply), asphalt (a petroleum product), or chemical fixants (energy intensive to produce) would be required. The environmental advantages are not balanced by the excess capital costs when other environmentally sound, cheaper alternatives are available. This is particularly true because no long-term data exist on potential leachability, and prudence would dictate lining the disposal impoundment with clay to prevent seepage, as mentioned in other alternatives.

2. Note that, as stated in Sect. 11.1, the primary benefit is the energy produced when the uranium product is used as nuclear fuel. Section 4.9 details the socioeconomic impacts on the affected communities (see State of Colorado comment 2), and the rest of Sect. 4 discusses the other expected impacts on the public and the environment. Section 6 discusses the monitoring and mitigating measures for environmental and public protection.

   No significant environmental losses are expected over the long term. No major socioeconomic impacts are forecast over the short term, and new employment opportunities will be created.

   The staff recognizes in Sect. 11 that no precise local cost-benefit balance is possible. Nevertheless, because the local costs and benefits are small compared to the benefit of energy production, the total benefits outweigh the costs.

   The staff is of the opinion that, even considering the net effect on the locale, the balance favors the economic benefits to the communities involved over the environmental costs, but this is unquantifiable in dollar values and is subjectively weighted by the attitudes and experiences of each observer.

3. The format and terminology in this document is essentially the same as that used by the NRC in environmental impact statements for a number of other uranium mill projects. Although the document was written primarily for review by Federal and other regulatory agencies in compliance with the requirements of NEPA, an effort was made to limit the length of the Statement and to simplify the contents to the maximum extent possible for ready understanding by the general public. The document was prepared by a multidisciplinary group and then edited to provide continuity. The Summary and Conclusions section is directed to those readers not able to interpret the detailed discussions in the text, and sufficient information is presented in the body of the document to provide a basis for judgment by an informed concerned layman.

   The cumulative effects of various potential environmental hazards are deliberately not considered because worst-case assumptions are usually used, and many mitigating measures not discussed in depth will be required by the FS and the 15 State of Colorado agencies involved in licensing and operation of the project. In the FES, note that new corrective measures have been added. This process will continue over the project lifetime. Please note that cumulative effects of exposure to radioactive materials were considered by comparing the integrated 50-year dose commitment to the whole body and critical organs with the present NRC and future EPA radiation protection standards (Table 4.4). Concentrations of airborne contaminants will meet Federal and State standards and will not affect the offsite environment. Potential water pollution will not exceed Federal and State standards offsite.

In situations where problems are expected, contingencies should be planned before serious difficulty arises. For example:

(7.) 1. Tailings pond seepage water will be monitored; if degredation of the waterways occurs, Homestake plans on intercepting the seepage and returning it to the tailings ponds. How much damage could occur before the seepage problem is corrected? The process of engineering and constructing a seepage return system could take quite awhile, depending upon, among other things, company responsiveness. Water quality in Marshall and Indian Creeks could be severely impacted by then.

Alternative #6 must be studied further, as well as #10. Steps should be taken beforehand to handle the seepage - trenches and pumps should be constructed before use. The goal should be zero discharge.

The seepage from the tailings ponds is mentioned a number of time during the report (estimated at between 50-60 gpm, or 65 acre feet per year), yet a possible alternative to construction which might prevent that seepage is rejected as "cost prohibitive" without proof.

(8.) The EIS-proposed settling ponds would get coarser particles, but may not get finer sand, silt, and clay particles. It concludes that ponds "may not be sufficient to adequately minimize the environmental degredation in Indian Creek," and says this may also effect Marshall Creek.

The document admits that additional measures may be necessary, but, again, lets them wait til damage is visible. This is unacceptable - the USFS and NRC should not just go along with the applicant's convenience, but should protect public interest in advance of damage.

(9.) 2. The EIS states that, regarding mine site air particulate levels, "estimates indicate that state and federal air quality standards occasionally could be exceeded." Mine operators expect this to be a "rare" occurance. However, it should not occur at all because it will degrade ambient air quality. What else could a mining company do to prevent it, ahead of time before impacts are felt (as opposed to monitoring and then taking action)? Should the licensing action be given if air quality emissions are expected, from the beginning, to not meet federal and state standards?

(10.) 3. The EIS estimates that 10% of the precipitation at waste disposal areas might infiltrate through waste overburden dumps (30-38 acre feet per year) which "could potentially leach and transport toxic and nontoxic materials into the ground water. Much of this contaminated ground water would probably discharge into Indian Creek ...:" How to minimize problems? Will water be entering below applicant's collection ponds and potential future treatment plant? If so, this could be a major mess, considering tailings pond seepage and other cumulative problems.

(11.) 4. "Gaseous effluents from the mill operation may combine with atmospheric moisture forming products that subsequently deposit on and adversely effect vegetation. The magnitude of this potential effect is not known." This problem should be studied in greater detail.

Potentially bad situations should be dealt with ahead of time; the time lag between the identification of the problem and corrective action could leave serious results.

Best possible technology should be employed wherever practicable. This requires carefull assessment of all possible technolgoy by the USFS and NRC, not just by the applicant.

4. Normal procedure calls for several inspections by State and Federal authorities to be conducted during construction of the tailings impoundment. Should the Colorado Department of Health decide that a full-time onsite inspector is needed, this could be made a condition of the Radioactive Materials License. The regulatory agencies will maintain surveillance to see that all licensing requirements are met.

5. The State of Colorado Department of Health, Radiation and Hazardous Wastes Control Division, has the responsibility for determining that company-proposed equipment will result in releases as low as reasonably achievable. Equipment selected by the applicant is considered by the staff to be consistent with the state of the art and acceptable for the purpose intended.

6. Air quality standards are given in Table 2.1, proposed Colorado water quality standards are listed in Appendix I, and pertinent radiation protection standards are given in Table 4.4. If, as expected, these standards are met, there should be no noticeable offsite effects. It should be pointed out that regulations promulgated by the USEPA* require any major source of air pollutants to comply with the Prevention of Significant Deterioration (PSD) of air quality. The purpose of these regulations is to keep clean air clean, and the primary focus is on limiting new emissions of sulfur oxides and particulate matter. Should the release of either of these materials exceed permissible limits, the applicant will be required to modify his system and/or operations to bring the level of emissions into compliance with PSD regulations.

7. Equipment for seepage water return will be operable before mill operation begins. Alternative 6 is discussed further in comment 1. Other alternatives to potentially reduce seepage have been added to the text (see Alternatives 10, 11, and 12). Recent studies indicate that the actual seepage rate is expected to be about 27 to 55 m^3/day (5 to 10 gpm) rather than 270 to 330 m^3/day (50 to 60 gpm). (See response to State of Colorado comment 15.)

8. The staff expects the new sediment pond to minimize the sediment load in Indian Creek. The applicant must meet the requirements of the NPDES permit to continue to operate. It is expected that measures necessary to meet permit requirements will be taken by the applicant.

9. The staff expects air quality standards to be met. Fugitive dust control is sometimes difficult if unforeseen weather conditions occur. This possibility can cause standards to be exceeded in untouched natural environments.

10. The Colorado School of Mines Research Institute has conducted leaching experiments on overburden and low-grade waste from the project. It was concluded from these studies that waste dump water quality would not be significantly different from that presently flowing in Indian Creek.

11. Such an effect would only be present within close proximity to the mill. Any such effects would not result in an environmental insult of any great magnitude.

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* *Fed. Regist.* 43(118): 26380-26410 (1978) and 44(11): 3274-3285 (1979).

(12.) While tailings pond breakdowns and other accidents are considered, various emergency plans of action and backup systems are not presented. (The EIS proposes to simply shovel all the tailings spilled back into the pond, although the soil is expected to be 1.6 inches deep over a mile down Marshall Creek). This is what is called a "last ditch" effort.

(13.) Growth figures for Gunnison County and for the City of Gunnison are unreasonably low - the EIS anticipates that the City of Gunnison will be growing at a rate of 1.5% per year in the near future. The growth rate between 1970 and 1976 was 3.5% to 5%. This new figure for anticipated increases is absurd considering such major developments as Homestake's Pitch Project, AMAX's molybdenum mine, and ski area expansion.

The EIS expects Gunnison County (population 8,788) to reach estimated maximum of 9,757 in 1980; 10,721 in 1985; and 11,936 in 1990. On the contrary, all projections for populations increase due to the AMAX development alone show nearly a doubling of the County population in 1985.

These figures should all be reconsidered.

Major problems with the radiological analysis include:

1. There is no calculation of maximum annual dose to workers on the site. Dr. Richard C. Wingerson (Ph.D., nuclear physics; alternate on the Gunnison County Planning Commission) calculated the following exposures using simple conversions of figures provided in the EIS:

* Tailing pond	slime area	125-250 rems/yr.
	sands area	40-80 rems/yr.
Mine pit	high grade ore area	11-22 rems/yr.
	low grade ore area	4.5-9.0 rems/yr.
* Tailings under water		negligible
Tailings wet		1-2 rems/yr.
Tailings dry		45-90 rems/yr.

(14.)

* These two sets of estimates are based on figures in two different sections of the EIS.

This is within the one-ten rem range which has been shown to have carcinogenic effects. Dr. Wingerson reports that exposure between 1-10 rem/yr. over long periods has been correlated to increased cancer rates and is considered to be the cause.

The conclusion is that there is a very serious health hazard to mine employees, and that the EIS grossly underestimates the exposure to people by not including the Homestake work force.

2. No explanation of possible likely effects of radiation exposure is included in the body of the report. Even if anticipated levels are below a dangerous level, implications of radiation exposure should be discussed. Also, what is average dose at sea level not near uranium ore deposit? Numbers such as these must be given meaning to the average reader by relating them to standard situations and levels which would cause harmful effects on humans.

3. Analysis is terribly inconsistent and confusing. Using consistent units and defining terms would alleviate much of the difficulty.

12. The carefully engineered tailings impoundment system has been designed specifically to prevent the inadvertent release of tailings due to failure of the tailings dam. On the basis of the design criteria used, the probability of a tailings release due to a natural disaster such as a flood or even a major earthquake is small. Should such an event occur, however, only a portion of the impounded tailings would be expected to be released. In the event of a release, action would be taken as soon as possible to construct embankments for containing the material, repairs would be effected, and the released material would be returned to the impoundment area. The tailings release postulated in Sect. 5.1.2.3 assumes a worst-case condition with no containment of the released materials. The historical data in Sect. 5 of the DES is for old nonengineered impoundments. This section has been updated and clarified.

13. Growth figures used by the staff are considered under present conditions. Conjectural projects that are not yet in the commitment stage can not be used in forecasting with any degree of accuracy.

14. See response to comment 3 of Gunnison County Planning Commission, September 13, 1978.

We appreciated the opportunity to comment on this Environmental Impact Statement.

Sincerely,

GUNNISON COUNTY BOARD OF COMMISSIONERS

By: Kenneth Watters

Kenneth Watters, Chairman

County Courthouse
Phone (303) 655-2321
or (303) 655-2231

Saguache County
LAND USE DEPARTMENT
P. O. Box 176
Saguache, Colorado 81149

September 11, 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
P. O. Box 138
Delta, Colo. 81416

Dear Mr. Wilkins:

I, once again, thank you for the opportunity to comment on Homestake Mining Company's Pitch Project Proposal.

The last two years of this project's review have been a tremendous learning experience for Saguache County. We have had to grapple with technological questions and areas of expertise that we were, and still are, in many cases totally incapable of dealing with. To the best of our abilities, we have attempted to address each of the environmental, technical and socio-economic questions and resolve in our minds that safe and acceptable solutions will be pursued and achieved by the Company and the various regulatory agencies involved.

Saguache County has found that many of its decisions, such as the site designation of the overburden and tailings disposal areas, are being supported by the Draft Environmental Statement. The recommendations and conditions found in the Draft E.S. indicate, to Saguache County and its residents, that acceptable sites and procedures can and have been found to accommodate Homestake Mining Co. and protect the citizens and environment of Saguache County.

Naturally, along with our confidence in the Company's desire to protect our interest, there are also questions that we feel should be addressed in the Final Environmental Statement. These comments, and questions, are as follows:

1. (2.4.1.4) Were any wells in the Sargents community tested for baseline data?

2. (2.9 second paragraph) This paragraph states "The natural concentration of radon in the Homestake Mining Company Pitch

RESPONSES

1. Two wells were sampled in Sargents for baseline data. One well was shallow (originating from a spring), and one well was deep [approximately 15 m (49 ft)].

2. The 500-1000 millirems per year dose listed under the section "Natural Environmental Background" is the estimated background dose to the bronchial epithelium from radon (and daughters) emanating from the project site area prior to any Homestake operation. The doses to the bronchial epithelium in Table 4.3 are the estimated doses from radon (and daughters) released in the airborne effluents of the actual operating mill and mine and are thus the doses directly attributable to the project.

Project area is in the range of 500 to 1000 pCi/m^3 based on the concentration of radium - 226 in the local soil. Exposure to this concentration on a continuous basis would result in a dose of 500 to 1000 millirems/year to the segmented bronchi."

Table 4.3 and 4.4 indicate that the dose to the broncial epithelium will be only 1.9 millirems per year, and the lung dose will be 0.30 millirems per year. Would you please explain why the difference in figures. Are these figures comparable or do I misunderstand the meaning of these figures?

3. (2.10.2.1) The statement is made that the 1975 Saguache County population of 4.100 was evenly distributed over the County. When 1,700 people live in Center, 700 live in Saguache and only 100 to 150 people live in the entire area west of the Continental Divide, I feel that this statement is grossly misleading, at best.

3. The text has been changed. The staff appreciates the information.

4. (2.10.5.1) The last paragraph of Section 2.10.5.1, entitled- Adequacy of Planning- found on page 2.43 of the E.S. The paragraph states, "The County is following a Master Plan for land use planning; however, the Saguache County Land Use Administrator has reported that the Pitch Project does not conflict with this Master Plan. (Priv. Com. M.D. 24, Feb. 78). For the record and the FINAL E.S., I would like to correct this statement because I did not make it. I recall the 24, Feb. communique, but I stated that Saguache County was only in the formative stages of developing a County Master Plan, and that as of that discussion, I felt that any plan developed by the County would not conflict with the Pitch Project Proposal. This is still the case.

4. The text has been changed.

5. (3.3.1 and 4.3.2.2) 48 to 64 acre feet seems to me to be quite a bit of water to be seeping from the tailings impoundment facility. If this estimate does not consider the sodium ion sealing effects, how much of a reduction in seepage can be expected? How fast and in which direction will this water travel through the soil, and what level of toxicity will this water have?

5. Tests completed subsequent to issuance of the DES indicate a reduction in calculated seepage to less than 10% of these values when the clays are exposed to tailings solution. Seepage would travel down Hale Gulch and mix with other groundwater in the alluvium. Most contaminated seepage would be returned to the tailings impoundment. It is unlikely that surface-water contamination greater than that permitted by Federal and State standards will occur. The seepage is not "toxic" to people in the "poison" sense but exceeds Federal and State standards based on long-term ingestion. (See answer to State of Colorado comment 15.)

6. (3.3.8) Two millirens/hour as the dose at the edge of the yellowcake transport beds sounds extremely high when future EPA Standards recommend a maximum dose of 25 millirems per year. How do per hour and per year dose estimates correlate and what will the long term effects to loading and transporting personnel be during a year of operation?

6. Doses decrease rapidly with distance from the radiation source. The future EPA standard applies only to public exposure, and because the truck is both loaded and unloaded in controlled areas, no significant public exposure is likely. Occupational exposures are measured and controlled to be as low as reasonably achievable. Only about 20 yellow cake shipments per year are expected. A truck containing 45 drums can be loaded in less than 2 hr. The staff estimates an individual occupational exposure from yellow cake loading to be less than 50 millirems per year.

7. (4.8.4 and 4.8.6 and 7.8) The total body dose attributed to background radiation is shown to be .0023 millirems per year in tables 4.3 and 4.4.

Sections 4.8.1 and 2.9 state that total body doses in the Pitch Project Area will be 230 millirems per year. Which figures are correct? If the 230 millirem per year figure is correct, then background radiation already exceeds the EPA Standards 40CFR Part 90, of 25 millirems per year. If these standards are already

7. The dose referred to (0.0023 millirem to the total body) is the dose to the total body via the inhalation pathway from the airborne effluents released during a one-year operation of the plant. It is not the dose from natural background. The 230 millirems per year dose given in Sect. 2.9 (Natural Environmental Background) is the average total-body dose from all sources of natural background plus that from medical exposures, such as x rays. Allowable limits such as those shown for future EPA standards (40 CFR Part 190) are for the exposures attributable to plant operations and are in addition to the exposure from natural background, which will vary from location to location.

exceeded, how can any additions to the background radiation be justified?

Saguache County is in complete support of the Pitch Project. At this time, I can honestly say that I have not heard a descenting opinion from any county resident. I base this statement on my personal attendance of the MLRB Hearings, Saguache County's Public Hearing, the various informal tours and hearings sponsored by the MLRB, as well as the question and answer sessions sponsored by the N.F.S.

Saguache County strongly supports the pre-operational monitoring program, the construction techniques specified in the E.S. and the operational monitoring program outlined in table G.4 on page G-13 of the E.S..

If concrete evidence can be presented that describes specific hazards or environmental problems which will occur or have occurred as a result of this project, then I am certain that the Board of County Commissioners and the citizens of Saguache County would reassess their thinking. Until such diffinitive statements can be made, we will remain confident that our questions can be answered, and we concur with section 11.4 of the E.S. and urge that the indicated action be to grant a C.D.H. Radioactive Materials License to construct and operate a uranium processing mill and such other licenses and approvals as are required for mine and mill operation.

Thank you again for your attention.

Sincerely,

Mark Daily

Mark Daily

MD/llc

cc:
Mr. Jeff Thatcher
Mr. Keith Edwards

County Commissioners
James C. Wilhite, Chairman
Keith Edwards
Ernest Bloxsom

County Commissioners
Saguache County
P.O. Box 356
Saguache, Colorado 81149
Phone 655-2231

County Attorney
Robert Gettes
County Administrator
Mel Stuart

August 3, 1978

To: Colorado State Health Department, Nuclear Regulatory Commission and Gunnison National Forest members.

From: Keith Edwards, Chairman Saguache County Board of Commissioners

Regarding: Homestake Mining Company's Draft Environmental Statement and Pitch Project Review

Dear Members of the Panel, Ladies and Gentlemen,

It has been almost two years since Homestake Mining Company has submitted their intentions to reopen the Pitch Mine in Saguache County. It has been over a year since the first hearing was held before the Mined Land Reclamation Board. Now we are right back where we were a year ago and, in our opinion, no new developments have materially changed the original permit plan. We need energy supplies and we feel that it is safer to mill here than any other location. We hope that the special interests of The Open Space Council, the Attorney Generals Office, and certain Mined Land Reclamation Board members have been thoroughly scrutinized so we can proceed ahead with this project.

My main question or request to this panel today is a plea for your assurance that needless and questionable delays will not become a part of this stage of the review process. As a County Commissioner for Saguache County, I am aware that every development hasits environmental trade-off's. However, I believe that the procedures and conditions outlined in the Draft Environmental Statement for this project will insure the utmost sophistication in mining, milling and reclamation procedures. I further believe that these procedures, when implemented conscientiously will provide the most satisfactory trade-off between environmental distrubance and production of this valuable natural resource.

I must remind you again of the importance of this project to the people of Saguache County and the surrounding area. The average annual income is only $5,000.00 in Saguache County. In 1971 we had the second highest unemployment rate in the State, 12.3%. Only 62% of the employed males of the county have year around work. We need help and it appears to me that this project is just what this county needs to help stabalize our tax base and provide employment opportunities.

No response is required.

County Commissioners
James C. Wilhite, Chairman
Keith Edwards
Ernest Bloxsom

County Commissioners
Saguache County
P.O. Box 356
Saguache, Colorado 81149
Phone 655-2231

County Attorney
Robert Crites
County Administrator
Mel Stuart

Thank you for your attention and I trust that you will do your utmost to honor Saguache County's needs and desires.

Respectfully submitted,

Keith Edwards

Keith Edwards, Chairman
Saguache County Board of Commissioners

Gunnison County CHAMBER OF COMMERCE
500 East Tomichi Avenue GUNNISON, COLORADO 81230 Phone: (303) 641-1501
Charles A. Page
Exec. Vice-Pres.

No response is required.

July 31, 1978

Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
Box 138
Delta, Colo. 81416

Dear Jimmy:

The Board of Directors of the Gunnison County Chamber of Commerce is on record as favoring Homestake Mining Company's Pitch Project near Sargents, Colorado. That policy has not changed in the meantime.

As individuals and as an organization, we have followed the progress of Homestake, have read the Draft Environmental Statement and other reports, many have visited the mine and mill site, seen and heard visual and audio programs related to the progressive studies, plans and impact the project might have on the social, economic and environmental factors of this area.

With the tremendous number of permits and other requirements placed on Homestake, we believe the company will comply in every way.

There is no question about the economic impact on Saguache, Chaffee and Gunnison Counties. This certainly should not be the number one consideration, but must be given equal value with all other factors. Even though the site location is within a federal forest, and therefore of national concern, our directors believe those residents of the three counties should have a greater voice in any final determination.

Respectfully Submitted:

Charles A. Page

Charles A. Page, Manager
For the Board of Directors
Gunnison County Chamber of Commerce

cc: Robert Wright, Pres.
Jeff Thatcher, Homestake
Mining Co.

Members of the Board

ROBERT E. WRIGHT, President
Russell, Angelo & Wright, Attys.

E. J. MILLER, Vice President
Miller's

CHARLES PETERSON, Treasurer
Self-Employed

[illegible]
[illegible]

GARNET MANNING
Paul Manning Realtor

THOMAS J. MARSHALL
Pioneer Savings & Loan Assn.

WILLIAM [illegible]
[illegible]

ROBERT J. PATTERSON
Certified Public Accountant

REED PERRY
Yale, Yale & Perry, CPAs

THOMAS J. [illegible]
Mario's Pizzeria

TERRY SARGENT
Western State Aviation

BILL SWEITZER
Sweitzer Oil Co.

COSC MINING WORKSHOP
2239 E. Colfax Avenue
Denver, Colorado 80206
5 September 1978

Mr. Jimmy Wilkins, Supervisor
Gunnison National Forest
U. S. Forest Service
P. O. Box 138
Delta, Colorado 81416

SUBJECT: Draft Environmental Impact Statement - Pitch Project

Dear Mr. Wilkins:

We would like to express the following concerns pertaining to the Pitch Project and the Draft Environmental Impact Statement:

1) The wilderness qualities of the Cochetopa Hill and Chipeta Roadless Areas may be substantially impacted by increased noise levels, off-road vehicular activities, and noticeable physical disturbances caused by the Project.

2) Although Section 5.1 alludes to the occupational health hazards of low-level radiation, the DEIS does not adequately address this problem. Even if radiological exposure is kept below "permissable" levels, what are the probabilities that Project employees will contract the various forms of cancer, leukemia, and atherosclerosis which are associated with the inhalation of radioactive dust particles? We believe that they are potentially high. What steps, if any, will be taken to warn employees of the long-term dangers of low-level radiation? Who will bear the burden of the related occupational health costs?

3) Sections 5.1.2.1 and 2 states that radiological releases will occur as a result of scrubber failure, disruption of the milling circuit, and leaks in the tailings distribution and decant return systems. Section 4.3.1.2 further states that there may be increased levels of toxic substances below the catchment areas. What will be the cumulative impact of these emissions; and what actions will be taken if there is a large-scale release of hazardous materials? We particularly are concerned about the consequences of major flooding or dam failure (Section 5.1.2.3).

4) What problems will result from the transpiration of toxic substances by plant and animal life as discussed in Sections 4.3.1.1 and 4.6?

5) The Project site will not be restored to its original contour: i.e. the pit, highwalls, access roads, and settling impoundment areas will remain. We propose that the pit be reclaimed with the tailings (Alternative 6) even if it is expensive, and that the access roads be closed and revegetated. If Homestake makes a mess, it should clean it up. What could be more logical, reasonable, and simple? There also is no substantial evidence that the site successfully can be revegetated. The Urad Mine is the only instance which we know of where a serious attempt is being made to reclaim a high altitude hard rock mining area, and the results are questionable so far.

RESPONSES

1. The Cochetopa Hill and Chipeta roadless areas will not be substantially affected by the project. However, if unforeseen events were to occur and result in the degradation of the wilderness attributes of these areas, the net result would be to remove the affected area from the inventory because the 1872 Mining Law provides any citizen the right to develop the nation's mineral resources on Federal lands of this type.

   The RARE II FES published January 4, 1979, allocated these two roadless areas to be managed for multiple uses other than wilderness. However, this allocation will not be implemented until at least 90 days following January 15, 1979.

2. Occupational radiological hazards will be evaluated in the Homestake Mining Company safety analysis report. Detailed conditions will be included in the Radioactive Materials License issued by the Colorado Department of Health. These will cover area and personnel monitoring, action levels, decontamination procedures, etc., to keep all occupational exposures "as low as is reasonably achievable." The Mine Safety and Health Administration and Colorado Division of Mines will also be involved. (See response to Gunnison Planning Commission comment 3 for discussion of risks associated with occupational doses.)

3. The potential effects of scrubber failure are evaluated in the text. Leaks in the tailings distribution and decant system will drain into the tailings impoundment. The NPDES permit requirements will limit toxic discharge below the catchment area. No cumulative effects are expected. Section 5.1.2.3 has been revised to indicate that the tailings dam has been designed to withstand a major earthquake. The impoundment is designed and operated to contain runoff from the maximum precipitation event. No large-scale releases are probable.

4. The referenced sections do not refer to "transpiration of toxic substances by plant and animal life." There is an indication that some of the water from the spring discharge in the vicinity of the mine is lost through transpiration by plants.

5. Restoration of the Project area to its original condition is not considered to be the goal of the proposed reclamation plan. The realistic goal is to grade and stabilize the site to attain compatibility with contours of the surrounding area. Because of the highly fractured nature of the pit area, Alternative 6, which has been described in greater detail in the FES, involves a greater potential for groundwater contamination than several of the other alternative management plans. As a consequence, the staff does not consider the proposal to reclaim the mined-out pit with tailings an acceptable alternative. Attempts to revegetate the high-altitude URAD mine site are being conducted on essentially sterile broken rock lying on top of molybdenum tailings. The results of studies on revegetation test plots at the Pitch Project site indicate that revegetation of the area is possible, and improved revegetation procedures are being developed. (See Appendix J for further details.)

6) A natural valley together with its subecosystem will be destroyed. This is not an isolated situation because mining, highway construction, and water and recreational development are taking their toll of valleys all over Colorado and the West. Valleys increasingly are in short supply, and the DEIS should relate the loss of the Marshall Creek watershed to the loss of valleys elsewhere.

7) We believe that Homestake's environmental record is sufficiently dubious to warrant examination and discussion.

8) Ground water regime and stream flow measurements are incomplete (Sections 2.4.1.1 and 2.4.2.2).

9) Part of the Project area geologically is unstable (Section 2.5.2.3). Will geological instability cause post-operational problems possibly leading to erosion, slides, and dam failures which have occurred elsehwere in the region?

10) Is it possible that the size of the Project will be expanded owing to the location of additional ore reserves?

11) Mining may decimate the elk herd which winters in the Project area (Section 2.8.1.1).

12) Will the operator be required to pay necessary government supervisory, enforcement, and monitoring costs?

13) Increased sedimentation and trace element concentrations probably will be detrimental to the aquatic biota of Indian Creek and possibly Marshall Creek (Section 4.7.1.2).

14) The socio-economic impacts discussed in the DEIS do not account for the multiplier effect. What will be the cumulative socio-economic impacts on Gunnison County of both the Pitch and Mount Emmons Projects not to mention that there may be others?

15) There is merited controversy surrounding the entire nuclear fuel cycle: i.e. occupational health hazards, nuclear power plant safety and reliability, and waste disposal. All aspects of the nuclear fuel cycle should be exhaustively evaluated before additional committments are made to a questionable technology.

16) We are leery of such catch words and phrases as "expected", "minimize", and "reasonably achievable." We feel that substantiative guarantees are in order, given the dangers which are involved.

17) Finally, the response period is too short for us to adequately comment on some of the technical questions which are discussed in the DEIS. In view of the longevity of the Project, its serious implications, and our limited resources, we prefer more time to solicit and provide more expert testimony.

6. The existing valley will essentially be replaced by the reclaimed mine pit. No net loss to the Marshall Creek watershed will exist after reclamation of the site is completed.

7. The applicant has provided details of past compliance with environmental laws and regulations to the Colorado Department of Health for consideration in negotiating the reclamation and long-term surety agreements for the project. These agreements must be completed before a license can be issued.

8. Subsequent to completion of the DES, additional data and analyses of the hydrogeologic regime at the project site have been developed. The results of these findings are discussed in responses to State of Colorado comment 20 and EPA comment 3.

9. No. The proposed locations for the mill and tailings disposal facilities were selected only after considering all potential geologic hazards.

10. The present size of the project is based on the anticipated discovery of additional ore reserves.

11. See responses to DOI comments 3 and 4, August 31, 1978.

12. State of Colorado supervisory and enforcement costs during project operation are borne by the State. The monitoring program is conducted by the applicant at company expense with independent double-check monitoring by the State at State expense.

Postoperational monitoring and maintenance costs are provided for by the long-term surety agreement that must be negotiated between the Colorado Department of Health and Homestake Mining Company before the license is issued.

13. NPDES permit requirements are set to protect both the public and aquatic biota.

14. The staff considers the potential socioeconomic impacts to be properly assessed (see State of Colorado comment 2). As stated in Sect. 4.9, the impacts discussed in the FES apply only to the Homestake Mining Company Pitch Project. (See response to Ralph E. Clark comment 4.)

15. All aspects of the nuclear fuel cycle are under continuing evaluation. A detailed dissertation on the studies of potential nuclear fuel cycle problems is not considered as within the scope of this specific FES. Uranium from the Pitch Project will be needed for reactors already under construction.

16. The regulatory process provides Federal, State, and local agencies the authority to control construction, operation, and reclamation. The conditions in permits and licenses provide for substantive guarantees of performance.

17. The NEPA states that 45 days be allowed for review of draft environmental statements.

The DEIS raises more questions than it answers. Not withstanding its inadequacies, it raises sufficient doubts in our mind that we oppose the Pitch Project on a variety of grounds.

Sincerely,

David McCargo, Jr.

High Country Citizens Alliance

P.O. Box 1066 Crested Butte, Colorado 81224

September 11, 1978

Mr. Jimmy R. Wilkins
USDA Forest Service
P.O. Box 138
11th and Main Street
Delta, Colorado 81416

Dear Mr. Wilkins:

(1.) My study of the Draft Environmental Statement for the Homestake Mining Company's PITCH PROJECT, USDA-FS-R2-DES(ADM) FY-78-03, convinces me that it is inadequate to serve its legally intended purpose of improving decision making in the management of public lands. As written, the draft EIS is a fair description of what Homestake proposes to do. At least some of the anticipated adverse impacts are analyzed in considerable detail. Furthermore, a number of alternatives are addressed which have the potential for mitigating adverse impacts.

The problem with the analysis is that the alternatives are considered in only the most superficial way. Essentially all adverse impacts are in the end judged to be acceptable. The one unacceptable impact seems to be a production cost increase for Homestake. It is my understanding that within the bounds specified by law and regulations, it is the duty of Federal land managers to exercise their authority for the greater public good. It is generally accepted that such management may from time to time impose hardships on particular individuals or groups. The attitude in the Homestake EIS seems to be that hardships to the public are acceptable, but hardships to the company are not. The ultimate hardship to the company would be for the costs of mitigating adverse impacts to be so high that profitable operation would be impossible. Under the law this is not necessarily an unreasonable imposition. It could merely mean that the uranium market is too weak to support a new mine meeting reasonable standards, and that mining should be postponed until the market or technological advances make mining practicable.

In the paragraphs which follow, I will make specific criticisms of various sections of the EIS - focusing on their failure to emphasize the greater public good.

(2.) The greatest environmental hazard posed by the Pitch Project is radioactive and mineral contamination of ground water by seepage from the tailings. The estimated seepage is 48 to 64 acre feet per year (sec 4.3.2.2). Significant addition of suspended solids to Marshall Creek and Indian Creek is also expected to degrade the quality of these streams (sec 4.3.3). Furthermore there is only a 2 out of 3 chance that the tailings dam will hold for the 20 years of mining operation (sec 5.1.2.3).

RESPONSES

1. See response to Gunnison County Planning Commission comments 1 and 2.

2. See response to Gunnison County Planning Commission comment 2.

Homestake is to deal with watershed problems as they arise (sec 4.7.3) which virtually guarantees major damage to Indian Creek, Marshall Creek, and perhaps Tomichi Creek. The Forest Service evidently considers this potential impact so minor as not even to be worthy of mention in their Benefit-Cost summary (sec 11.3). They also consider this impact so minor as to render unnecessary such mitigating measures as dewatering the tailings (sec 10.4.2 Alternative 10), solidification of tailings (sec 10.4.2 Alternative 6), or location of mill and tailings in a safer area (sec 10.2.3) where it could be used later to serve other uranium mining operations in the upper Gunnison Basin. It is interesting to note that in Table 10.1 an alternative is considered to treat tailings seepage before discharging to a local waterway. This alternative is rejected because "Technology not available to allow seepage water treatment sufficient to attain water which is environmentally and legally acceptable for release"; but the Forest Service seems to feel it is all right to let this untreatable waste go into the water table as long as no one sees it.

(3.) The analysis considers in great detail the hazard to the off site public (sec 4.8, Appendix E, Appendix F, Appendix G). The hazard here does seem to be minimal except possibly if the tailings dam should break or if the tailings seepage fails to vanish as assumed. The largest radiation hazard, however, will be to the workers. This is dismissed in one small paragraph as being acceptable in other mines (sec 4.8.7). No numbers are given for the actual doses anticipated, or for the cancer deaths expected. Despite the absence of any supporting data or computations for workers comparable to that for the off site public, the Forest Service concludes that "The radiologic impact of the Homestake mine and mill is low." (sec 11.3) Compared to what?

3. See response to Gunnison County Planning Commission comment 3.

(4.) The third significant impact will be socioeconomic (sec 4.9 pages 4-19 to 4-24). This lengthly analysis has two major defects. Repeated reference is made to Homestake's intention to hire locally thereby minimizing impacts on housing, schools, and public services. Since Homestake will be paying wages higher than the local average, they certainly should be able to hire locally; but Gunnison County has low unemployment and significant growth already. Thus new workers will have to be attracted to replace the local hiring, and wages throughout the county will probably be forced up thereby hurting other segments of the economy. Local hiring will thus not reduce impact problems but will probably make them worse. The second major defect is in the computation of social costs of increased population based on historical per capita budgets. The error here arises because the historical budgets reflect mainly operation and maintenance costs of existing infrastructure, whereas new growth requires additional capital investment to enlarge the infrastructure. These costs are not considered, but must be for a fair evaluation of whether the new growth will be paying its way. The adverse impacts of sudden growth (the boom town syndrome) are well known. Although the Homestake impact will certainly not be so large as to be called a boom, its impact should not be understated by erroneous analysis or be brushed off as is done in the summary (sec 11.2).

4. See response to Gunnison County Planning Commission comment 4.

5. All of the costs and adverse impacts of the Pitch Project must be weighed against its potential benefits. The most significant benefit is judged to be satisfaction of the national need for uranium and the energy it provides (sec 1.7 and sec 11.3). This need is supported in section 10.6.1 primarily by reference to "Project Independence" a document published in 1974 and now largely discredited because of its heavy content of wishful thinking. The facts are that major expansion of the nuclear power industry is not occurring, and projections of uranium needs have been revised downward every year since 1974. Before a final decision is made on the issuance of a Radioactive Materials License for the Pitch Project, the need should be reviewed in the light of current data, and the conclusions in sections 10.7 and 11.4 should be reevaluated.

It seems to me that in evaluating the Pitch Project we need to look at two possibilities. If there is no pressing national need for more uranium and the market will not support the costs of full mitigation of adverse impacts, then the Benefit-Cost analysis ends up all on the cost side. If, on the other hand, there is a growing national need for uranium, then more than just the Pitch Project will be needed. We should then be planning for several mines in the upper Gunnison basin supplying a common mill and tailings operation, and Hale Gulch at the upper end of an important watershed and drainage basin is not the right location. Thus whether there is a national need for uranium or not, the mill and tailings operation as now proposed is not in the public interest.

Sincerely,

Dick Wingerson
Chairman, Technical Committee

DW/krf

Approved for the Board of Directors

Chuck Malick
President

5. See response to Gunnison County Planning Commission comment 6.

Environmental
Defense
Fund

1657 Pennsylvania St., Denver, Colo. 80203 (303) 831-7559

September 13, 1978

Jimmy Wilkins
Forest Supervisor
U.S. Forest Service
P.O. Box 138
Delta, Colorado 81416

Re: Draft Environmental Statement for Homestake Mining Company's Pitch Project

Dear Mr. Wilkins:

The Environmental Defense Fund (EDF) has been concerned for sometime over the lack of adequate assessment of the environmental impacts of Homestake's Pitch Project. Such concern was formalized July 11, 1977 when EDF requested the U.S. Forest Service and the Nuclear Regulatory Commission to prepare an adequate Environmental Impact Statement (EIS) on the Project. 1/ In our letter we stated that an EIS is not only legally required but is needed to help ensure that meaningful consideration of environmental factors is part of the decisionmaking process. We also stated that the EAR that was prepared by the U.S. Forest Service 2/ failed to provide EIS-adequate data, as it contained serious defects and omissions and therefore did not provide decisionmakers, relevant governmental bodies, and the public with adequate information upon which to review the proposal and base decisions.

In reviewing the draft EIS (DEIS), we found it wholly inadequate and have concluded that it does not meet the requirements of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. §§ 4321 et seq., and implementing regulations. The DEIS fails completely to provide the adequate

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1/ Letter from Mastbaum, Pring, and El-Ashry for EDF to McGuire (USFS) and Smith (NRC), dated July 11, 1977.

2/ U.S. Forest Service, Environmental Analysis Report, Pitch Project, Sagnache County, Colorado, for Homestake Mining Company, February 18, 1977.

data essential to any assessment of project impacts, and thus renders the discussion of alternatives virtually meaningless. Any intelligent choice among alternatives must be based on an understanding of their varying impacts and feasible mitigation measures, and this understanding cannot be gleaned from the DEIS; entirely too much of the "information" presented is based on speculation and guesswork.

It is apparent that this DEIS is little more than a pro forma attempt to comply with NEPA's procedural requirements while virtually ignoring the Act's clear substantive mandate to improve government decisionmaking. The myriad inadequacies of the DEIS have led us to conclude that a new and thoroughly revised draft environmental impact statement should be prepared and circulated for review and comment.

In the following comments, we will address primarily the statement's discussion of project impacts on water resources. We wish to emphasize, however, that the DEIS is inadequate in virtually every area and must be redone if it is to comply with NEPA and other applicable laws and regulations.

The DEIS's cavalier handling of the crucial concern of impacts on water resources is evident on its face. For example, the DEIS states that "information about the groundwater regime at the site is incomplete at this time." (p. 2-6) It further states that "it is . . . concluded that aquifer and groundwater flow characteristics are inadequately known to predict accurately the impacts to groundwater that may occur during and after the mining operation." (p. 6-4) Yet, on the following page the DEIS speculates that "except for potential seepage, no effects on groundwater are expected." (p. 6-5)

In our opinion, one of the most essential components of long-term environmental effects from mining and milling operations is the water resource system. This system has been neglected in this impact statement insofar as quantitative analysis is concerned. The DEIS demonstrates superficial investigations which have culminated in the assertion that "no effects on groundwater are expected." (p. 6-5) In order to protect the valuable water resources of this region, a change in preplanning concepts, mining techniques, and post mining practices should take place. Preplanning must recognize that streams and ground water aquifers are an integral part of the total mining activity with a reclamation priority equal to that of land contouring and revegetation.

We also believe that the analyses of certain key issues and concerns are superficial in that the commitments by the company are expressed as intentions to take a proper course of action when, and if, a given problem occurs. For example, in relation to ground water mitigation measures, the DEIS claims that "monitoring will detect any unexpected problems, and mitigating measures will be initiated." (p. 6-5) The planning for these problems should take place during the pre-operational phase and not after they have occurred. The delay in abatement response could produce serious and irreversible impacts that are avoidable. To proceed on the basis of such inadequate data and clearly unsupportable optimism, with nothing more than the assurance that problems will be dealt with after they occur, is unwarranted.

Specific Comments

1. More information is needed relative to radiological and chemical content of the mine waste piles and subsequent reclamation. It appears presumptuous to assume that reclamation goals are attainable based on the information provided in the DEIS.

2. The impacts of waste dumps were not discussed in the DEIS. Certainly, this could not have been done since no information on ground water was gathered at the proposed waste dump site. (p. 2-13)

3. The statement that "an additional unknown amount (probably small) of groundwater will also enter the mine pit" (p. iii) contradicts a later statement on the same page that "after reclamation of the mined area, a . . . 29-acre lake may form in the northern portion of the mine pit." Where will the water supply for the lake come from?

4. Assuming a lake does form in the mine pit, its probable water quality, impacts on ground and surface water, any restrictions on use or access that may be required, and any needed mitigation measures must be assessed, particularly in light of the undocumented assertion that the lake "would provide an increased amount of surface water which may represent a change in use to include recreation activities and a source of livestock and wildlife water." (p. 8-1) To present highly speculative benefits without also addressing possible detrimental impacts makes a mockery of the NEPA process.

5. There is no documentation or justification for the statements on p. 1-5 that "there is a need for new mill capacity prior to 1981 (probably as early as 1979)," and "a deferral of operation of Homestake mill . . . could affect adversely the ability of reactors now operating or under construction to deliver needed

RESPONSES

1. The mine waste piles will contain about 0.3% of low-grade waste (less than 0.02% U_3O_8). Both barren overburden and low-grade wastes have been analyzed and leaching experiments performed to determine the potential impacts of the waste dumps on water quality. This work was done by the Colorado School of Mines Research Institute. The results and conclusions have been furnished to the Colorado Department of Health, Radiation and Hazardous Wastes Control Division, which will license the waste dumps as a regulated activity. The Colorado School of Mines Research Institute's conclusion was that waste dump water quality would be similar to that observed at monitoring station SW-1. The applicant's safety analysis report to Colorado Department of Health, Radiation and Hazardous Wastes Control Division, must demonstrate the ability to meet NPDES requirements. More detail in the FES would not serve a useful purpose.

Reclamation goals appear attainable (see Appendix J).

2. Groundwater will not affect the waste dumps. The hydrological regime at the mine and waste dumps is demonstrated in Fig. 2.6 and Table 2.4. Potential impacts of the waste dumps are discussed in Sect. 4.

3. This is not a contradiction. Groundwater inflow into the open pit may be as low as 1000 m^3/day (190 gpm), a small amount of groundwater by aquifer flow concepts but, together with runoff, sufficient to maintain a 72-ha (29-acre) lake.

4. This was discussed in Sect. 6.2.1 of the DES and has been amplified in the FES and in the responses to State of Colorado comment 20 and EPA comments 3, 24, 42, and 51. The lake water quality is expected to be suitable for livestock use and public recreation. If not, access will be restricted.

5. This issue is discussed in Appendix C. In addition, refer to Sect. 10.6, which has been updated for the FES.

electrical power. Such a shortfall of electrical energy is generally construed to be harmful to the public interest."

6. The lack of quantitative information is exemplified by the following (emphasis added):

- "From a few feet to many feet below the surface, the rock over much of the site has been weathered into poorly consolidated debris." (p. 2-6)
- "[T]he volume of groundwater stored in the volcanic rocks is very small." (p. 2-10)
- "Because the groundwater in the Precambrian rocks comes mainly from fractures, the storage volume is probably small. Continued pumping of Well DM-13 at a maximum yield would probably dewater the fractures in a relatively short time and reduce, or possibly stop the water yield of the well." (p. 2-10)
- "If all the mine water is used in the mining and milling operations, a slight reduction in the discharge of Indian Creek may result." (p. 4-4)

6. Exact quantification of these points adds nothing to the purpose of the Environmental Statement, which is to make an assessment of potential environmental impacts and to propose monitoring and mitigating measures to minimize such impacts.

7. The statement on p. 2-19 that "the only local use of groundwater is for stock watering and domestic supplies" is not accurate since it ignores maintenance of streamflow through baseflow.

7. The text has been changed.

8. The statements that the "loss of recreational opportunities . . . should be temporary and minor" (p. iv) and that "[a]fter reclamation, existing recretational activities could be resumed" (p. 4-2) are misleading and are directly contradicted by the admission that the tailings retention site (approximately 69 acres) "would be permanently restricted." (p. 10-10)

8. The effect of the potential permanent loss of 170 ha (69 acres) of dispersed recreation opportunity is judged to be minor when compared to the tens of thousands of hectares (acres) available in the immediate vicinity.

9. The capacity of the proposed drainage diversion ditch (p. 3-28) is not addressed. It should be capable of diverting the probable maximum flood, and the flood recurrence interval utilized to determine the probable maximum flood (for both the ditch and the reservoir (p. 3-28)) should be disclosed.

9. The design capacity of the diversion ditch is 3 m^3 (110 cfs). It is not safety related because the impoundment is designed to contain the probable maximum flood from all of the upstream drainage. The impoundment design will meet all of the requirements of NRC Regulatory Guide 3.11 as well as the requirements of the Colorado State Engineer Office, Dam Safety Branch.

10. The DEIS contains no information relative to Homestake's past record of compliance with environmental laws and regulations and license or permit requirements designed to protect public health and the environment. Such information is directly relevant to any assessment of Homestake's ability and/or willingness to live up to the many promises and assurances contained in the DEIS, and thus to the appropriate amount of the performance bonds, and should be included in a new draft.

10. The amount of a bond is determined on the basis of what the cost would be to the responsible agency if it were obliged to perform the required work at any particular time because of bond forfeiture. Bonds can in no way be punitive. Therefore, past performance is not a factor in determining the amount of bond.

11. The section on Benefit-Cost Summary (section 11) is very misleading and should be eliminated. There is not a single figure or documentation of the costs and benefits in this section. The claim that "the overall benefit-cost balance for Homestake mine and mill is favorable" is based on a value judgment. To recommend on the basis of the inadequate and insufficient data provided in the DEIS that a CDH Radioactive Material License be granted is irresponsible.

Conclusion

We urge that a detailed and adequate EIS be prepared and circulated in a draft form and that action on the project be deferred till all data is at hand. An adequate EIS will help ensure meaningful consideration of environmental factors in the decision-making process, and indeed is required by NEPA:

> [NEPA] mandates a particular sort of careful and informed decision-making process and creates judicially enforceable duties. . . . [I]f the decision was reached procedurally without individualized consideration and balancing of environmental factors--conducted fully and in good faith--it is the responsibility of the courts to reverse. 3/

Sincerely,

Mohamed T. El-Ashry, Ph.D.

Paula C. Phillips, Esq.

3/ Calvert Cliffs' Coordinating Committee v. AEC, 449 F.2d 1109, 1115 (D.C. Cir. 1971).

11. Quantifiable costs and benefits represent a relatively small part of the overall balance for this project. The problem lies in assessing nonquantifiable factors on which agreement could be reached. The major nonquantifiable costs include the removal of a small amount of national forest land from uses such as recreation or grazing, impacts on the quality of life, risks of air and water quality degradation, potential health hazards, and short-term socioeconomic inconveniences. The major benefit is an increase in the nation's supply of energy resources. Other benefits include a stimulus to the local economy through the creation of jobs and an increased tax base to support county, municipal, and school district expenditures.

Any cost-benefit consideration applicable to FS needs would have to relate to the reclamation aspects of the project, for example, the net results of the proposed reclamation resulting in certain losses or increases in productivity. Even at that, it is vague how it applies within the FS authorities and responsibilities. (See also response to Gunnison County Board of Commissioners, September 6, 1978, comment 2.)

FUTURE Folks United to Thwart Unsafe Radiation Emission

P.O. Box 2626 • Denver, CO 80201

Steering Committee
Kathy Kaiser
Boulder, CO
Timothy Lange
Denver, CO
William Long
Rollinsville, CO
Elizabeth Morrissett
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Barbara Parker
Boulder, CO
Margaret Puls
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Ellen Stark
Gold Hill, CO

August 18, 1978

FS R-2
RECEIVED
AUG 2 2 1978

Craig Rupp
Regional Forester
USDA-Forest Service
P. O. Box 25127
Lakewood CO 80225

Dear Mr. Rupp:

We are writing to request that your agency provide a full legal hearing on the environmental statement for the Pitch Project at some time before the mill license is granted. It is our understanding that the Forest Service has not yet agreed to do this, even though as "lead agency" for the EIS, you are legally allowed to do so. If you do not provide a legal hearing on the draft EIS, we respectfully request that you do so when the statement appears in final form.

We are not happy with the "public meeting with transcript" format your agency has scheduled for August 23 and 24 for the following reasons:

1. Unlike a legal hearing, this procedure does not give us or other groups or individuals a right to obtain party status to the proceedings. Hence we feel our legal basis for appealing a decision founded in part on these public meetings may be weakened.

2. A legal hearing provides clear definition of who may cross examine whom and under what conditions. We feel that the present "public meeting" format could easily turn into a verbal free-for-all, with industry and government intimidating citizen witnesses (or vice versa). Legal proceedings were developed for a purpose, and with respect to a controversial issue such as the Pitch Project, we would like to see the rights of "expert" and "non-expert" witnesses defined and protected as much as possible.

3. We feel that citizen testimony would have more impact if delivered at a legal hearing. It has been the experience of members of FUTURE for the last year and a half that the Forest Service offices in Delta and Denver have been rather forcefully against citizen input re Pitch, and even against pertinent comments from other agencies!

RESPONSES

A personal response discussing the position of the FS as it relates to legal public hearings was sent to the FUTURE group by Jimmy Wilkins, Forest Supervisor.

Two instances come to mind: Forest Service opposition to the environmental statement last year, and, more recently, Forest Service attempts to prevent any oral testimony from being heard on the EIS. In addition, members of our group have been given the run-around when they attempted to obtain information about Pitch under the Freedom of Information Act and have been given inaccurate information by Forest Service employees. In short, we think your agency has looked out entirely too much for Homestake's interests, and we think a legal hearing will be the best safeguard that our comments will be taken seriously. We have also urged in our last mailing (enclosed) that a copy of any testimony submitted be sent to Dr. Robbins, since the Health Department has final legal authority over the mill.

We feel that the Forest Service has some serious misconceptions about how it should relate to environmental groups and concerned citizens on mining issues. We would like to see you take steps to remedy these problems. A legal hearing on Pitch would be a good start.

Sincerely,

FUTURE

By Margaret Puls

Enclosure

cc: David Ehrman, Staff Assistant to Senator Floyd Haskell
Anthony Robbins, M.D., Director, Colo. Department of Health
Hubert Farbes, Assistant Attorney General
David Griffith, Attorney at Law
Myron Levin, Reporter, ROCKY MOUNTAIN NEWS

Gunnison County CHAMBER OF COMMERCE
500 East Tomichi Avenue GUNNISON, COLORADO 81230 Phone: (303) 641-1501
Charles A. Page
Exec. Vice-Pres.

No response is required.

Aug. 31, 1978

Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
Box 138
Delta, Colo. 81416

Dear Mr. Wilkins:

The Board of Directors of the Gunnison County Chamber of Commerce has continuously supported Homestake Mining Company's Pitch Project near Sargents, Colorado through letters to the National Forest Service, the Colorado Mined Land Reclamation Board, Colorado Health Department, Governor's office, our Congressional delegation and our State Legislators.

The directors speak for 300 members, made up of business and professional people, ranchers and individuals in all walks of life. To date no member has formally directed the board to change its position.

The directors have read or been reviewed on all or parts of the Draft Environmental Statement. They have not changed their position. They feel that Homestake Mining Company is an organization that employs only professionals. Because these professionals are very closely involved in the project, they know more about the environmental impact than anyone else,, particularly those minority protestors who are certainly not qualified to make a determination about the scientific, social or economic impacts.

They also object to the long delays confronting developers of energy or other materials, for these delays are one of the primary causes of inflation, which is detrimental to the economy and therefore detrimental to the people of this country.

Sincerely

Charles A. Page

Charles A. Page, Mgr.
For the Board of Directors

Members of the Board:
[illegible], President
[illegible]
[illegible], Vice President
[illegible]
[illegible], Treasurer
Self-Employed
[illegible]
[illegible]
[illegible]
[illegible]
THOMAS J. MARSHALL
[illegible]
[illegible]
[illegible]
[illegible]
Certified Public Accountant
[illegible]
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August 3, 1978

Dear Mr. Wilkins,

We would like to receive answers to the following questions and would like them included in the final draft environmental impact statement for the Homestake Project on Marshall Pass.

Is there a critical need for additional uranium reserves in light of the difficulty in starting up new nuclear power projects?

How many nuclear power plants have been started during the past year?

Can someone compare the amount of energy to be used in construction of the Homestake mine, mill, new and upgraded roads, tailings area, exploration, trucking of uranium, mining and milling, construction of heavy machinery used on the project, and transportation to and from the mill by construction workers and miners to the amount of usable energy resources extracted from the mill?

We would appreciate receiving answers to these questions and also a copy of the final draft for the Homestake Project.

Your truly,

/s/ Paul Kaplan
Box 23
Forest Dale, Vermont 05745

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

RESPONSES

1. Yes, present production is inadequate to fuel reactors now under construction (see Sect. 10.6 and Appendix C).

2. Seven reactors in 1977 and five reactors in 1978 started commercial power production. Seventy-one reactors presently under construction are scheduled for commercial production by the end of 1984. Four reactors in 1977 and two in 1978 were contracted for.*

3. From initial exploration to final delivery of U_3O_8 during a ten-year operating life, the total energy input for the Pitch Project was calculated to be 12,329.847 x 10^9 Btu as shown below.

Activity	Energy input (10^9 Btu)		
	Direct	Indirect	Total
Exploration	35.277	19.443	54.720
Plant construction	106.480	613.075	719.555
Stripping	983.465	1,349.804	2,333.269
Mining	154.766	188.333	343.099
Milling	6,636.563	1,776.103	8,412.666
Reclamation	194.946	270.592	466.538
Total	8,112.497	4,217.350	12,329.847

The energy analysis was obtained by following the procedure described in *Net Energy Analysis: Handbook for Combining Process and Input-Output Analysis*, by Bullard, Penner, and Pilatti, published by the Center for Advanced Computation, University of Illinois at Urbana-Champaign in October 1976.

The potential energy (output) contained in the project's estimated ten-year production of 6,236,000 lb of yellow cake was determined to be as shown below.

**Electrical World*, Jan. 15, 1979.

Type of reprocessing	Percentage of enrichment plant tails	Net electrical energy per pound of U_3O_8[a] (kWhr)	Net electrical energy in 6,236,000 lb U_3O_8 (10^9 Btu)	Input/output (%)
No recycle	0.20	17,741	377,811.69	3.45
No recycle	0.30	14,839	316,010.44	4.12

[a]This is the net amount of electricity potentially producible per pound of U_3O_8 if the uranium is used in equal quantities in PWRs and BWRs of 1000 MW(e) capacity, operating at an average plant factor of 0.75. All losses and inefficiencies in the nuclear fuel cycle have been deducted to arrive at this figure.

In addition, an article by Seymour Baron* indicates the energy payout time for the entire nuclear fuel cycle for a light-water reactor from mine, mill, nuclear reactor, through transmission is 0.4 year. By interpretation of information in Baron's report, it is indicated that less than 1.43% of the energy produced by a light-water reactor and delivered to the load center is used in the mining and milling phase.

*Seymour Baron, "Energy Cycles: Their Cost Interrelationship for Power Generation," *Mech. Eng.* 98(6): 22-30(1976).

August 24, 1978

To: Mr. Wilkins

Re: Homestake Pitch Project

Following is our comment on the Homestake Project.

We are opposed to it for the following reasons:

1. The possibility of ground water contamination exists (4.3.2.2 of D.E.S.).

2. We feel contamination of Marshall Creek is a good possibility. We question whether monitoring at the tailing site is frequent enough. When mining operations cease monitoring doesn't seem frequent enough.
3 years after operations cease samples will be taken annually. This seems ridiculous.

3. Increased sediment in Marshall and especially Indian Creek could effect spawning and survival of trout (4.7.1.2 of D.E.S.).

4. Other recreational opportunities will be effected by this project for a large number of years (hiking, hunting, camping, fishing, etc.).

5. A large release of tailings resulting from a major accident or natural disaster could contaminate Marshall Creek and on further to other portions of the Gunnison River watershed.

6. This is the beginning of the nuclear operation. There are potential environmental dangers associated with the Homestake operation (above).

When the mined uranium is eventually used in a power plant operation what is done with the waste from the power plant. Our solutions right now are temporary.

Until we come up with safe permanent solutions for the whole process, the beginning of this nuclear process, the mining of uranium, should not take place.

Yours truly,

/s/ Paul Kaplan
Cindy Kaplan
Box 23
Forest Dale, Vermont 05745

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

RESPONSES

These comments have been addressed in detail in responses to comments from DOI, EPA, and the State of Colorado. Before licensing of the project can be completed, mitigatory measures to protect the environment adequately must be proposed by the applicant and accepted by cognizant regulatory agencies. Once these requirements have been met, statutory authority does not allow denial of a license.

RALPH E. CLARK III
519 EAST GEORGIA AVENUE
GUNNISON, COLORADO 81230
(303) 641-2907

August 27, 1978

Mr. Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
P. O. Box 138
Delta, Colorado 81416

Re: Comments on Draft EIS for Homestake Mining Company's Pitch Project; USDA-FS-R2-DES (ADM) FY-78-03.

Dear Mr. Wilkins:

Thank you for the opportunity to review and comment upon the Draft Environmental Statement (DES) for the Homestake Mining Company's Pitch Project. The following are personal comments from my perspective resulting from my review of the draft and other relevant material. They are submitted for your consideration and assistance in the preparation of the final environmental statement.

1. The information presented with respect to the social and economic aspects of the existing environment, Section 2 of the DES, is too outdated to be useful in describing the current situation. This information was carried over from the environmental analysis report which was in turn a carry over of the information for the consultant's report submitted to the Homestake Mining Company. More current information is available and should have been utilized as the social and economic conditions of the affected area have changed significantly over the past three years.

2. As the information presented on the social and economic aspects of the existing environment constitute the basis for the evaluation of the projected environmental impacts, Section 4, an updating and reevaluation of the projected environmental impacts is also necessary.

3. Some of the figures presented in the DES are at variance with those provided from original sources. These should be revised or the reasons for the differences explained as well as the reasons for the use of particular figures. For example, the population range for 1975 (2-39, references are to paging in the statement) is given as 8,788 to 8,605. The Region 10 Overall Economic Development Program, June 1977, cites a figure 9,700 as the 1975 population of Gunnison County based upon U. S. Bureau of the Census reports identified in the publication. A figure of 9,105 as the county population is given, with cited sources, in the West-Central Colorado Coal Environmental Statement (Draft), Volume I, prepared by the Bureau of Land Management in 1978, and the same figure is given in 1975 Local Government Financial Compendium prepared by the Division of Local Government for the state of Colorado in 1976. There are similar inconsistencies between the figures presented in the DES and those for the same thing in other source documents for other elements of social and economic data. Among these are data relating to sectorial employment, unemployment, assessed valuations, general funds expenditures, education, and housing. When this information is updated, citations to the original sources should be provided, as opposed to the reference to

RESPONSES

1. The staff utilized as a basic source the Environmental Report for the Pitch Project prepared by Dames and Moore and submitted in October 1976. The members of the staff have visited the area several times from October 1977 through August 1978. Where more current information was deemed necessary, local government officials were contacted. (Note February 1978 citations in Sect. 2.10.5.1.)

   The staff considers the information to be adequate for forecasting potential socioeconomic impacts. (Also see State of Colorado comment 2.) Table 2.18 has been revised to reflect more recent data.

2. No reevaluation is required because the data base used was considered adequate for evaluation.

3. In Sect. 2.10.2.1, it is pointed out that some 2100 students at Western State College leave Gunnison during the summer months. No actual census has been taken since 1970. All other figures are derived values used for the various assessments.

   Within this context, the difference between 8788 and 9100 proposed by the Division of Local Government of the State of Colorado is inconsequential.

   The Bureau of Census reports may be somewhat optimistic.

Mr. Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
Delta, Colorado

Re: Comments on Draft EIS for Homestake Mining Company's Pitch Project.

to the Environmental Report cited within the DES.

4. The discussion of the environmental impact relating to the influx of population only deals with the projected direct or primary increase expected in the population. There will be an indicated maximum influx of workers, their spouses, and their children amounting to 800 persons (4-20). The DES does not consider the population increase related to the proposal due to secondary service employment which may consist of the creation of 2.3 service jobs for every 1.0 direct mining job as indicated in the September, 1977, issue of Colorado Business. Figures for the calculation of secondary employment related to the creation of mining jobs vary but tend to be around a 2.0 ratio. Other sources which should be consulted are The Economic and Social Costs of Coal and Nuclear Electric Generation prepared for the National Science Foundation by the Stanford Research Institute and Impact Analysis and Development Patterns Related to an Oil Shale Industry prepared for the Colorado West Council of Governments by THK Associates, Inc. in 1974. Using the 2.3 ratio, the 150 permanent jobs (4-21) represent 345 secondary jobs with a population increase of an additional 1035 persons with an expected 3 persons coming in for each job created.

5. The DES is incomplete in that it does not specify precisely what the Homestake Mining Company proposes to do. The milling operation is indicated as lasting for 20 years (v); however, the estimated life of the reserves at the mine site are expected to last for 11 years (3-1). It is expected that additional ore will be hauled to the mill. It is necessary to discuss in the DES the expected sites and mining plans for the development of additional ore. The information filed by the company with the Colorado Mined Land Reclamation Board and other material indicate other potential sites being considered for mining development. The full scope of the Homestake Mining Company project proposal must be examined and incremental decision making with regard to this proposed action must be avoided as it is necessary for the DES to consider all the ramifications of what is being proposed.

a. Of particular concern in the evaluation of the full ramifications of the proposal is transportation of the ore for processing at the mill. Discussion of uranium development in southwest Colorado, The Denver Post, November 2, 1977, page 47, indicates that it is possible to have an economic hauling distance for the ore of about 250 miles by truck and further if a railroad is used. This implies a potential for the proposed mill to serve a very large geographic area. The DES should examine the expected transportation routes and their capacities to accommodate this traffic as well as other traffic increases projected for them.

b. The DES is inconsistant when it indicates that the construction workforce associated with the proposal will decline following the construction phase at the Pitch Project site. If the mill requires the indicated development of ore supplies at other sites, construction

4. Between 0.3 and 0.9 indirect employees are generally needed for each construction worker during the construction phase of an energy project.* Fewer than 150 construction workers, many hired locally, will be used. Because of the short construction period, the staff considers the 0.3 figure, or a maximum of 45 indirect jobs (not necessarily in the local area), appropriate. Because the potential population increase (Table 4.7) was based on no local hiring, the staff opinion is that potential population increases from indirect job formation during construction are more than accounted for in these maximum figures.

The staff agrees that during project operation the proportion of indirect to direct employment will increase.

Because the applicant intends to employ local residents as much as possible and because these residents are already supporting present secondary service employment, the 2:3 ratio would seem to be inappropriate. The staff considers that, because no marginal costs (capital additions to service infrastructures) are associated with the project, the maximum project-induced population increase in Table 4.7 represents an upper limit and that a more likely limit during project operation is the 596 persons given in Sect. 4.9.2.2, paragraph 1.

The staff agrees that, if the project caused a large increase in local employment of new residents, the information presented by the commenter would represent a valid method of assessment.

5. The following statement appears in Sect. 3.1.1: "To extend the operational life of the project, Homestake is exploring other areas within economic hauling distance of the mill . . . Each new mining operation will require a new set of reviews and approvals." It is not feasible to assess potential impacts for as yet unknown mining locations.

5a. The staff considers it very unlikely that ore would be shipped 402 km (250 miles) to the Homestake mill. If it were, only about 20 truckloads per day would be necessary, which would not create any serious traffic problem.

5b. Exploration for additional ore supplies, presently in progress, will continue. This is not an additional impact. The applicant has identified an 11-year ore supply at the present site and expects his reserves (proven) to increase as mining and exploratory drilling proceed. Even if this increase does not occur, additional mining sites would not be developed for at least ten years. No new mill construction crew would be required (150-worker peak).

*Department of Housing and Urban Development, *Rapid Growth from Energy Projects*, Office of Community Planning and Development, 1976.

Mr. Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
Delta, Colorado

Re: Comments on Draft EIS for Homestake Mining Company's Pitch Project.

would be expected to continue for an extended period. The construction workforce and the transportation force for hauling the more distant ore to the mill would constitute a permanent workforce. In turn secondary employment would be created. A consistant work force of about 286 persons could be expected which would result in a population influx of about 2,750 in total for the proposed project. This figure more closely resembles the projected population increases associated with the proposed project in the West-Central Colorado Coal Environmental Statement (Draft), Volume I, under the consideration of other activities proposed within the region, than those presented in the DES.

The staff agrees that temporary workers would be hired to open a new mine site, but these men would no longer be required when the present mine site is closed. Also a few more truck drivers might be required over the longer term, depending upon mine to mill distance.

The staff does not feel the DES is inconsistent in its discussion of the present project.

6. The proposal should be evaluated within the context of what else is happening and proposed to happen within the affected area. For example, the West-Central Colorado Coal Environmental Statement (Draft), Volume I, page 266, projects an increase in the population of Gunnison County of 152.7% between 1977 and 1985 giving the county a population of 25,400 in the latter year. The proposed resource development projects of Homestake Mining Company at the Pitch site and the AMAX Mt. Emmons Project at Crested Butte are the basis for the projected increase in the population. The economic and social impacts of the proposed Pitch Project in conjunction with those of the Mt. Emmons Project will not resemble the discussion of projected impacts presented in the DES.(4-19 to 4-24, 6-14, 7-3, and 8-3).

6. Section 4.9 notes that only the Homestake Mining Pitch Project impact is assessed. Because of the uncertainties involved in other development activities, it is not considered reasonable to speculate on the economic and social impacts of possible projects still in the engineering design stage. The Colorado Division of Planning will address cumulative impacts as other projects are proposed and implemented.

7. Financial information presented in the DES regarding local government is inconsistent with original sources and also should be updated. Projections of anticipated local expenditures is based upon an assumed influx of 160 persons which does not appear reasonable with reference to paragraphs 4,5,and 6 above. The projections for anticipated local governmental expenditures is not comprehensive. This type of examination is needed and is very useful in assisting the affected local governments to respond to the implications of the proposal. Two references for strengthening this aspect of the DES are: Impact Analysis and Development Patterns Related to an Oil Shale Industry prepared by THK Associates in 1974 for application in Colorado and The Fiscal Impact Handbook: Estimating Local Costs and Revenues of Land Development prepared by R. W. Burchell and D. Listokin in 1978 for the Center for Urban Policy Research.

7. The staff appreciates the source material citations. For the Pitch Project only, as stated in response 6 above, the treatment of socioeconomic impact is considered adequate. (See State of Colorado comment 2.)

8. Consideration should be given to the implications of cloud seeding and other weather modification efforts as they may effect maintenance of water quality, and air quality and the the management of the tailings.

8. No potential weather modification efforts would alter any conclusions reached in the DES.

9. Section 6 of the DES, "Monitoring Programs and Mitigating Measures", should address the responsibility of the proponent for insuring its subcontractors appropriately perform necessary mitigating measures and follow appropriate procedures to prevent or reduce environmental damage. The Corps of Engineers order to cease and desist further filling of the Marshall Creek waterway on August 1, 1978, is an example of the need to closely and effectively monitor actions directly and indirectly related

9. The applicant is responsible for complying with all Federal and State regulations and permit restrictions to prevent or mitigate environmental impacts. The licensing agencies will require demonstration of compliance.

and taken on behalf of the proposed project. As project proponent the Homestake Mining Company should assume responsibility for these actions.

10. The amounts of anticipated fugitive dust resulting from the proposal (4-1 and 4-2) and the indicated mitigating measures for its control (6-1 and 6-2) do not appear to reflect best management practices to reduce particulate emissions. The implications of the proposal with respect to the Clean Air Act and its amendments should be more fully considered in the DES. Pavement can be used on all haul roads in place for more than a year and semi-permanent dust surpressants should be applied to haul roads expected to be in place for more than two months. Additionally, the methods to be applied to control fugitive dust as the ore trucks are both loaded and unloaded.are not specified.

11. Anticipated degradation of the water resources of the affected area is indicated.(4-3 to 4-6). An NPDES Permit has been applied for by the proponent (4-4). The details of that permit, or the proposed conditions of the draft of that permit if it has not been issued, should be set forth in the Appendicies to the DES. Likewise the rational for finding a necessity for degrading the existing quality of the water in the area's streams should be set forth in the DES as this appears to be required in accordance with federal and state water quality regulations.and requiements. This rational could be presented in the Appendicies, if necessary.

12. The discussion of alternative sites for the mill and the tailings disposal area outside the Pitch Project site is limited by the concept of the reasonable ore transport distance (10-6). This concept is not defined in the DES and it appears that an economic distance for hauling ore to a mill is in excess of 250 miles ("Paradox Ore Boom", The Denver Post, November 2, 1978, page 47). Given that as an approximate economic hauling distance the consideration of alternative sites for the mill and tailings disposal area should have been far more extensive than appears evident in the DES. Consideration for the haulage of ore from the other potential mines to the proposed mill should be presented.for evaluation in the determination of the "net environmental advantages" (10-6). A far more rigorous examination of alternative sites over a much wider geographic scope may likely yield the environmental advantages cited on page 10-6 and reduce the "deleterious" impacts which were suggested.

13. The Benefit-Cost Summary (11-1) is insufficient. The methodology utilized in the West-Central Colorado Coal Environmental Statement (Draft) and others presented in the references cited in paragraph 7 can be used to strengthen this section. These provide an opportunity to approximate the numerical balance between the costs and the benefits, and to identify to whom they are expected to accrue. In determining the cost-benefit balance it is particularly important to consider future costs for monitering and maintaining the integrity and safety of the tailings deposit which may be required of the public. It is also important to include

10. The project has received applicable emission and fugitive dust permits required by the State of Colorado. The applicant was required to develop adequate control measures, and compliance with regulations is required. (See response to Gunnison County Board of Commissioners comment 6.)

11. The NPDES permit requires that the applicant maintain radioactive, ionic, and sediment discharge limits to protect the public and the environment. These limits will be set at the time of licensing and enforced by the State of Colorado. Inclusion in the FES is not deemed necessary. Any additions to the surface waters of radioactive, ionic, or sedimentary constituents will not result in these waters exceeding the limits set by regulatory agencies to protect public health and safety. There is no need for a rationale for degradation. Some degradation of groundwater may occur but will be local in nature and monitored and controlled in a manner such that any contaminated groundwater when mixed with surface waters will not cause the above standards to be exceeded. Therefore, no rationale is required for potential contamination of groundwater.

12. The economic haulage distance from uranium ore is dependent upon mining cost, ore grade, ore type, haulage cost, milling cost, and product market price. As haulage distance increases, the ore grade cut-off also increases, resulting in a loss in uranium natural resource as well as an increase in the consumption of natural resources for transportation of the ore. Other potential mines that may later supply ore to the Pitch Project mill are expected to be near the site.

13. Section 11 is a summary that is not independent of the rest of the Environmental Statement. Section 11.1 points out that the need for uranium mills is integral to the operation of nuclear power reactors and that the benefits of energy production are greater than incremental impacts from subsidiary, but necessary, facilities.

Section 11.3 summarizes the small environmental costs of the project. No detailed benefit-cost in terms of numerical balance is required for a support project for power production if the environmental costs are small because the overall cost-benefit balance is considered in reactor licensing evaluations.

Ralph E. Clark III
Gunnison, Colorado

August 27, 1978
page5

Mr. Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
Delta, Colorado

Re: Comments on Draft EIS for Homestake Mining Company's Pitch Project.

the anticipated costs of public assistance to mitigate and cope with the burdens of rapid population growth within the affected area.

14. Letters received during the process of the review of this DES are critical to the effective and efficient review of the final environmental statement. All letters received should be printed and the paraphrased statements discussed in the text should be referenced to specific letters. There is no way for the reviewer to check the accuracy of the translation of the comments into a paraphrased concern and there is no way for the reviewer to examine the specifics and qualifications expressed by each respondent during the course of the public involvement process. Reduction of copies of responses to one fourth the original size retains readability while conserving space and funds.

14. The staff agrees.

In summary, the preparation of a DES on the Homestake Mining Company's proposed Pitch Project should have been utilized to update and improve weaknesses in the Environmental Analysis prepared on the proposal. However, it appears that the social and economic information and analysis were transcribed from the outdated reports. New information was readily available for the preparation of the DES as well as having new methodologies available for use. The social and economic aspects of the DES appear to require major revision. Following that, they should again be circulated in draft form for review and comment prior to the preparation of a final environmental statement upon which a decision regarding the proposed Pitch Project will be based.

15. The staff utilized both old and new material in preparing the DES. Because DES preparation takes many months, the socioeconomic data used will never be entirely current. The staff considers the methodology used as adequate as any in a nonexact science. The Statement is considered adequate in its treatment of socioeconomic impacts from this project.

Respectfully:

Ralph E. Clark III

Ralph E. Clark III

c. Board of County Commissioners
Gunnison County, Colorado

August 30, 1978

Jeff Eric Thiemass
1512 S. Owens #227
Lakewood, Co 80226

No response is required.

J. R. Wilkins
Forest Supervisor
Box 138
Delta, Co 81416

Dear Sir,

Dark, Middle, Classical, Industrial, Electronic and Atomic Ages have left the earth in a condition comparable to that which prevailed while Jesus was alive. At a recent public hearing on Nuclear Wastes held in Denver one opponent noted that it was a sin to promote radio-active pollution — the ultimate garbage. Well, it is also a sin to put any gods before our Creator; an electric or petroleum economy does just that. I could submit a lengthy critique on the status of the nuclear industry but in consideration of the insanity with which you are already confronted a humble plea for a moratorium on nuclear-related activities, at least until all the problems that currently exist are resolved, seems appropriate. Worldwide proliferation of these toxic materials will only hinder any attempts to clean up the mess we've made.

Peace and a Waste-Free Future,

/s/ Jeff Eric Thiemass

P.S. If the design for the Pitch Project tailings class is so good, why not use it on piles that already exist? I don't believe 2 feet of clay will protect us from the number of uncertainties that exist in this proposal.

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

Aug. 31, 1978

Jimmy R. Wilkins
Forest Supervisor
Gunnison National Forest
Box 138
Delta, Colo. 81416

Dear Jimmy:

This is my personal input into the review of the Homestake Mining Company's Pitch Project Draft Environmental Statement and it is no different from my personal views expressed many times regarding the project.

Someone has said that if Moses had to submit an Invironmental Impact Statement, he would still be in Egypt. No question about it. And how different the world would be today.

Since the sun became the sun, and since metals and minerals became metals and minerals, there has been radiation. It is not a human product, although I realize man can make it do things either detrimental or advantageous to mankind.

A firm such as Homestake Mining Company does not hire amateurs; therefore,as one individual I believe those professionals know what they are doing, and they are going to do it right for two reasons: (1) for the good of the company and (2) for their own good since they are also part of the environment, and want to protect themselves as well as everyone else.

I protest strongly the weight given to a handful of amateurs, many of whom apparently don't have to make a living in this life. I sincerely believe government agencies at all levels and the Congress as well as the Administrations in Washington and Denver lean more heavily toward the opinions of that small minority.

I am in favor of strong, sensible rules, but I am not in favor of deliberate delays placed in front of enterprises, because I do not believe it is moral, and because I believe many of the solutions to problems in this country are so delayed with tremendously increased costs. And the costs fall directly onto the consumer, who is everyone in the nation.

As a lifelong resident of Colorado and 23 years in Gunnison, I take a personal interest in my surroundings. I very strongly support Homestake Mining Company's Pitch Project.

Respectfully Submitted

Charlie Page

Charles A. Page
Box 368
Gunnison, Colo. 81230

No response is required.

Dale E. Bailey
766 MAIN – Room 436
Worcester, Massachussetts 01608

September 2, 1978

RESPONSES

Jimmy R. Wilkins
USDA Forest Service
P.O. Box 138
Delta, Colorado 81416

Dear Sir:

I am writing in regards to the Draft Environmental Impact Statement for the Homestake Mining Company's Pitch Project for mining of Uranium Ore in Colorado. (USDA-FS-R2-DES(ADM) FY-78-03).

In general, I am opposed to the project and ~~the~~ below are some of the considerations I have:

(1) The draft EIS failed to adequately show how the new people associated with the project would find housing. With the shortages stated and problems in getting natural gas and sewer service in near-by towns it is questionable whether or not the increase in people in the towns of Salida and Gunnison, Colorado could be accomodated.

(2) There is question as to whether or not Homestake Mining Company has a valid, dated and signed Development and Extraction Mining Permit. The EIS should not be approved unless this is corrected.

(3) Was the Public given opportunity to comment publicly on the Mineral Resource Development, Mine Waste Disposal Site Permit, and Tailings Disposal Facility Permits granted by the Saguache Board of County Commissioners?

(4) Indian and Marshall creeks presently support Trout populations. Section 3.2.4.2 of the EIS states "if seepage is detected in quantities sufficient to cause water quality degradation in Indian and Marshall creeks, provisions would be made to intercept the seepage and return it to the tailings pond". By the time seepage reaches a stream, the damage to fish populations could already be done. I feel Homestake Mining Company should be required to state in the EIS that it will undertake all costs of restoring fish populations affected by any seepage from the tailings disposal site into Indian and Marshall creeks.

(5) Land immediately northwest and north of the site is being considered under the RARE II Program. Because a twenty-year mining operation could adversely affect this extremely valuable remote area I feel that the this EIS should not be approved until the Final Environmental Statement (FES) for the Chipeta Area (Area Code 2358) is completed.

1. City officials and developers have indicated an ability to meet the housing needs of people moving into Gunnison and Salida as a result of the Pitch Project. Adequate gas connections and sewer capacity are available both in Salida and Gunnison to accommodate the projected increased demand. Again, the point must be stressed that the projected socioeconomic impacts on Gunnison and Salida were based on a worst-case estimate, with the assumption that all new employees for the project will be hired from outside the immediate area. Actually, the applicant will hire as many employees as possible from Gunnison and Salida. It is also important to remember that much of the construction work force, even if from outside the area, will be temporary residents of the communities, and any associated impacts will be short term in nature.

2. A valid, signed Development and Extraction Mining Permit was issued on April 19, 1978 by the Colorado Mined Land Reclamation Board, Department of Natural Resources.

3. In accordance with Chap. II of the Saguache County Land Use Zoning and Development Code, a public meeting was held at Saguache, Colorado, on April 28, 1977, in connection with the three permits issued by the Saguache County Board of County Commissioners.

4. Monitor wells will be located in the immediate area of the tailings impoundment. Thus, any seepage that might occur would be detected and intercepted well in advance of its reaching any stream in the area and would be pumped back to the tailings impoundment area. (See response to State of Colorado comment 1.)

5. See response to COSC comment 1.

Dale E. Bailey
766 MAIN – Room 436
Worcester, Massachussetts 01608

(6) Section 5.3 covers shipment of "yellowcake" and process chemicals like Anhydrous Ammounia but it fails to provide for transportation of explosives used in mining operations. This <u>must</u> be adequately covered <u>before</u> the EIS is approved.

(7) The EIS should not be approved until the Emergency Action Plan discussed in Section 5.3.1 has been submitted to the Colorado Department of Health <u>and</u> the public has had the opportunity to comment on it.

(8) Homestake's present plans for the tailings disposal dam show that the dam is planned to withstand an intensity VI intensity earthquake. There is the possibility that a VIII intensity earthquake could occur, therefore, this EIS should not be approved until Homestake has submitted plans for revision of the dam construction designs and has been granted it's Radioaction Materials License by the Occupational and Radiological Health Division. Also, the public should be allowed the opportunity to comment on the proposed dam construction.

(9) What about the latent effects of radon-222? What will be done to protect miners from this dangerous gas?

In Summary: There remain a lot of questions to be answered. I feel that commencing mining in a high mountain area, great for recreation, primitive in appearance, and low in population should not be done. I strongly recommend that the Forest Service not approve this Environmental Impact Statement.

I would appreciate receiving a copy of the Final EIS when it is completed. Please mail it to: Dale E. Bailey, 766 Main, Room 436, Worcester, Massachussetts 01608.

Thank You,

Dale E. Bailey

Dale E. Bailey

6. The transporation, handling, and storage of explosives are strictly regulated by law, and the applicant will be governed by these requirements.

7. The Colorado Department of Health, Division of Radiation and Hazardous Wastes Control, will require that an emergency action plan be submitted by the Homestake Mining Company before a license is issued. The public will be able to comment on the plan in a public hearing arranged by the Colorado Department of Health.

8. The tailings disposal dam design must be approved by the State Engineer before construction can be started. (See p. v in the Summary and Conclusions, part 7b.)

9. Occupational radiological hazards will be directly addressed in detail in the safety analysis report that must be submitted by the applicant and evaluated by the Radiation and Hazardous Wastes Control Division prior to issuance of a Radioactive Materials License for the project. (See response to comment 3 of the Gunnison Planning Commission.)

August 30, 1978

No response is required.

Forest Supervisor, Gunnison Nat'l Forest
P.O. Box 138
Delta, Colorado 81416

Dear Sirs:

I see by the paper of August 24th that the concensus seems opposed to the Homestake plan. Why not give them a chance to show what they can do for the environment & not penalize them before they even get started. Everyone is scared silly, they are not using their collective brains, Homestake isn't going to make the atmosphere a hazzardous place for us all to live in. We as a nation need nuclear material to produce electricity at the cheapest possible cost. We know oil & gas for the production of electricity is not the answer. I believe that American know-how will come up with an answer on what to do with nuclear-waste, might even use it itself in the production of some vital mineral that we don't have. Let's give the companies that are trying to lick the problem a chance. No one other than our federal government can go on printing paper money, private industry has to make there ends meet or go down the drain. The nuclear industry programed 160 nuclear power plants in this country for 1985, & we only have 60 such plants, today, way behind schedule by at the least 20 plants. The delays caused by E.P.A. & the Sierra Club have cost our utilities 100% of their original cost & the cost of such facilities is rising every day. Lets get started & get this mining operation in full swing so we can save our oil & gas to run our automobiles, and so the cost of uranium can be brought down to a reasonable level.

Sincerely,

/s/ Geo. F. Dominick 3rd
7370 County Rd 120
Salida, Colo. 81201

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

Kathryn Partridge
980 Pleasant St.
Boulder, Co. 80302
September 7, 1978

Mr. J.R. Wilkens
Forest Supervisor
Delta, Colorado

Dear Sir:

My testimony in response to the DEIS on the Pitch Project concerns sections 10.6 and 10.7, which discuss alternative energy sources and energy conservation. The findings of these sections, used to justify the neccesity of the Pitch Project and the nuclear economy as a whole, are based on one-sided information, specifically two reports by the FEA designed to emphasize the desirability of a nuclear economy. Until adaquate mention is made of independent reports which contradict both the projections for use of alternative energy sources (10.6.2) and the requirements for electricty (10.6.4), among other points, the DEIS cannot be considered a complete Environmental Impact Statement on the Pitch Project.

The DEIS states that "a maximum of %6 of projected energy requirements is expected to be derived from solar, geothermal, and synthetic fuel resources combined," a figure from the FEA National Energy Outlook (p.10-20) In actuality, solar technology is already available, at costs competitive with nuclear (when we consider the entire cost of the nuclear fuel cycle), for the low-grade energy uses that account for 58% of the end-use needs in the US today, according to Amory Lovins. As for the DEIS projection, based on an ERDA report for the uranium industry, that electrical needs will grow twice as fast as other forms of energy needs, Lovins counters that only 8% of our energy needs must rely on high-grade electricity, though we actually met 13% of our energy needs with electricity. Thus, our over-reliance on electricity might be expected to decrease rather than grow, as the nuclear industry would like. The DEIS briefly and somewhat quixotically mentions the role conservation might play in reducing the need for uranium, dismissing it as insignificant. In actuality, conservation or improving the effeciency of energy production and usage could met **all** our energy needs for the next 25 years, at a considerable savings. A GE plant in Ohio managed to save $8.6 million by cutting its energy use 45.1%, through use of a $400,000 investment. It is clear that nuclear power is an unneeded and dangerous plaything for a few scientists and corporate elites, and that the real answers lie in the utilization of solar and other alternative technologies, and conservation. The only real and desirable alternative to the Pitch Project is the unspoiled natural beauty of the Gunnison National Forest and the Hale Gulch.

Thank you,

RESPONSES

The National Energy Plan, which has conservation as its cornerstone for providing the cleanest and cheapest source of new energy supply, clearly states that both coal and nuclear facilities for electrical generation will be needed to meet estimates of U.S. energy requirements through the year 2000, even if the conservation goals of the Plan are met.

Chaffee County Times

P.O. Box Z
Buena Vista, Colo. 81211
(303) 395-8621

September 7, 1978

Mr. Jim Wilkins
Forest Supervisor
Gunnison National Forest
P. O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

Enclosed you will find this week's edition of the Chaffee County Times in which appears our in-depth story on Homestake Mining Company's Pitch Project. On behalf of Times General Manager Brodie Farquhar, I am requesting that the article appearing on pages two and three be accepted in its entirety as our public comment on Pitch.

We are also asking that those items appearing on page four that deal with the Pitch Project be included as our comment. These include my personal column entitled Ed-ification, the editorial entitled Casandra's Warning written by Mr. Farquhar, the excerpts from the speech by NRC Commissioner Victor Gilinsky, and the article reviewing research in the area of low-level radiation exposures as they relate to carcinogenic occurances.

Thank you for the opportunity to have our comments and research articles become part of the public record involving the U.S. Forest Service's draft environmental impact statement on the Pitch Project.

Sincerely,

Ed Skinner
Salida Bureau Editor
Chaffee County Times

Note: The articles, which appeared in the Chaffee County Times *on Thursday, September 7, 1978, are not reprinted. Copies are on file at Forest Service offices in Delta, Colorado.*

RESPONSES

The information included in the attachments appeared in the September 7, 1978, issue of the *Chaffee County Times* and is readily available.

Sept. 9, 1978
902 Marine
Boulder Colo

J. R. Wilkins
Forest Supervisor
Box 138, Delta, Colo.

Dear Sir,

I am writing this letter to express my opposition to the Pitch Project uranium mine that has been proposed for the Gunnison National Forest. It can serve no useful purpose & will desecrate a beautiful area.

Yours truly,

/s/ Diane McElvain

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

RESPONSES

1. The project will provide fuel for nuclear power stations presently under contruction, which is considered by the staff to be a useful purpose.

104 Davey Lab.
Penn. State University
University Park, Pa.
16802
11 September 1978

Mr. Jimmy R. Wilkins
U.S.D.A. Forest Service
P.O. Box 138
11th and Main Street
Delta, Colorado, 81416

Dear Sir:

Enclosed is my assessment of the radiological impact of the Homestake Mining Company's Pitch Project. Please note that that the information presented is my own, and not the opinion of The Pennsylvania State University, whose affiliation is given for identification purposes. It is hoped that my concerns will be addressed in the final EIS.

(1.) The electrical power needed by the project is described in section 2.3.4, but the electrical energy (kwh) is not indicated, and does not seem to have been considered.

(2.) It would seem prudent to evaluate the danger of acid mine drainage by calculating the relative quantities of sulfur - bearing minerals and carbonates. A quantitative evaluation would seem appropriate.

(3.) It is proposed to seed the soil covering the mill tailings with species which are shallow - rooted to minimize the chance of root penetration into the tailings. In time long -rooted species will seed themselves and penetrate. See Page 10 - 9.

(4.) The rejection of fossil fuels on the basis of availability in section 10.6.1 seems improper. Other fuels are available such as wood, or solar.

(5.) A mining operation that would leave a scar a mile long and 700 feet deep in a national forest seems like some kind of ultimate desicration of public land. The use of these mining techniques in such rugged terrain is what gave strip mining such a bad reputation in West Virginia and other Eastern States. The use of such strip mining on this site is inviting gross erosion and slides. The mine Pit should at least be filled as much as possible.

(6.) There is no adequate site for disposal of mill tailings. These tails should be transported out of the area to a site which has the geological structure to accomodate their disposal.

Sincerely,
William A. Lochstet
Wm. A. Lochstet

Sorry to be late.
I received DEIS on 7 Sept.

RESPONSES

1. The estimated annual electrical energy required for the operation of the mill (3 shifts per day, 7 days per week, 350 days per year) is 3.09×10^7 kWhr. For mine operation (time requirement as above, except two shifts per day), the estimated energy consumption is 4.9×10^6 kWhr, or 1.5 days of operation of a 1000-MW reactor.

2. Results of soil analyses generally indicate that overburden layers are moderately to strongly alkaline. No acid drainage problem is anticipated. The drainage from the old Pinnacle Mine is alkaline (see responses to EPA comments 15 and 23).

3. On a long-term basis, it is possible that deep-rooting species will establish. Because of the design of the reclaimed tailings area, further deposition over the surface will be promoted. This action will increase the thickness of the cover and reduce the probability of plant root penetration. Even if plant roots penetrate the clay cap, it should not necessarily be concluded that significant amounts of radon will escape.

4. Neither wood fuel nor solar energy can supply increasing power needs within the time frame of project operation.

5. The applicant's reclamation plan, which has been approved by the Colorado Mined Land Reclamation Board, Department of Natural Resources, is designed to minimize the potential for erosion and slides.

6. The chosen site for the tailings facility will be adequate (Sect. 10.2). Disposal of tailings within the project boundaries presents fewer environmental risks than transporting them to some other location.

Radiological Impact of the

Pitch Project

by

William A. Lochstet

The Pennsylvania State University*

September 1978

The draft environmental statement on the Pitch Project of Homestake Mining Company (Ref. 1) attempts to evaluate the public health consequences of the operation of the proposed uranium mine and mill. This estimate is then used in a benefit - cost assessment for the proposal. The health consequences are evaluated over a 50 year period from one year of exposure for people within an 80 kilometer radius of the plant. This arbitrary cutoff invalidates both the health and the benefit - cost evaluations. The evaluation of health consequences without cutoff will be attempted here.

In 1976, Pohl pointed out that the thorium - 230 in the mill tailings decays to radium - 226, which in turn decays to Radon - 222, with a time scale determined by the 8 x 10^4 year half life of thorium - 230 (Ref. 2). Recently, Kepford has pointed out that the uranium - 238 in the mill tailings decays by several steps thru thorium - 230 to radon - 222 and should also be considered (Ref. 3). This position has been supported by the 21 September 1977 memorandum of Dr. Walter H. Jordan of the ASLBP (Ref. 4). These matters have also been reviewed by Dr. R.L. Gotchy of the NRC Staff (Ref. 5). These arguements will be considered in the case of the Pitch Project.

* The opinions and calculations contained herein are my own, and not necessarily those of The Pennsylvania State University. My University affiliation is given here for identification purposes only.

RESPONSES

The staff has chosen to limit its radiological assessment to an evaluation of the dose to the population within an 80-km (50-mile) radius of the plant integrated over a 50-year period from one year of exposure for the following reasons:

(*a*) The radon dose commitment becomes a very small fraction of the natural background dose beyond 80 km (50 miles). Table 4.5 of this document shows that the bronchial epithelium population dose within 80 km (50 miles) (4.6 man-rems per year) is only about 0.014% of the bronchial epithelium population dose from natural background (33,200 man-rems per year).

(*b*) The calculation of the maximum annual dose from one year of exposure integrated over 50 years provides a realistic estimate that can easily be compared to applicable standards and regulations. The staff does not feel it is realistic or meaningful to consider effects on a time scale of 4.5 x 10^9 years as proposed by the commenter. It should be noted that the 1.3 x 10^7 deaths estimated by the commenter over 4.5 billion years is only 0.003 statistical premature deaths per year.

The tailings management plans for the proposed Pitch Project provide for essentially below-grade disposal of all tailings from the anticipated 20 years of mill operations. The proposed plans are designed to minimize erosion over the long term.

The planned mill will have a capacity of 544 metric tons (600 tons) and operate for an estimated 20 years (Ref. 1, Pl-1,F-12). In this case, 4×10^9 kg of ore will be processed. This is about twice the known reserves indicated in section 3.1.1 which is 2.1 million tons (2×10^9 kg)(Ref. 1, P 3-1). The larger figure was used in the radiological assessment presented in the EIS, and shall be used here. With an average ore quality of 0.2% U_3O_8 (Ref. 1, P F-12) the equivalent of 8×10^6 kg of U_3O_8 will be mined containing 6.7×10^6 kg of uranium. This uranium will be in secular equilibrium with 115 kg of thorium - 230 which remains in the mill tailings. The ultimate decay of this thorium will result in the production of 1.7×10^{10} curies of radon - 222 with a time scale determined by the 80,000 year half life of thorium - 230. It is suggested that 93% of the uranium will be extracted from the ore (Ref. 1, P 3-28,F-12). Thus, 6.3×10^6 kg of uranium will be shipped away as yellowcake, while 4.7×10^5 kg will remain in the mill tailings. The uranium in the mill tails will ultimately decay to produce a total of 6.7×10^{13} curies of radon - 222. Of the 6.3×10^6 kg of uranium to be sent away, 5×10^6 kg will end up as depleted uranium from the enrichment process. The decay of this depleted uranium will eventually decay to produce a total of 7×10^{14} curies of radon - 222. These figures are shown in Table 1.

It is estimated that the ~~xx~~ radon emanation from the stabilized tailings pile will be 0.2 $pCi/m^2 \cdot sec$ for the slimes area and 2.0 $pCi/m^2 \cdot sec$ for the nonslimes area (Ref. 1, P G-5). The area of the pile is expected to be 28 ha (69 acres), and it is suggested that about half of the tailings will be slimes (Ref. 1, P 3-28, G-4). From these data, the radon emitted by the planned tailings pile is about 10 curies per year when stabilized. The background emission from a 28 ha (69 acre) area is expected to be 14 curies per year (Ref. 1, P G-4). Although the 10 Ci/y rate would imply reduction to less than twice background,

The staff feels that several of the proposed tailings management plans satisfy all of the staff's "Performance Objectives for Tailings Management", are environmentally sound, and resolve all outstanding issues raised during the comment period on the DES. The Colorado Department of Health, Radiation and Hazardous Wastes Control Division, has the responsibility for selecting the most environmentally acceptable method of tailings disposal.

Recent public hearings before the Atomic Safety and Licensing Board to consider the question of the proper assessment of the impact of radon releases from the nuclear fuel cycle and health effects that can reasonably be assumed associated therewith have supported the staff's position.

"We believe that to attempt to fix absolute figures for health impacts over hundreds of thousands of years as Dr. Pohl did, represents pure speculation . . . Our 'rule of reason' then, would be to look at absolute figures only for those periods for which reasonable estimates can be made . . . and to accept the notion that effects beyond that time can be adequately quantified by noting that they are 'immeasurably small' compared to natural backgrounds."*

". . . we believe that we have an obligation to assess the effects of today's actions on future generations. We certainly must consider any known effects on our immediate successors as of importance comparable to effects on those now living. When it comes to balancing adverse impacts to those descendants who may follow a million years from now against the benefits to the present generation, we would weight benefits to the present population. The benefits are certain — the impacts hypothetical. The action presently proposed is not one that presents a serious risk to any future generation."†

This evaluation is supported by the preliminary conclusion in the draft Generic Environmental Impact Statement on uranium milling to be issued by the NRC in early 1979.

*The July 24, 1978, Partial Initial Decision of the Atomic Safety and Licensing Board Authorizing Limited Work Authorization, Black Fox Station, Units 1 and 2.

†The July 14, 1978, Partial Initial Decision of the Atomic Safety and Licensing Board, Perkins Nuclear Station, Units 1, 2, and 3.

(Ref. 1, P. G-6) it will be used here. Considering the thorium to uranium ratio present in the mill tailings due to milling, and the half lives of concern, an xx initial rate of 10 Ci/y implies an ultimate release of 4.6×10^{9} curies of radon -222. Comparison with the quantities of Radon generated in the pile of 6.7×10^{13} Ci, indicates that about 1/15000 is expected to escape into the atmosphere.

At present, some recent dry mill tailings piles have two feet of dirt covering. In this case, the EPA estimate is that 1/20 of the radon escapes into the air(Ref. 6). Since the Pitch Project disposal pit is upx to 7 times deeper an average factor of 1/3 will be used for the added depth. The EPA also suggest that a 6 meter cover of dirt would reduce the radon emissions by about 90% and that a wet pile would emit 1/25 of a dry pile. These two x factors combine to a factor of 1/250 which is close to the attenuation indicated for the nonslimes area in reference 1 (P. G-5). No attempt is made here to be quantitative about the use of clay rather than sandy soil. It should be noted that these factors result in :

$$1/20 \times 1/3 \times 1/10 \times 1/25 = 1/15000$$

a reduction factor of 15000 as found in the previous paragraph.

The deteriorization of the stabilization of mill tails piles is recognized by the NRC staff (Ref. 5, P. 4). The placement of the tailings behind an earthen dam in Hale Gulch with a slope of 1:7 (present gulch) (Ref. 1, P. 5-5) cannot be expected to be free of erosion forever. When compared to the half lives of Thorium - 230 and Uranium - 238, the reinforced concrete spillway of the tailings stabilization will x last only a short time. The riprap cover on the dam face will only slow the erosion at that location. The discussion of the dam failure accident in section 5.1.2.3 (Ref. 1) is pertinent here. The major question is not whether, but when. It is expected that the tailings would continue to erode and be carried away by Marshall Creek. It is very difficult to estimate how much material will remain near the surface and for how long before being reburied. A reduction factor of 1/200 will be used for the mill tailings to average over the time and spacial distributions which natural erosion will induce. This is indicated in Table 1.

The existance of 5 x 10^6 kg of depleted uranium tails from the isotopid enrichment process is a definite result of this project. At present such material is located in the eastern part of the country, and no method of disposal has been clearly indicated. It is assumed that it will be buried near their present locations. A reduction factor of 1/20 was indicated above for a dry pile with 2 m dirt cover. A second factor of 1/25 will account for it being fairly wet climate and soil. This results in a reduction factor of 1/500 as is shown in Table 1. These estimated reduction factors are, of course fairly uncertain, and should be considered to have error bars of a factor of ten.

The surface of the low-grade ore in the mine pit walls will emit radon. This is estimated in appendix E (Ref. 1, P. E-4) to be 4.2 curies/year. With this initial rate decaying with the half life of Uranium - 238, a total of 2.7 x 10^8 curies will be released directly into the air. The effects of erosion in burying some of this material while uncovering new surface elsewhere will not be estimated here. No reduction factor will be used for this release, although this is quite uncertain. The basis for the estimate of appendix E should also be examined.

To estimate the health consequences of these releases, it is necessary to determine the population at risk. The population of the entire U.S. will be considered here, along with some of the northern hemisphere population. Since it is not possible to predict the U.S. population thousands of years into the future, the present population in its present spatial distribution will be used as a basis for a beginning. The NRC has already done this, assuming a U.S. population of 300 million (Ref. 5, P. 3), with the result that the release of one curie of radon - 222 from a typical tailings pile in a western state will result in a total dose of 0.56 person - rem to the bronchial epithelium, for the total population. Since the uranium enrichment tails are located in the east, an additional reduction factor of 2 will be used to account for the fact that much of this radon will decay over the unpopulated ocean. The total doses are shown in Table 1, and are calculated using the reduction factors discussed above.

It should be noted that 10 CFR Part 50, Appendix I presents a guideline of $1000 per total body person - rem. If this were applied to the bronchial epithelium the open mine pit accounts for a dose of 1.5×10^8 person - rem which equates ~~af~~ to $150 billion. It would seem that this would be enough to mitigate this release. One action that would mitigate this release of radon would be to return material from the waste dump to the mine pit to fill in the depression. This would reduce the escape of radon from the bottom of the pit, considerably.

The NRC estimate of cancer risk is 22.2 deaths per million person - rem to the bronchial epithelium (Ref. 5, P. 7) and is taken from WASH-1400 and GESMO. Even though this estimate may be too low, it will be used here. The results, shown in Table 1, are that the thorium in the mill tails would cause about 1000 deaths, while the uranium therein would cause 4.2 million. The uranium in the enrichment tails would cause about 9 million deaths. The radon released from the uranium in the open pit would cause 3400 deaths. These are not insignificant numbers of deaths. These deaths are attributable to the Pitch Project.

Such deaths in the future have been considered by Dr. Walter Jordan who notes(Ref. 4, P. 7):

> It is very difficult to argue that deaths to future generations are unimportant. But it can be shown that the number is insignificant compared to those due to the radon contribution in natural background.

The comparison with background is totally irrelevant. To carry out a properly informed cost - benefit one must add up all the costs regardless of whether or not it might be possible to statistically measure them or not. This is required by the National Environmental Policy Act of 1969, as amended. An environmental assessment of background is not required.

The radon releases from uranium decay considered here are governed by the 4.5 billion year half life of uranium - 238. Footnote 12 of NRDC v. USNRC, 547 F.2nd 633 (D.C. Cir. 1976), states in part:

> We note at the outset that this standard is misleading because the toxic life of the wastes under discussion far exceeds the life of the plant being licensed. The environmental effects to be considered are those flowing from reprocessing and passive storage for the full detoxification period.

This was upheld in Vt. Yankee Nuclear Power v. Natural Res. D.C., 98 S.Ct.1197,1209 (1978), in particular:

> Many of these substances must be isolated for anywhere from 600 to hundreds of thousands of years. It is hard to argue that these wastes do not constitute "adverse environmental effects which cannot be avoidedshould the proposal be implemented," ....

And further:

> As the Court of Appeals recognized, the environmental impact of the radioactive wastes produced by a nuclear power plant is analytically indistinguishable from the environmental effects of "the stack gases produced by a coal-burning power plant."

There is no language about comparison to background here, and the full time scale of radioactive decay must be considered.

It may be argued that someone in the future should bury these wastes. This would tend to ignore the burial costs . The result is an invalid cost - benefit analysis,and is in violation of the National Environmental Policy Act of 1969 (NEPA), as amended. In Calvert Cliffs Coordinating Committee v. USAEC, 449 F. 2nd 1109 (D.C. Cir., 1971) the court stated:

> We conclude, then, that Section 102 of NEPA mandates a particular sort of careful and informed decision - making process and creates judicially enforcable duties .... But if the decision was reached procedurally without individualized consideration and balancing of environmental factors--conducted fully and in good faith--it is the responsibility of the courts to reverse. (emphasis added)

Thus, everything must be considered fully and honestly. There ~~is~~ is no basis for a cutoff at 80 kilometers distance from the plant, or a 50 year limit.

It is hoped that the statutory requirement to address these issues is fulfilled.

Table 1

Dose commitments to Humans due to Pitch Project Uranium Mine

Origin of Radon	Radon Generated Curies	Reduction Factor	Population Dose Bronchial Epithelium Person-rem	Deaths
Thorium in Mill Tails	1.7×10^{10}	200	4.8×10^{7}	1065
Uranium in Mill Tails	6.7×10^{13}	200	1.9×10^{11}	4.2×10^{6}
Uranium in Enrichment Tails	7×10^{14}	500 x 2	4.0×10^{11}	8.9×10^{6}
Uranium in Mine Pit	2.7×10^{8}	1.0	1.5×10^{8}	3400

References

1 Draft Environmental Statement related to the Homestake Mining Company Pitch Project, USDA-FS-R2-DES(ADM) FY-78-03, U.S. Forest Service and U.S. Nuclear Regulatory Commission, July 14, 1978.

2 R.O. Pohl, "Health Effects of Radon - 222 from Uranium Mining", Search, 7 (5),345 - 350 (August 1976)

3 Testimony of Dr. Chauncey R. Kepford, "Health effects Comparison for Coal and Nuclear Power" in the matter of Three Mile Island Unit 2 (Docket No. 50-320) operating license hearings and portions of transcript related, in which the NRC staff supports Kepford's numbers.

4 Memorandum of Dr. Walter H. Jordan, Atomic Safety and Licensing Board Panel to Dr. James R. Yore, Chairman, Atomic Safety and Licensing Board Panel, U.S. Nuclear Regulatory Commission, (September 21, 1977)

5 Affidavit of R.L. Gotchy,"Appendix", "Radiological Impact of Radon -222 Releases", U.S. Nuclear Regulatory Commission, in the matter of the Three Mile Island Unit 2 (Docket No.50-320), (January 20, 1978)

6 "Environmental Analysis of The Uranium Fuel Cycle, Part I - Fuel Supply" EPA-520/9-73-003-B, U.S. Environmental Protection Agency, (October 1973)

Denise Knapp
845 Lafayette
Denver, Colorado 80218

September 12, 1978

J.R. Wilkins
Forest Supervisor
Gunnison National Forest
P.O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins,

The following are the comments which I would like to submit to the Forest Service regarding the proposed uranium mine and mill in the Gunnison National Forest called the Pitch Project proposed by Homestake Mining Company.

It is my contention that there remains several questions yet to be answered regarding the hazards of uranium mining and milling and the radioactive tailings to be left behind, which have not been answered in the Draft Environmental Impact Statement nor anywhere else. An Interagency Review Group on Nuclear Waste Management current sub-group draft report pointed out that there are still seven major areas of research and development defiencies. These are: 1) analysis of long-term disposal and stabilization methods including the effectiveness of soil and clay covers to reduce radon emissions; 2) methods and feasibility of extracting radionuclides from tailings piles; 3) analysis of the health impacts of radon daughters which EPA is currently funding the National Academy of Science's BEIR committee to investigate; 4) dosimetry of radon daughters and radon, which EPA is currently funding the National Council on Radiation Protection and Measurements to develop; 5) development of models to explain the airborne exposure pathway for radon and its daughter products; 6) develpment of models to explain the liquid exposure pathway for disolved and eroded radionuclides from uranium mines and mills, and 7) methods for measuring the amounts of radon released from tailings piles.

In testimony before the Subcommittee on Energy Production and Supply on July 25, 1978, David Berrick of the Environmental Policy Center said, "The state of knowledge concerning mill tailings is far from complete and development of both regulations and control technology will require a considerable and ongoing effort. The data base and technology, as the GAO notes are not mature. A case in point is a 1977 EPA study which reported that radon levels actually increased at one inactive pile after it had been stabilized with an earth cover".

Furthermore, Mr. Berrick continues, "The IRG sub-group notes that to date no mill tailings piles have been stabilized according to NRC current criteria which has been in effect since May, 1977". Can we assume that the Pitch Project will be the one exception to this trend? Or should we insist on more research and documentation that the methods of stabilization proposed will indeed be effective?

In conclusion, I would like to say that due to the fact that insufficient research has been done to insure that the radioactive waste will not present a severe health hazard, I would like to recommend that the license be denied until such time as the public can be assured of safety now and in the future from radioactive waste emmission.

Thank you for this opportunity to comment.

Yours Truly,

Denise Knapp

RESPONSES

Techniques for long-term disposal and stabilization methods are an improving art. The performance objectives are stated in Sect. 10.4.1. There is no question that soil or clay cover reduces radon emissions effectively when sufficient depth or cover is applied.

Methods of extracting radionuclides from tailings are known. However, the economic feasibility is questionable, and because they are in no greater concentration than in the original ore, the necessity for extraction and concentration is not evident. Other acceptable methods for disposal of these low-level wastes are available.

Radon and radon daughters are ever present in the natural environment. Models to calculate the potential exposure to radon and daughters plus other radionuclides present through all pathways have been used to assess the Pitch Project as detailed in Appendix F. The radon dose calculation utilized the most recently available lung model. The development of models is a cumulative process, and the studies mentioned are to both validate and/or improve existing models. The staff opinion is that presently used models overestimate both dose and effects.

NRC criteria established in May 1977 are applied to new projects, and because construction of a milling and mining operation takes two years or more, no stabilization of tailings piles would be expected as of July 1978.

Susan Petersen
c/o 10825 Linda Vista Dr.
Lakewood, Colo. 80215

September 12, 1978

J.R. Wilkins
Forest Supervisor
Gunnison National Forest
P.O. Box 138
Delta, Colorado 81416

Dear J.R. Wilkins:

Enclosed are my comments on the proposal by Homestake Mining Co. to begin a uranium milling operation near Sargents, Colorado.

Uranium mining and milling, i.e., the process of processing uranium in any way is hostile to air and water quality. Varied reports show that such processes can have many effects (and are at present) on wildlife. Some general to consider regarding natural processes are:

- effects on organic material in the soil
- nutritional binding with edible plant life
- effects on certain species

Some specific effects are:

- effects on birds in the area and their potential to carry small alpha particles and disburse them
- shallow rooted trees (for example, aspen) How susceptible are they to radiation damage and, if they are, what are the results in terms of mass erosion?
- effects of heavy metal deposition on the forest floor
- effects on ground bacteria and soil micro-organisms, which are essential to fixing nitrogen into the ground - and the effect of this on the whole icosystem.

Aside from these questions and effects are, of course the inevitable ones of money and responsibility.

According to the EIS, many precautions are required of Homestake during its milling operation. These precautions are not foolproof and assume stability in natural processes. They also are based upon radiation figures which are in turn based upon the effects of a relatively unknown substance (in terms of its long, long-term effects).

Even beyond this, though, is the question of responsibility after the milling operation is concluded. DOE has set a figure of $23 billion for disposing of nuclear wastes until the year 2000. And, according to DOE, the grade of uranium is decreasing, price is increasing - this spells out a possible future shortage problem. For a milling operation, this poses a problem. How does Homestake intend to guarantee its financial stability in order to maintain perpetual care and surveillance over tailings' pond - beyond the duration of their operation.

Cordially yours,
Susan Petersen

RESPONSES

1. Before a license can be issued, the Colorado Department of Health, with the assistance of the Colorado Attorney General's office, must negotiate with Homestake Mining Company those agreements guaranteeing financial provisions for decontamination, reclamation, and long-term care of the mill site and tailings impoundment areas.

Sept. 12, 1978

Mr. Jimmy R. Wilkins
U.S. Department of Agriculture
Forest Service
Grand Mesa & Uncompahgre National Forests
Delta, Colorado 81416

Dear Mr. Wilkins:

Enclosed is a statement my son, Todd Buchanan has written for your consideration in the preparation of the Final Environmental Statement.

I understand the statement was due Sept. 13. Todd returned to Bowdoin College in late August and sent his statement on to me to mail. I was out of town when it arrived and could not get it to you until now. I hope you will read it and consider the comments when drafting your final statement.

If you wish to correspond with Todd, his address is:

Todd Buchanan,
M.U. Box 278,
Bowdoin College,
Brunswick, Maine 04011

Thank you,

Janet Buchanan

Note: Accompanying comments not reprinted. The statement had no implications for the environmental effects of the Pitch Project.

RESPONSES

The statement did not address any substantive comments to the DES. The general discussion of overall costs and benefits of nuclear power generation is not considered to be within the scope of the site-specific Pitch Project Environmental Impact Statement.

September 5, 1978

J.R. Wilkins, Forest Supervisor
Box 138
Delta, CO 81416

Mr. Wilkins;

Please note this written statement concerning the proposed Pitch Project in Gunnison National Forest. We are aware of both the arguments for and against uranium mining and are much opposed to the proposed mining operation of Homestake Mining Company. Following are specific concerns of ours pertaining to the Pitch Project and the EIS draft which we have studied.

First and foremost, we believe human life must not be endangered to any degree for economic or technological gain. It has not yet been generally agreed as to what level of radiation may be dangerous, but we do assume that some radiation is harmful. "Risks due to radioactive waste...to a future generation should be no greater than those accepted by the current generation"(Background Report, Considerations of Environmental Protection Criteria for Radioactive Waste, USEPA, February 1978), thus, if we view radiation exposure as dangerous, increased mining can only increase the dangers.

Also related to this concern is the insignificance placed on "the nearest town, Sargents, about 8 km west of the project area, (which) has about 15 year round inhabitants."(EIS draft p.1-1). Any radiation emission from the mining operation would effect these individuals in some way. The EIS estimates that increased mining operations would also increase the surrounding population by about 160 people (p.4-22) most related to mine operation, thus risking 175 individuals to radiation exposure in the immediate area.

A second concern about the EIS is the proposed method of waste disposal. Homestake Mining Company proposes to dump hazardous waste into "three dumps (that) will cover the upper drainage areas of Indian creek" (p.2-13). Indian creek then drains into Marshall creek which "is also used for livestock watering" (P.4-18). This proposal cannot be acceptable. The EIS states on p.4-18 that consumption of meat raised in the area "would result in a maximum annual dose commitment of 0.015 millirems to the total body, 0.17 millirems to the bone, and 0.018 millirems to the lung by way of the ingestion pathway." Combining ingestion exposure pathways with inhalation and external exposure pathways, according to Table 4.3, gives the area residents a total dose of .32 millirems per year to the lung alone. This dose level may prove detrimental and should not be tolerated. There is no current evidence which gives/us reason to believe that a safe level of radiation exposure exists.

Another cause for our concern is the reputation of Homestake Mining Company. Information concerning past mining operations and waste disposal in New Mexico is evidence that Homestake neglected any efforts to return the environment to its previous condition (in regards to tailings piles). In the EIS section on decommissioning (pp.3-30&3-31), the company must submit a detailed plan including stated conditions. We feel this plan should be submitted before approval on the Pitch Project be granted and that public reveiw be asked. Because we consider past

RESPONSES

1. Potential radiation exposure of the general public is discussed in detail in Sect. 4.8. As shown in Table 4.4, the maximum doses to residents of Sargents are in all cases only a small fraction of the present NRC or the future EPA permissible standards. Occupational exposure is measured and controlled at levels as low as reasonably achievable to protect the workers' health and safety.

   Concerns related to the potential for contaminating Marshall Creek with runoff from the mine waste dumps have been addressed in responses to comments by EPA and the State of Colorado.

2. Area residents already receive bronchial epithelium doses 1000 times this high from natural sources (Sect. 2.9).

3. The applicant has provided details of past compliance with environmental laws and regulations to the Colorado Department of Health for consideration in negotiating the reclamation and long-term surety agreements for the project. These agreements must be completed before a license can be issued.

   A personal response discussing the position of the FS as it relates to legal public hearings was sent to Dan Teska et al. by Jimmy Wilkins, Forest Supervisor.

records of decommissioning assurance of future actions, we also call for disclosure of Homestakes' previous mining locations and decommissioning records.

The considerations mentioned above deserve your attention if the welfare of Colorado residents are to be safeguarded. As all the questions are being researched and the dangers being discovered, a moratorium on all uranium mining should go into effect immediately. Lastly, we are requesting a full legal hearing on the matter and we will remain opposed to the Pitch Project in veiw of all the dangers involved.

Sincerely,

Dan Teska
709 Stover, Ft. Collins, 80524

Terry Goddard
Kathy Goddard
812 W. Oak, Ft. Collins, 80521

Laurie G. Jeng
2300-303 W Horsetooth, F.C.

James W. Heyser
1619 Whedbee
Ft. Collins, CO 80525

Robert E. Lucune
604½ S. Grant
Ft. Collins, CO. 80521

Paul A. Kates

Kathleen W. Bangert
P.O. Box 1663 Ft. Collins 80522

Jim C. Bonetti
131 N. Loomis Ft. Collins 80521

Linda M. Petrotta
900 S. College Ave.
Ft. Collins, Co. 80524

cc. Dr. A. Robbins, Director
Department of Health
4210 East 11th Ave.
Denver, CO 80220

Follow-up Testimony and Written Comments Regarding the Application for Licensing of a Uranium Mill at the Pitch Project in Gunnison National Forest

Jack Miller
2070 S. Milwaukee St. #1
Denver, Colorado

September 5, 1978

September 5, 1978

J.R. Wilkins
Forest Supervisor
Gunnison National Forest
P.O. Box 138
Delta, Colorado

Dear Sir:

Enclosed is my written testimony pertaining to the hearing on the Pitch uranium mill:

Uranium mining and milling technology, as we already know, requires stringent controls and careful handling to minimize environmental impact. Gunnison National Forest represents a fragile ecosystem, a national heritage, and a source of income for the state of Colorado through tourism and other uses accorded it by the Forest Service multi-use program. Currently the Homestake Mining Corporation has plans to add a mill to the uranium mining project in the forest. This would be a mistake.

According to George Woodwell, in his article, "Effects of Pollutants on the Structure and Physiology of Ecosystems," Science 168 (3930): pgs. 429-433, shows that chronic radiation of plants cause changes in structure, diversity, primary porduction, total respiration, nutrient inventory, and with time, death of less hardy species. In the nuclear fuel cycle, most of the radiation released comes from the milling process which allows 98% of the radium to go into the tailings piles. This radiation would consist partially of gaseous radon-222 with alpha decay particles, gamma radiation, and other decay products too numerous to mention. In tests at the Brookhaven National Laboratory, the Argonne National Laboratory, Oak Ridge, and others it has been shown that long term radiation has the same effect on forest systems as chronic fires, pesticide use, or repeated exposure to heavy metal industrial wastes. Those effects involve the favoring of hardy low-growing shrubs and grasses over more diverse plant life, such as trees. Apparently, this is due to the interruption of photosynthesis process by continued irritation of the plants. Since the larger plants have a lower O_2/CO_2 ratio, they eventually suffocate. By simplifying the plant community, there is a loss of nutrient flow and bound organic matter, which in time, affects the animal life in the forest.

Numerous studies have shown that warm blooded animals (birds and mammals) are usually more sensitive to radiation than cold blooded species. Radiation also has the unique ability to favor species with greater toleration bearing on their size, habitat, eating habits, and complexity. Radiation has been shown to be concentrated up to thousands of times in some species causing genetic changes in succeeding generations. In a study in 1967, Dr. Woodwell in an article, "Toxic Substances and Ecological Cycles," Scientific American 216 (3): 24-31, stated that Cesium 137 - a pollutant from the fuel cycle - moves from plants to animals to man, spreading to all body tissues with a concentration factor of "two or three times," with each step. These effects, "may not show up for years."

(1.) Already throughout the Western United States there are 23,000,000 tons of unstabilized uranium mill tailings with no currently acceptable plans for long range disposal. Studies by the Federal Water Pollution Control Administration, the Environmental Protection Agency, and the Colorado Department of Health has indicated definite wind and water transport of radioactive tailings materails from the piles to the surrounding community areas. As little as ten tons of these materials eroded into the water supply will render them unsafe for drinking. Studies by the Environmental Protection Agency show elevated radiation levels in 22 sites below these piles in the Colorado River basin. Every study makes one explicit point: exposure to any radiation is a hazard to be avoided.

(2.) Which brings us to the Pitch Project. Currently, there are Radiation Hazard signs along Indian Creek below the Pitch Project uranium mine. Since very little radiation is released as a result of mining, the question is raised: How much more radiation will be released in the milling process? It is also obvious that radioactive materials require scrupulous controls and constant checking in order to reduce the hazards associated with them.

In this regard the Homestake Mining Corporation's previous history is doubtful. The United Nuclear-Homestake Partners uranium milling operation in the Grants Mineral Belt of New Mexico was originally licensed in 1957. By 1961, "The possibility of ground water contamination due to the United Nuclear-Homestake Partners tailings pond was noted in the early 1960's by Chaves (1961)." *

A letter dated 01/09/62 regarding renewal of the license asked the company for additional data including:

"Where retention systems such as levies, dikes, ponds, etc., are used to prevent the release of liquid or solid waste containing radioactive material to offsite areas, describe and submit an analysis of the retention capabilities and integrity of the system, conditions which might lead to an accidental release, the environmental effect of such a release, and an outline of the inspection and maintenance program designed to prevent such an accidental occurence."**

The licensee replied on 07/31/62 and "responded only sketchily to the questions asked."** Despite United Nuclear-Homestake Partner's poor reply, the license was amended several times until 1968 at which point the original application was ten years old. During this time several problems and possible violations were noted:

1. "Samples from on-site monitoring wells completed in the alluvium contained from 0.8 to 9.5 pCi/l (pico-Curies/liter) radium less than two years after the start of milling. The normal range was 0.1 to 0.4pCi/l in wells several miles west of the mill."*

2. Approximately 15% of the total flow through the United Nuclear-Homestake Partners is discharged into Arroyo del Puerto contributing to violations of New Mexico Water Quality Standards. "The facility is currently violating conditions of the applicable State license."***

3. "Potable supplies at four industrial sites exceed limits for selenium in drinking water. Three systems exceed the limits for Radium 226."***

RESPONSES

1. The Uranium Mill Tailings Radiation Control Act of 1978 (Public Law 95-604) defines responsibility and provides funds for remedial action at the abandoned tailings sites. Recognizing errors made in past regulatory control of tailings management practices, criteria, and performance objectives have been developed, specifically designed to eliminate recurrence of this problem (see Sect. 10.4.1).

2. See response to Dan Teska et al. comment 3.

4. "Company radiochemical analytical methods are inadequate for measuring environmental levels of radionuclides and have high minimum detectable activities and error terms." The analyses were found generally incomplete with, "...no data on Thorium isotopes, Polonium 210, and Radium 228."***

5. Off-site monitoring wells used are those already existant rather than those constructed for sampling purposes which means there is no way to show the impact of the mill on native ground water.

6. "Proven geophysical and geohydrological techniques to formulate environmental monitoring networks are not used."***

7. "United States Atomic Energy Commission Records," pertaining to site visits, mill licens applications, and seepage reports, "...are incomplete and disorganized."***

The "liberal mill licensing regulations," with respect to "...ground water monitoring and water quality impact have never been reviewed," - again the Environmental Protection Agency. Also during the period up to 1977, the Homestake Partners group continually built up their tailings dike walls with radioactive sands from inside their tailings ponds. Current industry practise calls for the use of materials in walls from outside the ponds.

In 1975 it was noted that peak values for the alluvium rose to 1.92pCi/l. "Although below the EPA drinking water standard of 5 pCi/l, this value does indicate movement of contaminants away from the tailings pond." Sorption of these contaminants may mask a sharp concentration gradient between the tailings pond and the monitoring wells. Relatively high concentrations in nearby wells, "may reflect plumes or fronts of contaminants that have advanced ahead of the main body through highly permeable zones in the alluvium."* It was also noted "The most significant contaminant is selenium," with downgradient wells containing, "340 times the recomended maximum for drinking water."* As a result of this contamination the state of New Mexico along with United Nuclear-Homestake Partners and others undertook a program to provide an alternate source of drinking water for the area.

On February 5, 1977 Homestake's failures caught up with them. At 5:00 A.M. the dike on their tailings pond broke releasing approximately, "... 50,000 tons of slimes and solids and approximately 2-8 million gallons of water over a 60 acre area." At the time of the break, the height of the dikes was estimated to be seventy feet. The breach was 250 feet across. Aerial photographs of the area after the break show a complete lack of vegetative stabilization in the neighborhood of the dikes, waste water run-off all the way to the borders of a nearby housing development, and wind-blown sand throughout the area.

All this poses yet another question: With the myriad of rules, regulations, and compliance orders on the part of several agencies, if this continual skirting of the law was allowed to take place in a populated area, what type of enforcement can we look forward to in Colorado?

A better question might be: If Homestake with their twenty year history of non-compliance culminating in the New Mexico spill receives the licensing for the Pitch Project mill, what guarantee do we have that they will not repeat these same practises? Their draft environmental impact statement shows the same lack of concern with the effects of the uranium milling process in Gunnison National Forest as their answers to the various queries of the New Mexico Environmental Improvement Agency.

A-128

(3.) For that matter, what would be the effect of a spill of the same magnitude as the one in New Mexico by this company if it took place into Indian Creek? The original tailings pond in New Mexico was ,"...constructed in 1957 and consisted of a ten foot high earthen berm. Over a 19-year period, it has been raised to a height of 70 to 80 feet with tailings sands."*** The plans for the Pitch Project call for dikes 142 feet high. With the altitude at Marshall pass could these tailings - if containment fails - contaminate the Gunnison River? If they do, who pays for the new water supply?

3. The engineered impoundment dam for the Pitch Project will be designed to withstand a major earthquake. Even if the dam fails, no new water supply would be required (Sect. 5.1.2.3).

(4.) Due to the nature of uranium mining and milling operations, only small numbers of people are employed by the project, yet the draft impact statement lists the new jobs as a reason for allowing the project to proceed. What provisions, if any, have been made for the people in the area who will lose their jobs as a result of decreased tourism in the area?

4. The Pitch Project should have no effect on tourism in the area.

(5.) According to a news release dated July 23, 1978, by Senator Floyd Haskell's office, "Estimates by the Department of Energy of the cost of clean up for 20 of the 22 sites identified by the DOE (Department of Energy assessment of unstabilized tailings sites currently in Colorado) range from $85 to $135-million." If, as the current trend continues, the market for uranium products falls, how can we guarantee the continued monitoring of the wastes resulting from this project?

5. See response to Susan Petersen's comment 1.

I feel that there are too many questions unanswered with this uranium mill to allow it to proceed. As research continues and the public becomes more aware of the problems associated with the nuclear industry and uranium mining, can we be assured of any gain - financial or environmental - during the time of the project? If new effects of radiation are discovered, how can we undo the damage to Gunnison National Forest? And lastly, who really pays for these damages and who makes the money from them? A close look at Grand Junction, Durango, the Highlands mine in Wyoming, and others will show that the towns themselves make little or no money off the projects and mines.

Colorado is renowned for its beautiful scenery and pristine environment. I urge you not to destroy the Gunnison National Forest. The risk is not worth it.

*Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico, Robert F. Kaufmann, Gregory G. Eadie, and Charles R. Russell, Las Vegas Facility, U.S. Environmental Protection Agency, P.O. Box 15027, Las Vegas, Nevada 89114, 1977

**Assessment of the Public Helath Impact of the Failed Mill Tailings Dam -- United Nuclear-Homestake Partners Mill, Grants, New Mexico, U.S. Nuclear Regulatory Commission, March 11, 1977

***Water Quality Impacts of Uranium Mining and Milling Activities in the Grants Mineral Belt, EPA #906/0-75-002, EPA Region IV, ORP - Las Vegas, NEIC - Denver, May 5, 1976.

Nate and K T Lund
P O Box 271
Gunnison, CO 81230

7 September 1978

Jimmy Wilkins
Forest Supervisor
Grand Mesa, Uncompahgre & Gunnison N F
P O Box 138
Delta, CO 81416

Subject: Comments on the Homestake Pitch Project Draft E I S

Dear Mr Wilkins:

As year-round residents of the city of Gunnison for almost seven years, we are deeply concerned about the Homestake proposal. We have read the Draft E I S and attended the informational meeting held in Gunnison this past month.

Our main concern is for our health, for now and for the future. Health is directly related to the air we breathe, the food we eat, and the water we drink. This project poses hazards of great and long-lasting implications, particularly for the water we drink. There is no getting around the fact that we are talking about extremely long-lived, toxic substances that could invade the natural water systems of this area, even with the most impeccable precautions taken.

If you put a bottle of poison on the shelf, you live with the possibility that it may fall, break, and release its lethal contents. You might minimize the probability of its doing so by any number of precautions, including using an "unbreakable" container, constructing a wider shelf, or even by placing it on the ground. The only justification for keeping the bottle is that you believe you derive a greater benefit by having it on hand and can therefore tolerate the small probability of harm coming from an accident.

Here we have a proposal to extract a source of energy. The extraction process results in a deep earth scar and a huge waste pile, some of it extremely toxic requiring strict impoundment for a very long time. We have the poison, and we have the shelf because this operation sits very near the Divide and overlooks a drainage area that flows directly to us in Gunnison. Alternative containers are proposed, the best seeming to be a dam able to withstand a "type VIII Mercalli scale" earthquake including a clay core and a pond behind it with a thick clay envelope. At the informational meeting, the NRC experts said that this was the best "container" available, but it was new and its track record had not yet been established. It is prudent to have the best container available by current standards if we must have the poison on the shelf. But it is also wise to remember the track

RESPONSES

Both the tailings impoundment and the mine waste dumps have been designed in accordance with rigid criteria directed toward preventing contamination of the area surface streams and groundwater. Completed studies indicate that the proposed operation will not significantly change the composition of the water in Indian and Marshall creeks. Moreover, before construction and operation of the tailings and mine waste areas can be started, responsible regulatory agencies must approve the designs and certify that the operations are safe for the environment and human health. The Colorado Department of Health will not issue a Radioactive Materials License permitting the Pitch Project to proceed until that agency is fully satisfied with the proposed designs and operation.

The tailings impoundment receives radioactive material that must be contained and isolated for many years. However, this material is not highly radioactive and is not a direct threat to human health. It would require constant and prolonged exposure — that is, 24 hr a day for a number of years — for an individual to receive a radiation dose known to be deleterious to human health (see response to comment 12 of the Gunnison County Board of Commissioners). A large release of tailings solution would have primarily a localized impact, with Blue Mesa Reservoir experiencing minimal effects because of the dilution of all contaminants to levels of concentration well below applicable standards.

The accident that occurred at the United Nuclear-Homestake Partnership mill in Grants, New Mexico, was *not* a dam failure. The tailings disposal facility at the Partnership mill is a *pile*, not an impoundment as proposed for the Pitch Project. The proposed Pitch tailings impoundment facility uses a modern concept that takes into account factors related to general safety, earthquakes, flooding, seepage, and reclamation.

The applicant would be committed to conduct the Pitch Project in accordance with applicable guidelines and regulations. A monitoring program has been designed and would be implemented to detect any environmental degradation that might result from operations or accidents, and appropriate mitigating measures would be employed in the event contamination is detected. In addition, the applicant would be required to provide sufficient surety for reasonable remedial action and reclamation of areas disturbed by the project.

Lund Comments on Homestake continued:

record of government nuclear experts apparently included the advice to our neighbors in Grand Junction to go ahead and use the "harmless" tailings in the construction of their homes. We do not know the track record of Homestake for building such containers, but we have read of their disasterous dam failure in Grants, New Mexico. The track record of nuclear as an economical and safe source of energy has yet to be determined.

If this project must go ahead, and we hope that it will not, you must make sure that the strictest standards for containing this poison on the shelf are not compromised in any way in the Final E I S. You must hold Homestake to the most conscientous guidelines in the design and actual construction of the container and its future monitoring. They should be held financially responsible for any failures to contain this poison. Our health depends on it.

Sincerely,

Nate and Kt Lund

copies to Mr Jim Montgomery, CO Dept of Health
State Senator Martin Hatcher

the Wilsons

11100 COUNTY ROAD 270 EAST, NATHROP, COLORADO 81236 (303) 539-4044

No response is required.

September 9, 1978

Jimmy Wilkins
U.S. Department of Agriculture
Forest Service
Gunnison, Colorado

RE: Pitch Project
of
Homestake Mining Company

Dear Mr. Wilkins:

Please add my violent objection to the proposed "Pitch Project" of the Homestake Mining Company when you prepare your "Final Statement". I feel that the possibility of environmental contamimation is too risky, and that we should seek other ways of generating energy.

Yours truly,

Jane H. Wilson

Jane H. Wilson

Teresa Erickson
302 12 avenue, Greeley 80631
September 11, 1978

J.R. Wilkins
Forest Supervisor
Box 138
Delta, Colorado 81416

To the Forest Service:

My name is Teresa Erickson , I'm a third generation Colorado native of the western slope and the daughter of a man who mined uranium of the west end of Colorado for over 9 years. I wish to speak against allowing the Homestakes Mining Company to extract uranium in the Pitch Project in the Gunnison National Forest. In fact, I wish to speak out against all uranium mining.

I attended the hearings held at the Gunnison High School August 23, 1978. I wish to criticise these "mock" public forums. The hearing itself was extremely under publicised. I believe the Forest Service had little intention of seeking public comment. For those who did make it to the hearings the microphone didn't work, speakers were asked to face Dennis Keaton rather than the audience, each speaker was strictly limited to a five minute speaking period, no exceptions, even though the entire hearing last from 7:PM to 8:10PM , and to top off all of these coincidences, no questions were allowed to be asked — heck of a way to have a public hearing.

I even have my doubts as to how much anyone said or letters like this one I'm writing now will even be used in making any decisions. The draft environmental impact statement (which wasn't available until 5 days before the hearings) is very poor. It deals with the uranium mine as though the radioactive tailings will cease to be radioactive when the mine is no longer producing. A slight oversight that the tailings remain radioactive and potentially carcinogenic for thousands upon thousands of years.

Also excluded from the draft EIS was the use of the uranium and its impacts, like nuclear reactors and nuclear armaments both producing vast quantities of more radioactive wastes which we have no way of safely disposing.

RESPONSES

1. See response to Amy Burton's comment letter.

   Long-term disposal of the mill tailings to protect the public is a major factor in the Environmental Statement (Sect. 10.2).

2. The greatest benefit of the project is the production of uranium to fuel nuclear reactors producing electric power for public use.

3. Occupational radiological hazards will be evaluated in the Homestake Mining Company safety analysis report. Detailed conditions will be included in the Radioactive Materials License issued by the Colorado Department of Health. These will cover area and personnel monitoring, action levels, decontamination procedures, etc., to keep all occupational exposures "as low as is reasonably achievable." The Mine Safety and Health Administration and Colorado Division of Mines will also be involved in ensuring safe working conditions in the mines.

A most important aspect again excluded from the draft EIS are the adverse health effects uranium mining has on its workers. My father,who worked in the mines for years has lost 15 of 20 co-workers to cancer, that he can recall. He's been a pall-bearer at funerals so often that he could be a professional at it. All of the 15 died of lung cancer or luekemia. Do the people of the Gunnison area and the people moving there seeking a job at the mine know of these things? Will they receive more than a routine lecture or pamphlet on the "side-effects" of uranium mining free of the nuclear industry's propaganda?

I feel allowing the Homestakes Mining Company to proceed with the pitch project on the basis of such short-sighted. profit-minded planning will be an injustice to the people of Gunnison County, Colorado, the United States, and the world for generations to come.

Sincerely,

Teresa Erickson
Concerned Citizen

THE
CHAFFEE COUNTY BANK
POST OFFICE BOX 1008 - SALIDA, COLORADO 81201

R. L. BOWEN
PRESIDENT

No response is required.

HOMESTAKE URANIUM PITCH PROJECT PUBLIC HEARING
August 3, 1978

Good afternoon.

It is indeed a pleasure to appear before you today, both as a private businessman and as an interested citizen of the Salida and Colorado communities.

While I understand that you have a charge to fulfill, I trust that your minds are open to make prudent and reasonable decisions. Private enterprise is what has made our country what it is today. Not ecologists or environmentalists, or even government. Without private enterprise there would be no need for ecologists, environmentalists or government. Private enterprise is the only entity in our society that contributes, the others take.

We seem to be so taken with government bureaucracy today that we allow it to bind private enterprise so that it cannot function without tremendous drains on capital. We require capital expenditures for studies that cost enormous sums of money. This must be figured in the finished product cost and very much contributes to the escalation of inflation of our nation.

We talk about inflation, in my opinion it is caused by government regulations and red tape, and by those who do not act in a way that could be deemed as reasonable and prudent. They act only in the interest of their particular special interest group regardless of the consequences to society as a whole.

The critics of business and industry labor under the illusion that they can draft a law to protect every right, defend every privilege, and anticipate every threat, and, when regulation fails, as it inevitably does, rather than repealing the laws, they amend it into an infinite complexity until the purpose of the original law is lost. The use of the regulatory reflex merely feeds an insatiable appetite for power on the part of an ever expanding bureaucracy. It is not only wasteful but serves to destroy incentive and to discourage ingenuity.

It is ironic that a society which looks to industry for the solution of many of its most pressing problems inhibits the ability of industry to respond. While present technology does not provide us these benefits, it is not reasonable to assume that these benefits cannot and will not be provided to us in the future. The essential ingredient is freedom to act and an understanding that individual liberty is not only precious, but happens to be efficient. The time has come for us to do two things, re-study the philosophy of free enterprise and recognize that we as businessmen and entrepreneurs have the same rights under the First Amendment as any other group in our society.

Yes, we are interested in the safety and health of the individuals who work at the Homestake project as well as those residents who live in Colorado and the surrounding area.

In my opinion, we must believe in Homestake Mines Pitch Project and the integrity, ingenuity and resourcefulness of those professional staff people.

We as a community very much want the Homestake project to flourish. We need the employment, we need the tax base and all of the benefits that go with increased employment. We need to let Homestake get on with the business of mining uranium to assist our country in solving its energy problems. It is our duty to do what we can.

We cannot allow a few special interest groups to block progress that we feel is good for the majority of those who live in our community. We need to encourage business expansion, not hassle it. We need to legislate less, not more. We need to believe in people's integrity and in people's concern for others.

Lets get on with the project. If there are details to be worked out, we're dealing with honest men that can handle those details as the project progresses. The capital expenditures have already been enormous. Those expenditures need to be recovered, and a return given to those individuals who invested in the stock of the Homestake Company, in anticipation of that return.

Once again I call on you as individuals to open your minds to make prudent, reasonable business like decisions that will benefit the majority of the people who are directly interested in this project.

Thank you for allowing me to appear.

10271 W. 59th Ave., #3
Arvada, Colo. 80004
August 16, 1978

Mr. Craig Rupp
Regional Forester
USDA-FS
Box 25127
Lakewood, Colo. 80225

Dear Mr. Rupp,

I am writing to request that a full legal hearing be held regarding the proposed Pitch Project, the uranium mill and mine in the Gunnison National Forest. A legal hearing will better serve to allow the facts regarding impact to the environment and the area around Gunnison to be examined, than will the currently planned public meetings.

Thank you for considering such a hearing.

Sincerely,

/s/ Amy Burton

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

RESPONSES

Public meetings are held to allow citizen input into the licensing process. All comments and suggestions are considered. The circulation of the DES to public agencies for comment and suggestions by experts not associated with the Project allows discovery of any unforeseen impacts and improvements in mitigating measures. A personal response discussing the position of the FS as it relates to legal public hearings was sent to Amy Burton by Jimmy Wilkins, Forest Supervisor.

August 23, 1978

No response is required.

Mr. Jimmy R. Wilkins, Supervisor
Mesa-Uncompaghue-Gunnison National Forest
P.O. Box 138
Delta, Colorado 81416

RE: Homestake Mining

Concern for our environment is such a big question...but its not what the mining industry is doing to it that should propose the problem, lets move to something else..

George Holcomb

August 24, 1978

No response is required.

Mr. Jimmy R. Wilkins, Supervisor
Mesa-Uncompaghue-Gunnison National Forest
P.O. Box 138
Delta, Colorado 81416

Re: Homestake Mining Company

Sir:

It would seem that this project could be solved without using any more of the taxpayers monies. Yes, it is beneficial to be able to give ones opinion on matters that are worthwhile, this envioronmental issue is repetitious; therefore, shouldn't we move on to something worthwhile for expenditures...this one is old.

If, all of our industries were as coutious as the mining industries, then this country would not have any environmental problems to speak of.

Yes, "Keep America Beautiful", but lets get off the mining companies "tailings".

Pat Browne

AUG 25 1978

1116 N. Weber St.
Colorado Springs, CO 80903
August 29, 1978

Jimmy R. Wilkins, Forest Supervisor
Grand Mesa, Uncompahgre and Gunnison N.F.
P.O. Box 138
Delta, Colorado 81416

Dear Mr. Wilkins:

Here is the book on nuclear power that I promised you. Also enclosed are two catalogues on nuclear information and alternative energies information.

I hope the questions raised by the book will be answered in the final EIS. I would like to ask you to read the book with an awareness of your responsibility in the fate of humanity and our planet. I can only use words to try to say this, but you must see the reality behind the words.

The economic, social, political and environmental implications of nuclear power are almost too enormous to believe. That makes it easier to take seriously the propaganda of the nuclear advocates who seek to have us believe that nuclear power is the answer. It is the answer, to the question, "Shall we live, and try to make this a better world- or shall we destroy ourselves?"

I wanted to send you The Silent Bomb, edited by Peter Faulkner, but couldn't find a copy. If you can, I urge you to read it; it is the definitive statement.

I am afraid that you will label me emotional. But like you, I am an intelligent and rational human being. Unlike you, I am not "caught in the middle." But I don't believe there is such a place as the middle. I have lived only twenty years on this earth, but I know from my personal background (my mother's family was killed by Nazis) and from studying history that to acquiesce is to be an accomplice. I only ask you not to abandon your personal convictions to your professional life- that is spiritual suicide and is one of the major reasons for the troubles of the world. Nothing is more important than your humanity (founded on your wisdom) in making a decision like this, or at least in speaking out to the world.

I hope I haven't offended you. I'll try to send you more information soon.

AUG 3 0 1978

With hope,

Michele Feingold

Michele Feingold

Enclosures

Note: Enclosures not reprinted.

RESPONSES

Discussion of the overall issue of nuclear power generation is not considered to be within the scope of the Pitch Project Environmental Impact Statement.

Box 776
Gunnison, CO 81230
September 1, 1978

No response is required.

U.S. Forest Service Supervisor
Grand Mesa, Uncompaghre
Gunnison Forests

Dear Sir:

As manager of that rich land near Marshall Pass that Homestake is applying for use, you are directly responsible for the health from radon free land and water in the Tomichi Gunnison, Colorado drainage from that area. My responsibility is to urge you, in the strongest possible terms, to insure much more adequate disposal or No mineral extraction. Costs for adequate disposal would be exorbitant.

/s/ Barbara Markwood

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

September 12, 1978
126 Teller St.
Salida, Co. 81201

Dear Sir:

My husband and I wish to object to the building of a mill at the Homestake Mine at Sargents, Colo.

We believe that those tailings present too much of a health hazard especially for future generations.

Sincerely yours,

/s/ Mr. and Mrs. Norman Hickel

Note: Letter transcribed from a handwritten copy. A file of originals is maintained at the Forest Service Offices in Delta, Colorado.

No response is required.

Appendix B

STATEMENT OF UNDERSTANDING BETWEEN THE FOLLOWING PARTIES: UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE, UNITED STATES NUCLEAR REGULATORY COMMISSION, AND THE STATE OF COLORADO

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STATEMENT OF UNDERSTANDING BETWEEN THE FOLLOWING PARTIES: UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE, UNITED STATES NUCLEAR REGULATORY COMMISSION, AND THE STATE OF COLORADO

The purpose of this Statement is to establish the roles of the parties hereto in preparing an Environmental Statement in accordance with the National Environmental Policy Act of 1969 (Public Law 91-190, 42 USC 4321, et seq.), Executive Order No. 11514 of March 7, 1970, and applicable Federal agency regulations. The Environmental Statement will discuss Homestake Mining Company's (HMC) Pitch Project, a uranium mining and milling venture on the Gunnison National Forest in Saguache and Gunnison counties, Colorado. The project involves both Federal and State governmental actions. A principal objective of the ES is the identification of environmental impacts and measures to control, minimize, repair, or prevent them where necessary.

WHEREAS, the Forest Supervisor of the Grand Mesa, Uncompahgre, and Gunnison national forests in the Rocky Mountain Region of the Forest Service (FS) is responsible for exercising Forest Service authority for management of the surface resources of the Gunnison National Forest and for those Federal actions related to the Pitch Project that are within Forest Service jurisdiction; and

WHEREAS, the Nuclear Regulatory Commission (NRC) has the technical expertise to analyze and assess the possible radiological impacts that could be caused by the operation of the proposed uranium mine and mill; and

WHEREAS, the State of Colorado (State) has the authority to issue the Radioactive Materials License necessary for operation of the uranium mill (Department of Health) and a State mined-land-reclamation permit (Mined Land Reclamation Board);

It is mutually agreed that:

I. The FS is the "responsible agency" for preparation and publication, with NRC and State assistance, of an Environmental Statement covering Homestake Mining Company's Pitch Project.

   A. The Forest Supervisor of the Grand Mesa, Uncompahgre, and Gunnison National Forests is the "responsible official" for the ES.

II. The ES will describe and analyze the identifiable onsite and offsite environmental effects of the proposed Pitch Project and alternative impact mitigation measures.

III. Participation in the ES effort by the parties hereto will be as follows:

   A. Each party will designate an ES team member who will coordinate his party's efforts with those of the other two.

   B. Each party will ensure that its work on the ES receives appropriate priority attention, subject only to limitations of funds or other resources.

      1. Each party will fund its own activities and inputs and use its best efforts to meet the target date of July 1978 for filing the Final Environmental Statement with the Environmental Protection Agency.

   C. Each party will keep the others currently informed with respect to any information or correspondence originated that is substantive to the content or progress of the ES.

D. Each party will cooperate and participate, to the extent it is permitted to do so by law and regulation, in public meetings held for the purposes of gathering and disseminating factual information and obtaining data from the public about the Pitch Project.

1. The Forest Service will be responsible for organizing any public meetings of an informational nature. NRC and State personnel will be available on request.

E. The Forest Service will act as overall coordinator of the ES effort, will be responsible for assuring that the products of each agency and the State are incorporated into the draft and the final ES, and will handle filing of the documents with EPA and the necessary Federal Register notices.

F. Within their areas of assigned tasks, the Forest Service and the Nuclear Regulatory Commission will be responsible for collecting and analyzing relevant data, preparing ES text and illustrations, and contributing to the development of all sections of the ES. Each will provide task leadership in specific areas as follows:

1. Forest Service — surface natural resources and reclamation of affected lands.

2. Nuclear Regulatory Commission — mining and subsurface resources, radiological health and safety, ore milling, and socioeconomics.

G. The State will be a principal source for data on socioeconomics, radiological hazard potentials, and mineral and other subsurface resources. The State will also participate in preparing the ES by providing timely reviews and comments on proposed text.

IV. Should any environmental factors remain unresolved, each party's separate views thereon will be stated in the Final Environmental Statement.

Appendix C

BASIS FOR NRC EVALUATION OF THE HOMESTAKE MINING COMPANY PITCH PROJECT

Appendix C

BASIS FOR NRC EVALUATION OF THE HOMESTAKE MINING COMPANY PITCH PROJECT

C.1 THE NUCLEAR FUEL CYCLE

The nuclear fuel cycle comprises all the processes involved in the utilization of uranium as a source of energy for the generation of electrical power.

The nuclear fuel cycle consists of several steps:

1. extraction — removing uranium ore from the ground, separating the uranium content from the waste, and converting the uranium to a chemically stable oxide (nominally U_3O_8);

2. conversion or fluorination — changing the U_3O_8 to a fluoride (UF_6), which is a solid at room temperature but becomes a gas at slightly elevated temperatures, prior to enrichment;

3. enrichment — concentrating the fissionable isotope (uranium-235) content of the uranium from the 0.7% occurring in nature to the 2 to 4% required for use in reactors for power generation;

4. fabrication — converting the enriched uranium fluoride to uranium dioxide (UO_2), forming it into pellets, and encasing the pellets in tubes (rods) that are assembled into fuel bundles for use in power generating reactors;

5. nuclear power generation — using the heat resulting from uranium and plutonium fission to generate steam for use in the reactor turbines;

6. spent fuel reprocessing — chemical separation of fissionable and fertile values (uranium-235, uranium-238, plutonium) from fission products (waste), with concurrent separation of uranium from plutonium; and

7. waste management — storage of fission products, spent fuel, and low-level wastes in a manner that is safe and of no threat to human health or the environment.

Step 6 (reprocessing, involving the recycling of plutonium), which had traditionally been considered as an essential part of the nuclear fuel cycle, was recently deferred by the National Energy Plan (NEP)[1] as a necessary part of the cycle. The U.S. commitment to advanced nuclear technologies based on the use of plutonium recovered by the reprocessing of spent light-water-reactor (LWR) fuel has also been deferred. These policy statements enter into the staff's evaluation of the need for licensing the Homestake Mining Company mill, because without reprocessing, all LWR fuel must be derived from the mining and milling of new U_3O_8 from projects such as the Pitch Project mill and the related uranium mines.

This cycle, as defined by current policy, is portrayed in Fig. C.1.

Nuclear reactor operation converts about 75% of the fissionable isotope (uranium-235) into fission products, thereby liberating thermal energy and creating plutonium, another fissionable element, in the process. Some plutonium is retained in the spent fuel.

The spent fuel removed from the reactor is stored at the reactor site (and later at the reprocessing plant, if policy changes) to "cool." The radioactivity of the fuel is reduced by a factor of about 10 after 150 days storage. Without reprocessing, this spent fuel is considered waste. Policies and methods regarding its storage and/or disposal are currently under study by the DOE and NRC.

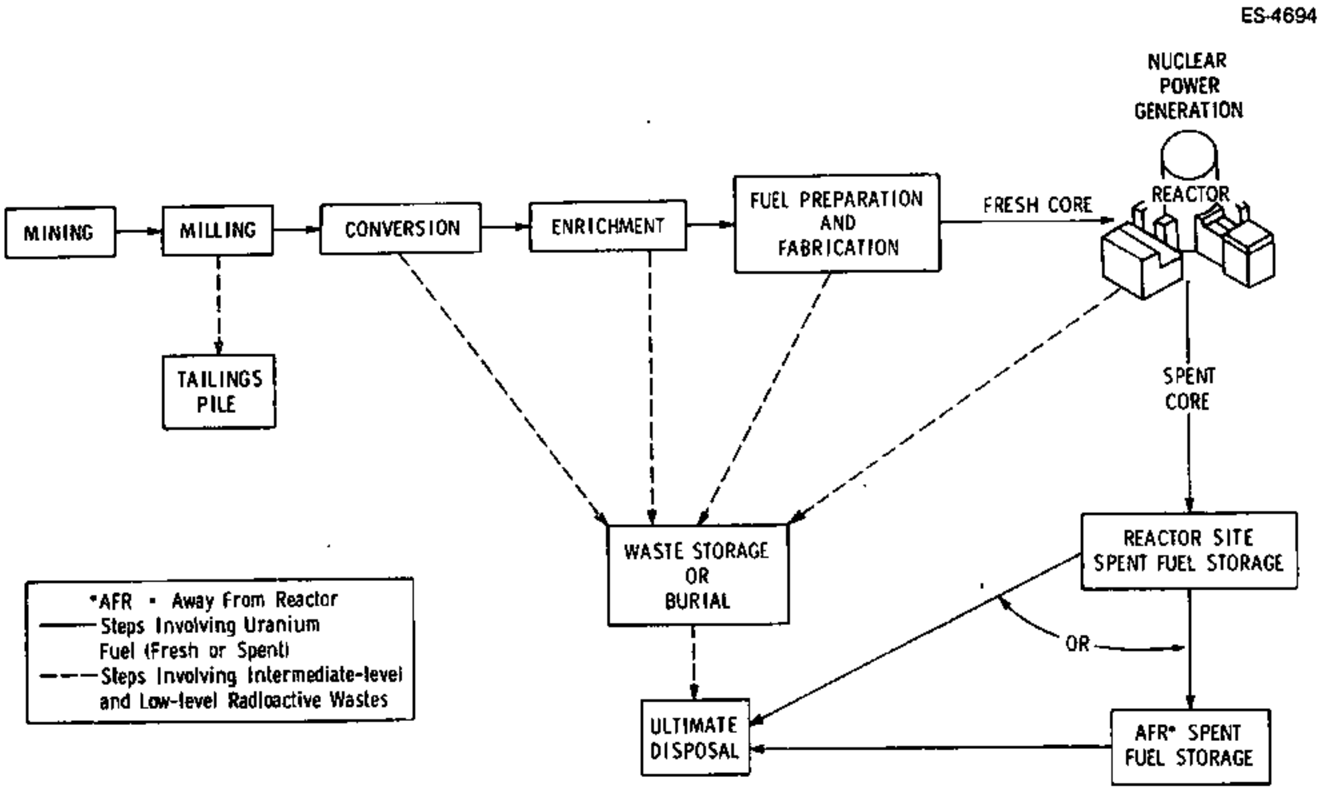

Fig. C.1. The LWR fuel cycle.

C.2 USE OF NUCLEAR FUEL IN REACTORS

Two types of reactors are currently used to generate essentially all of the nuclear energy sold in the United States: the boiling-water reactor (BWR) and the pressurized-water reactor (PWR). Each reactor type is operated with a fuel-management scheme designed to meet the requirements of the utility operator. Different fuel-management schemes result in different fuel burnup rates which, along with other design parameters, affect the quantity of residual fissionable materials, the type and amount of radioactive wastes in the spent fuel, and the quantities of nuclear fuel consumed.

The need for uranium fuel, as dictated by the installation of 380 GWe of nuclear capacity anticipated by the year 2000, is shown in Table C.1. A 1000-MWe reactor will require ≈30 MT of uranium fuel per year at a plant factor of 0.6 and ≈30 MT of uranium fuel for a plant factor of 0.8. The term "plant factor" indicates the ratio of the average power load of an electric power plant to its rated capacity. For a 3% enriched fuel and 0.25% enrichment tails assay, 7.9 times the metric tons of fuel replaced equals the standard tons of U_3O_8 required for a 1000-MWe power plant. The percentage of total electrical generating capacity over the same time period that this schedule represents is shown in Table C.2. On the basis of recent statements by the industry and the DOE, the staff believes that this schedule represents a maximum for nuclear reactor installations between 1990 and 2000 but is reasonably accurate through 1990.[2]

Cumulative requirements through the year 2000 would be 883,000 MT of uranium as U_3O_8 (Table C.1). Table C.3 compares this requirement with available uranium (reserves and probable resources) for the year 2000 and the 30-year plant lifetimes of the 380 GWe projected for installation by the year 2000. Requirements and resources are in reasonable balance;[3] that is, the sum of reserves and probable resources is approximately equal to the lifetime requirements of the 380 GWe installed by 2000.

Table C.I. Projected U.S. requirements for U_3O_8, 1976–2000[a,b]

Year	Generating capacity (GWe)	Annual U_3O_8 requirements (MT)	Cumulative U_3O_8 requirements (MT)
1976	43	9,500	9,350
1977	49	10,000	19,100
1978	53	10,000	29,100
1979	57	11,000	40,200
1980	61	11,000	52,000
1981	74	17,500	69,400
1982	87	18,000	87,600
1983	100	20,500	108,000
1984	112	22,500	130,000
1985	127	26,500	157,000
1986	141	28,000	185,000
1987	154	30,000	215,000
1988	167	32,500	248,000
1989	181	35,500	283,000
1990	195	38,000	321,000
1991	210	41,000	362,000
1992	225	43,500	406,000
1993	240	46,500	452,000
1994	260	51,500	504,000
1995	280	54,500	558,000
1996	300	58,000	616,000
1997	320	61,500	678,000
1998	340	65,500	743,000
1999	360	68,500	811,000
2000	380	71,500	883,000

[a]The annual U_3O_8 requirements were calculated on the basis of annual discharges of 28 MT/GWe (0.7 plant factor) of spent fuel and replacement of that spent fuel with a 3% enriched fuel with tails assay of 0.25% in enrichment.

[b]To convert to short tons, multiply by 1.1.

Table C.2. Comparison of total and nuclear generating capacity, operating in years 1977–2000

Year	Total generating capacity (GWe)[a]		Nuclear generating capacity (GWe)				
	Minimum	Maximum	Actual	Planned or under construction	Estimated	Nuclear, minimum case (%)	Nuclear, maximum case (%)
1978	507	507	49			12	12
1980	544	627		84		16	14
1985	624	840		127		20	15
1990	734	1131		195		26	17
1995	869	1525			280	32	18
2000	1039	2092			380	36	18

[a]From "Electric Utilities Study" by TRW for ERDA, Contract E(49-1)-3885, pp. 1–19, et seq. Maximum case is 7.0% compounded annual growth through 1985, then 6.4% to 2000. Minimum case is 3.9% through 1985, then 3.5% to 2000.

Table C.3. Comparison of U.S. reactor requirements and domestic resource availability (in metric tons of U_3O_8 as of January 1978)[a,b]

Time period	Reactor demand	Resource availability	
		At $30/lb[c]	At $50/lb[c]
Through year 2000	883,000		
For 30-year lifetime of 380 GWe	2,051,000		
Reserves[d]		626,000	808,000
Probable resources		921,000	1,180,000
Sum of reserves and probable resources		1,550,000	2,000,000

[a]To convert to short tons multiply by 1.1.

[b]Based on information presented by U.S. Energy Research and Development Administration (now U.S. Department of Energy) at the Uranium Industry Seminar, Grand Junction, Colorado, October 1977, and in "ERDA Makes Estimate of Higher Cost Uranium Resources," U.S. Energy Research and Development Administration, June 1978.

[c]Costs include all those incurred in property exploitation and production except costs of money and taxes.

[d]Does not include 126,000 MT of U_3O_8 which could be produced as a by-product of phosphate fertilizer and copper production.

In 1977, 23 mills produced about 12,000 MT of U_3O_8 while handling 32,000 MT of ore per day. These mills operated at 80 to 85% of capacity. The U_3O_8 content of the ore was less than 1.5 kg/MT (3 lb/ton; <0.15%).[4] Ores processed by the Homestake Mining Company mill will have a U_3O_8 content approximating this national average.

As can be seen in Table C.1, the annual requirement for U_3O_8 in 1981 (17,500 MT) exceeds the output of existing uranium mills (12,000 MT). In 1981, the Homestake Mining Company Pitch Project will produce 5% of the national capacity for tons of ore per day, and its total production of U_3O_8 through the next 15 years of operation would be about 1.5% of the national requirements. The project will contribute to meeting the demand forecast for the nuclear power industry.

REFERENCES FOR APPENDIX C

1. Office of the President, *National Energy Plan*, Washington, D.C., April 1977.

2. Brown and Williamson, U.S. Department of Energy, "Domestic Uranium Requirements, Policy and Evaluation," paper presented at the Uranium Seminar, Grand Junction, Colo., October 1977.

3. "ERDA Makes Preliminary Estimate of Higher Cost Uranium Resources," U.S. Energy Research and Development Administration Notice, June 1977.

4. J. F. Pacer, Jr., "Seminar on Uranium Resources," paper presented at the Uranium Seminar, Grand Junction, Colo., October 1977.

Appendix D

U.S. FOREST SERVICE POLICY STATEMENT FOR HOMESTAKE MINING COMPANY'S CURRENT OPERATING PLANS*

Appendix D

U.S. FOREST SERVICE POLICY STATEMENT FOR HOMESTAKE MINING COMPANY'S CURRENT OPERATING PLANS*

In October of 1977 the Forest Service had separate conversations with the Uranium Developments staff of Homestake Mining Company and with personnel from the Nuclear Regulatory Commission and the State of Colorado about the activities covered by the current Forest Service-approved operating plan for the Pitch Project under 36 CFR Part 252.

In an August 15, 1977, letter to the Colorado Department of Health, the Forest Service stated that the current operating plan remains in full force and effect. However, as indicated in the aforementioned conversations, no supplemental plans or substantial modifications of the current plan can be approved before the Environmental Statement is completed.

It is necessary to define the limitations of the approved plan currently in effect. The plan consists of three documents: (1) the four-page approval document itself, with attached performance bond, signed on April 27, 1977, by the Acting Forest Supervisor; (2) the Dames and Moore "Environmental Analysis Report," transmitted to Homestake on October 29, 1976; and (3) the Forest Service "Environmental Analysis Report" of February 22, 1977.

The Forest Service has completed another detailed review of the current plan. A Colorado Mined Land Reclamation Board's "Development and Extraction Mining Permit" was issued on April 19, 1978.

The Forest Service stresses that it does not expect a "final" operating plan. Except for a plan describing an overall concept or approach, there probably is no such thing, other than the plan in force at the time operations terminate. During operations, particularly those of long duration, new information will become available. Some of it can result in either the operator or the regulatory authorities seeking necessary and reasonable operating modifications for protecting surface resources and the environment or for efficiency and economy of operations. The Forest Service regulations, 36 CFR Part 252, provide for accommodating such modifications, with reasonable protection of surface resources and the environment a prime consideration.

The key items of the current operating plan, with respect to this policy statement, are indicated in numbered item "4" of the approval document. This item refers to "Exhibit B — *VIII. Management Requirements and Constraints* of Environmental Analysis Report prepared by Forest Service, dated February 22, 1977."

The emphasis of the Environmental Statement is well stated in the following sentence from the October 3, 1977, letter of Dr. Anthony Robbins, Executive Director of the Colorado Department of Health, to Mr. Joseph Sullivan, Chairman of the Colorado Mined Land Reclamation Board, "The reclamation and stabilization of the radioactive materials affecting the health and safety of Colorado citizens will be a key focus on the environmental impact statement."

The following commentary on items B, C, D, and E of part VIII of "Exhibit B" of the operating plan (Forest Service Environmental Analysis Report, dated February 22, 1977) is based on the content of items B, C, D, and E and on the concepts expressed in Dr. Robbins' letter.

Item B lists the plans which must be submitted for approval by the Forest Service before work may commence in the specified related areas.

---

*This policy statement reflects substantially the content of a letter dated March 15, 1978, from Jimmy R. Wilkins of the Forest Service to Harold A. Powers of Homestake Mining Company.

"B1. Road Design."

Comment: The Forest Service will not withhold approval of appropriate, environmentally protective road locations, design, or construction prior to completion of the Environmental Statement.

"B2. Layout, location, and design of powerlines, telephone lines, and power substations."

Comment: The Forest Service will not withhold approval prior to completion of the Environmental Statement, subject to appropriate, environmentally protective layout, location, and design.

"B3. Design criteria for sediment basins and sediment dams (if sediment basins are necessary). Such plans will be approved by the Forest Service in advance of construction."

Comment: From the Dames and Moore report and the Forest Service Environmental Analysis Report, it is clear that those structures are for the purpose of protecting existing natural drainages and waters. The Forest Service will not withhold approval of such environmentally protective structures and facilities prior to completion of the Environmental Statement.

"B4. Waste dump area design and plans."

Comment: "Waste," as used in item 4 above by the Forest Service, means tailings, that is, mill effluents, and mineralized mine waste (the latter in this situation averaging 0.01% or more of U_3O_8).

Therefore, prior to completion of the Environmental Statement, the Forest Service, with respect to Item VIII, B4, of Exhibit B of the operating plan:

a. will not approve extraction of ore-grade material in quantities greater than the current 300 tons per day average being extracted as part of the mine development;

b. will require that the extracted ore-grade material continue to be shipped out of the area at a rate approximating that of its extraction;

c. will require that extracted pit-development, mineralized waste averaging 0.01% or more of U_3O_8 be stored within the projected pit limits and not be disposed of within the overburden piles, pending resolution as to its final disposition through decisions made after completion of the Environmental Statement;

d. would, because of the Federal law applying to mill sites and their use, not object to the construction of mill facilities under appropriate environmental protection and reclamation provisions; and

e. will not approve mill operation, or construction or operation of tailings retention structures or facilities.

"C. Supplemental Operating Plan will be submitted as necessary to meet stipulations of 36 CFR 252.4(d) and 36 CFR 252.4(e)."

Comment: Before the Environmental Statement is completed, the Forest Service will not approve supplemental plans for additional or unforeseen significant disturbances of surface resources not included within the current operating plan.

"D. Authorize by Special Use Permit those facilities or uses which are located on National Forest lands but outside of areas under mining claim by Homestake Mining Company."

Comment: The Forest Service will not withhold such authorizations before the Environmental Statement is completed, subject to appropriate environmental controls and reclamation provisions and as long as such facilities or uses do not involve storage, treatment, or handling of radioactive materials.

"E. Comply with appropriate mitigating measures for adverse environmental effects listed in Section II of this report."

Comment: This item requires no further elaboration.

Appendix E

RADIOACTIVE RELEASES FROM OPERATIONS

Appendix E

RADIOACTIVE RELEASES FROM OPERATIONS

This section lists the assumptions and shows the calculations used in defining the radiological source terms of Sect. 3.3. The applicant's estimates as presented in the Environmental Report were revised to give a more complete accounting of radioactive effluents from the mine and mill.

E.1 MINING OPERATION

E.1.1 Particulates

Dust formed by mining operations is assumed to settle out within the pit area. Therefore no radioactive emissions are calculated for this source.

E.1.2 Radon

- The surface mine area is assumed to cover 61 ha (150 acres), of which 0.4 ha (1 acre) is exposed ore.
- Underground workings are assumed to consist of 900 m (3000 ft) of tunnel with an average cross section of 2.1 m by 2.4 m (7 ft by 8 ft) totaling 8000 m^2 (90,000 ft^2) of exposed ore.
- The diffusion of radon from a surface is estimated[1] by

$$J_0 = -E(D_e/v)[C_v\sqrt{\lambda/(D_e/v)}\ ] \ , \qquad (E.1)$$

where

J_0 = flux at surface of an area (μCi/cm^2·sec),

E = fraction released from solid (emanation coefficient),

D_e = effective diffusion coefficient through the void spaces of the medium (cm^2/sec),

v = void fraction of the medium (the fraction of the total volume not occupied by solid particles),

C_v = concentration of radium-226 in bulk medium (μCi/cm^3),

λ = decay constant for radon-222 = 2.1 x 10^{-6} sec^{-1}.

- Exposed high-grade ore is assumed to have an average grade of 0.2% U_3O_8, to consist largely of limestone which shows an emanation coefficient[2] of 0.016, and to have a density[3] of 2.7 g/cm^3. Therefore C_v = 1.52 x 10^{-3} μCi/cm^3.
- Exposed low-grade ore is assumed to have an average grade of 0.025%, to consist of a mixture of shale and sandstone that has an emanation coefficient of 0.064, and to have a density of 2.3 g/cm^3. Therefore, C_v = 1.6 x 10^{-4} pCi/cm^3.
- The remaining surface area of the mine is assumed to have background concentrations of uranium and its daughters.

- D_e/v for exposed surfaces is conservatively chosen as 5.0×10^{-2} cm^2/sec, which is representative[4] of fine quartz and with an 8.1% moisture content. Mine surfaces May actually consist of very coarse fragments, which would have a smaller diffusion coefficient.
- Free radon within the ore is assumed to be released when the ore is disturbed; the emanation coefficient for disturbed ore is assumed to be 0.2.

Using these assumptions, radon emissions from the mine surfaces and from ore disturbance can be calculated.

Emission from the ore body

The radon flux from the exposed ore surface will be as follows:

$$J = 5 \times 10^{-2}\ \text{cm}^2/\text{sec} \times 0.016 \times 1.52 \times 10^{-3}\ \mu\text{Ci/cm}^3 \times \sqrt{\frac{2.1 \times 10^{-6}\ \text{sec}^{-1}}{5.0 \times 10^{-2}\ \text{cm}^2/\text{sec}}}$$

$$= 7.88 \times 10^{-9}\ \mu\text{Ci/cm}^2\cdot\text{sec.}$$

Applying this source flux to the ore surface area, 1.24×10^8 cm^2 [0.4 ha (1 acre) of exposed ore in the surface mine plus 8000 m^2 (90,000 ft^2) of exposed ore underground], the radon release from the ore surface is

$$7.88 \times 10^{-9}\ \mu\text{Ci/cm}^2\cdot\text{sec} \times 1.241 \times 10^8\ \text{cm}^2 \times 3.154 \times 10^7\ \text{sec/year} = 3.08 \times 10^7\ \mu\text{Ci/year}$$

$$= 30.8\ \text{Ci/year.}$$

Emission from the remainder of the mine

The flux from the surface of low-grade ore in the mine will be as follows:

$$J = 5 \times 10^{-2}\ \text{cm}^2/\text{sec} \times 0.064 \times 1.6 \times 10^{-4}\ \mu\text{Ci/cm}^3 \times \sqrt{\frac{2.1 \times 10^{-6}\ \text{sec}^{-1}}{5.0 \times 10^{-2}\ \text{cm}^2/\text{sec}}}$$

$$= 3.32 \times 10^{-9}\ \mu\text{Ci/cm}^2\cdot\text{sec.}$$

Applying this source flux to the surface area of 4.047×10^7 (1 acre), the radon release from the mine surface is

$$3.32 \times 10^{-9}\ \mu\text{Ci/cm}^2\cdot\text{sec} \times 4.047 \times 10^7\ \text{cm}^2 \times 3.154 \times 10^7\ \text{sec/year} = 4.2 \times 10^6\ \mu\text{Ci/year}$$

$$= 4.2\ \text{Ci/year.}$$

Other areas of the mine will be releasing radon at the background rate and therefore do not reflect a significant increase.

Radon released from ore disturbance

From ore disturbed in mining, the radon released will be

$$192{,}000\ \text{tons/year} \times 512\ \mu\text{Ci/ton} \times 0.2 \times 10^{-6}\ \text{Ci}/\mu\text{Ci} = 19.7\ \text{Ci/year.}$$

Totaling the contributions of these sources gives an annual release of

30.8 Ci/year + 4.2 Ci/year + 19.7 Ci/year = 54.7 Ci/year ≈ 55 Ci/year.

E.2 ORE STORAGE AND FEEDING

E.2.1 Particulates

Wind erosion and movement of ore by bulldozers and front-end loaders will be the major cause of dust release. The following assumptions are used:

- Only 0.4 ha (1 acre) will be involved in operations at a given time, with the rest of the pile dormant.
- Operation proceeds 8 hr per day for 365 days per year. (This schedule makes allowance for any additional pile-shaping operations.)
- About 4.5 kg of fugitive dust are released per hour per hectare (4 lb per hour per acre).[5]
- The ore contains 0.564 μCi of uranium-238 per kilogram.

On the basis of the above assumptions, it can be calculated that about 3000 μCi of uranium-238 will be released per year. Assuming secular equilibrium, other nuclides should show similar losses.

E.2.2 Radon

The following assumptions were made with regard to the ore-storage pile:

- The total area of the pile is 2.4 ha (6 acres), on the basis of analysis and the practices at other mills.
- The area at 15% moisture is 0.4 ha (1 acre), again on the basis of analysis and the practices at other mills.
- For the area at 15% moisture, $D_e/v = 10^{-2}$ cm²/sec.
- For the remaining area, $D_e/v = 10^{-4}$ cm²/sec.
- The concentration of radium-226 (C_v) is 11.29×10^{-4} μCi/cm³.

If these values are substituted in Eq. (E.1), the diffusion from the area at 15% moisture will be 3.27×10^{-8} μCi/cm²·sec, and from the rest of the pile will be 3.27×10^{-9} μCi/cm²·sec. The total release of radon from the entire 2.4 ha storage pile will then be 1.99 μCi/sec or 62.7 Ci/year.

Because a six-month supply of ore will be maintained in storage, residence time of the ore will be long enough to allow radon to build up to near-equilibrium levels. Disturbance of the ore during feeding operations will result in the release of another 19.7 Ci of radon per year (see mine release data).

The total annual release of radon from the ore pad will then be 82.4 Ci.

E.3 ORE CRUSHING

E.3.1 Dust

The following data and assumptions were used with regard to the dust release rate from the ore crushing operation:

- The ore moisture content is 5%.
- The dust rate is 0.01% of the release rate (from ref. 1, Tables 4.2 and 4.3).
- The dust collector used is an orifice type (from ref. 1, Table 4.2).
- At least 53% of the crushed ore particles are less then 80 μm in diameter (from Table 7.1).
- The radioactivity in these fines is 85% (from ref. 1, p. 55).

These data and the assumption that 5.4×10^5 kg (1.2×10^6 lb) of ore are processed daily yield a release rate for fines of 3.5 kg (7.7 lb) per day.

Then, if the concentration of uranium-238 in the ore is 0.56 μCi/kg (0.26 μCi/lb), the release rate for uranium-238 from 3.5 kg/day of released fines will be 36.5 pCi/sec.

Because secular equilibrium is assumed to exist, the release rates of uranium-238, uranium-234, thorium-230, radium-226, polonium-210, bismuth-210, and lead-210 will all be 36.5 pCi/sec. The annual release rate for any of these elements, assuming 320 working days per year, will accordingly be 1 mCi/year.

E.3.2 Radon

Crushing and grinding operations release radon in quantities equivalent to 10% of the uranium-238 activity in the ore.[1] Because ore with 0.2% concentration will contain 512 μCi of uranium-238 per ton, the resulting radon loss will be 51.2 μCi per ton processed. At a processing rate of 192,000 tons/year, the annual radon release rate will be 9.8 Ci/year.

E.4 YELLOW CAKE DRYING AND PACKAGING

E.4.1 Dust

The following assumptions were made with regard to the dust release from the yellow cake drying and packaging operation:

- The dust loss will be 0.025% of the product (from ref. 1, Tables 4.2 and 9.13).
- The activity input for radium-226 and daughters will be 2% of the uranium-238 (from ref. 1, pp. 122 and 123).

The uranium-238 release rate was calculated to be 827 pCi/sec or 23 mCi/year on the basis of these data and the previous assumptions about milling rate and ore concentration. Therefore, the release rate of uranium-234 would also be 827 pCi/sec, and the release rate of radium-226, polonium-210, lead-210, and bismuth-210 would all be 16.5 pCi/sec or 0.46 mCi/year.

E.4.2 Radon

Radon release from this step will be negligible.

E.5 TAILINGS RETENTION SYSTEM

E.5.1 Dust release

The following data and assumptions were used with regard to the release from the tailings disposal area:

- The area used for tailings disposal is 23 ha (58 acres).
- The area subject to dusting is 2 ha (5 acres) on the basis of analysis and the practices at other mill locations.
- The activity input for radium-226 and daughters is 0.56 μCi/kg (0.256 μCi/lb) of ore.
- The activity input for uranium-238 and uranium-234 is 7% of the ore content.
- The activity input for thorium-230 is from 100% of the ore content.
- The dust is all fines (0-80 μm).
- The fines constitute 53% of the tailings (from ref. 1, Table 7.1).
- The radioactivity in the fines is 85% (from ref. 1, p. 55).
- The average wind speed is 16 km/hr (10 mph) (from ref. 1, Table 7.2).
- The amount of fines lifted by the wind will be 0.0576 g/sec·ha (from ref. 1, Table 7.4).

Calculations for the release rates of the important radionuclides were based on the above data and assumptions. The radioactivity in the fines will be 9.05×10^{-4} μCi/g. The resulting release rate of thorium-230 over the entire 2-ha (5-acre) area subject to dusting will be 105 pCi/sec or 3.3 mCi/year. The release rate for radium-226 and its daughters over the same area will be 3.2 mCi/year and for uranium-238 and -234, 0.23 mCi/year.

E.5.2 Radon

The following data and assumptions were used to determine radon-222 release rates from the tailings disposal area:

- Area 1 [11 ha (28 acres)] will contain 100% moist tailings solids covered by at least a 0.3-m-thick (1-ft) layer of tailings liquid (water).
- Area 2 [10 ha (25 acres)] will contain 100% moist tailings solids not covered by liquid.
- Area 3 [2 ha (5 acres)] will contain 15% moist tailings solids (the area subject to dusting).
- The concentration of tailings solids is 2.0 g/cm³. (Based on past experience, this assumption is conservative because, as moisture is increased, this figure decreases.)
- D_e/v for tailings solids at 100% moisture equals 5.7×10^{-6} cm²/sec (from ref. 1, Table 9.29).
- D_e/v for tailings solids at 15% moisture equals 10^{-2} cm²/sec (from ref. 1, Table 9.29).
- D_e/v for tailings liquid equals 1.13×10^{-5} cm²/sec (from ref. 1, Table 9.29).
- Activity input for radium-226 in tailings solids equals 0.256 μCi per pound of ore.
- Activity of radium-226 in tailings liquid equals 2 pCi/cm³. (The estimate is based on past measurements of this concentration at other mills which have, however, always been less than this figure.)

It was assumed that the activity of radium-226 will be equal to the activity of radon-222. The radon-222 flux, J_0, at the surface of any given area is given by Eq. (E.1).

For a source medium covered by a second medium of thickness x, the flux is given by[1]

$$J_x = -E(D_e/v)[C_v\sqrt{\lambda/(D_e/V)}\ ] \exp\left\{-[\sqrt{\lambda/(D_e/v)}\ ]\ x\right\} \quad ,$$

where the value of D_e/v in the exponent is for the second medium, or

$$J_x = J_0 \exp\left\{-[\sqrt{\lambda/(D_e/v)}\ ]\ x\right\} \quad ,$$

where J_0 is evaluated by Eq. (E.1).

Calculating C_v, the activity concentration of radium-226, to be 11.3×10^{-4} μCi/cm³ and substituting the above data and assumptions in the equation for J_0, the radon flux and the resulting total release for the three areas can be calculating values:

Area 1

For the tailings solids:

$$J_0 = 7.8 \times 10^{-10}\ \mu\text{Ci/cm}^2\cdot\text{sec} \ .$$

The flux passing through the covering tailings liquid = 15.4×10^{-16} μCi/cm²·sec. The total release of radon from the solids = 1.74×10^{-6} μCi/sec.

For the tailings liquids:

$$J_0 = 1.95 \times 10^{-12}\ \mu\text{Ci/cm}^2\cdot\text{sec} \ .$$

The total release from the liquids = 2.21×10^{-3} μCi/sec. The total release from the tailings, solid and liquid, in Area 1 = 2.21×10^{-3} μCi/sec.

Area 2

J_0 for the tailings solids = 7.8×10^{-10} μCi/cm²·sec, as in Area 1.

The total release from Area 2 = 7.9×10^{-1} μCi/cm²·sec.

Area 3

$$J_0 = 3.27 \times 10^{-8}\ \mu\text{Ci/cm}^2\cdot\text{sec} \ .$$

The total release from Area 3 = 6.62 μCi/sec.

Summing all the contributions from the three individual areas yields a total release from the tailings of 7.41 μCi/sec or 234 Ci/year.

REFERENCES FOR APPENDIX E

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2. P. M. C. Barretto, "Radon-222 Emanation Characteristics of Rocks and Minerals," in *Radon in Uranium Mining*, STI/PUB/391, IAEA, 1973.

3. S. P. Clark, Jr., Ed. *Handbook of Physical Constants*, revised ed., Geological Society of America, New York, 1966.

4. A. B. Tanner, "Radon Migration in the Ground," in *The Natural Radiation Environment*, J. A. S. Adams and W. M. Lowder, Eds., University of Chicago Press, Chicago, 1964.

5. U.S. Environmental Protection Agency, *Investigation of Fugitive Dust — Sources, Emissions, and Control*, Publication AP TD-1582, Research Triangle Park, N.C., 1973.

Appendix F

DETAILED RADIOLOGICAL ASSESSMENT

Appendix F

DETAILED RADIOLOGICAL ASSESSMENT

When evaluated in conjunction with Sects. 3.4 and 4.8, the following information permits a detailed analysis of the radiological impact of the Homestake Mining Company Pitch Project and permits complete review and verification by qualified radiological scientists. Calculations of radiation doses have been made for radionuclides and receptors around the site.

F.1 MODELS AND ASSUMPTIONS

AIRDOS-II, a FORTRAN computer code[1] was used to estimate individual and population doses resulting from the continuous atmospheric release of airborne radioactive materials from the normal project operations and from accidental releases. Pathways to man include (1) inhalation of radionuclides in air, (2) immersion in air containing radionuclides, (3) exposure to ground surfaces contaminated by deposited radionuclides, (4) ingestion of food produced in the area, and (5) immersion (swimming) in water subjected to surface deposition from plumes. Doses are estimated for the total body as well as for the following organs: gastrointestinal tract, bone, thyroid, lungs, muscles, kidneys, liver, spleen, testes, and ovaries. The dose to the bronchial epithelium from radon daughters is also estimated.

The area surrounding the project was divided into 16 sectors. Each sector is bounded by radial distances of 0.8, 1.6, 3.2, 4.8, 6.4, 8.0, 16, 32, 48, 64, and 80 km (0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 10, 20, 30, 40, and 50 miles) from the point of release. Human population, numbers of beef and dairy cattle, and specifications as to whether each of the areas lying outside the plant boundary is used for producing vegetable crops or is a water area are required as input data.

The first part of AIRDOS-II is an atmospheric dispersion model (AIRMOD) that estimates concentrations of radionuclides in the air at ground level and their rates of deposition on ground surfaces as a function of distance and direction from the point of release. Annual average onsite meteorological data are supplied as input for AIRMOD.

AIRMOD is interfaced with environmental models within AIRDOS-II to estimate doses to man through the five pathways. One such model is a terrestrial model (TERMOD) developed by Booth, Kaye, and Rohwer[2] which estimates radionuclides intakes from ingestion of radionuclides deposited on crops, soil, and pastures. Such intakes result from drinking milk and eating beef and vegetable crops.

Population doses are summarized in the output tables of AIRDOS-II. Actual population distributions were summarized from 1970 Census Bureau tape records. The computer code PANS[3] provides sector summaries which correspond to the same sectors and annuli in the 16 compass directions for which χ/Q values are calculated. The population dose is calculated for each division and then summed over the entire 80-km (50-mile) radius.

The dose conversion factors for the radionuclides are based on two ICRP reports.[4,5] The method used in estimating radiation doses is given in a reference handbook.[6]

F.2 ATMOSPHERIC DISPERSION (METEOROLOGY)

The basic equation used to estimate atmospheric transport to the terrestrial environment is Pasquill's Equation[7] as modified by Gifford.[8] For particulate releases, the meteorological χ/Q values are used in conjunction with dry deposition velocities and scavenging coefficients to estimate air concentrations. Radioactive decay during plume travel is taken into account in

AIRDOS-II.[1] Daughters produced during plume travel must be added to the AIRDOS-II source term. Concentrations in air for each sector are used to calculate the doses via inhalation and submersion in air. Ground-surface concentrations are used for external radiation exposure. The ground deposits are also assimilated into food which, when ingested, results in an additional dose via the food-chain pathway.

The meteorological data required for the calculations are joint frequency distributions of wind velocities and directions summarized by stability class. These data are shown in Tables F.1 and F.2 for the onsite meteorology.

The χ/Q values for receptor points at the nearest residences (Sargents, Colorado) and for the potential future nearest residence are shown in Table F.3. In addition, χ/Q values for various distances in each compass direction are shown in Tables F.4, F.5, and F.6.

F.3 CONTRIBUTION OF RADIONUCLIDES, PATHWAYS AND VARIOUS OPERATIONS TO DOSE

The amounts of radionuclides routinely released (source terms) during a year's operation of the mill and mines on which annual dose calculations to the individual and the population are based are shown in Table F.7. Other information concerning contributions of specific operations to dose, contributions of individual radionuclides to dose, and the significances of various pathways for dose are given in Tables F.8 through F.11.

F.4 OTHER PARAMETERS USED IN RADIOLOGICAL ASSESSMENT

Dose conversion factors used in the radiological assessments are given in Table F.12. Other principal parameters used in the radiological assessment of the Pitch Project are shown in Table F.13.

TABLE F.1 FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS[a]

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)					
		A	B	C	D	E	F
N	0.017	2.03	2.75	4.25	4.52	3.95	2.44
NNW	0.050	2.60	3.03	3.88	4.36	3.22	1.95
NW	0.054	2.60	2.22	3.24	3.42	3.52	1.79
WNW	0.049	0.0	2.99	3.33	3.22	3.06	1.65
W	0.090	0.0	2.18	3.25	4.47	3.87	1.66
WSW	0.085	0.0	1.72	2.43	4.25	3.86	1.30
SW	0.035	0.0	1.77	1.48	2.65	4.10	0.99
SSW	0.039	0.0	1.77	2.38	3.05	4.40	0.96
S	0.036	0.0	1.05	0.90	2.02	3.68	1.04
SSE	0.022	0.0	2.65	3.23	2.16	2.60	1.26
SE	0.044	0.0	1.47	2.39	2.63	3.95	1.48
ESE	0.130	2.60	2.28	4.22	5.55	4.04	1.59
E	0.247	2.03	2.16	4.70	6.45	4.09	1.70
ENE	0.076	2.35	2.37	4.17	4.35	3.98	1.56
NE	0.014	0.90	2.49	5.18	5.77	3.58	1.32
NNE	0.012	0.0	2.64	4.71	4.39	4.19	2.36

[a] PROPOSED MILL SITE METEOROLOGY FOR PERIOD NOV. 1975-NOV. 1976
SOURCE: ER SUPPLEMENT, APPENDIX E.

TABLE F.2 FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EACH DIRECTION[a]

SECTOR	FRACTION OF TIME IN EACH STABILITY CLASS					
	A	B	C	D	E	F
N	0.0226	0.1128	0.1504	0.5113	0.1203	0.0827
NNW	0.0051	0.1544	0.2405	0.4310	0.0658	0.0532
NW	0.0023	0.1596	0.1338	0.4262	0.0962	0.1873
WNW	0.0	0.1175	0.0914	0.2424	0.1227	0.4256
W	0.0	0.0553	0.0851	0.2451	0.1588	0.4057
WSW	0.0	0.0314	0.0374	0.1303	0.1300	0.6233
SW	0.0	0.0368	0.0441	0.1029	0.0441	0.7721
SSW	0.0	0.0132	0.0528	0.0495	0.0066	0.8779
S	0.0	0.0389	0.0212	0.0742	0.0177	0.8441
SSE	0.0	0.0118	0.0176	0.1176	0.0118	0.8412
SE	0.0	0.0264	0.0205	0.1343	0.0934	0.6745
ESE	0.0023	0.0530	0.0844	0.4210	0.1560	0.2836
E	0.0046	0.1239	0.1575	0.5792	0.0563	0.0785
ENE	0.0119	0.1700	0.2323	0.4512	0.0438	0.0909
NE	0.0090	0.1171	0.1441	0.5585	0.0931	0.0721
NNE	0.0	0.0879	0.1758	0.4725	0.1869	0.0769

[a] PROPOSED MILL SITE METEOROLOGY FOR PERIOD NOV. 1975–NOV. 1976.
SOURCE: ER SUPPLEMENT, APPENDIX B.

Table F.3. χ/Q values at receptor points for the proposed Homestake Mining Pitch Project

Location and distance[a]	χ/Q value (sec/m³)	
	Particulates	Rn-222
Sargents, Colorado (nearest residence)		
Mill (8528 m)[b]	3.70E−8	
Ore grinding (8528 m)	1.46E−8	1.21E−7
Tailings pile (6597 m)	2.53E−8	1.73E−7
Mine (9976 m)		1.68E−7
Fee land (nearest potential residence)		
Mill (5149 m)[b]	1.36E−8	
Ore grinding	9.30E−9	2.37E−8
Tailings pile (7723 m)	4.57E−9	1.31E−8
Mine (2896 m)		8.67E−7

[a]Distances from residences shown in parentheses.

[b]Mill effluents released from stack with following parameters: height, 21.3 m; diameter, 0.3 m; and velocity, 4.6 m/sec.

TABLE F.4. GROUND-LEVEL χ/Q VALUES FOR PARTICULATES RELEASED AT A 21.3-M ELEVATION[a] AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION.

DISTANCE (M)	X/Q TOWARD INDICATED DIRECTION (SEC/M^3)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
100	0.485E-06	0.132E-05	0.192E-05	0.138E-05	0.126E-05	0.789E-06	0.392E-06	0.224E-06
500	0.433E-06	0.136E-05	0.176E-05	0.124E-05	0.193E-05	0.142E-05	0.543E-06	0.367E-06
1000	0.192E-06	0.567E-06	0.897E-06	0.996E-06	0.169E-05	0.205E-05	0.997E-06	0.114E-05
2000	0.717E-07	0.205E-06	0.376E-06	0.514E-06	0.890E-06	0.122E-05	0.634E-06	0.768E-06
3000	0.375E-07	0.105E-06	0.197E-06	0.277E-06	0.484E-06	0.659E-06	0.339E-06	0.413E-06
4000	0.239E-07	0.654E-07	0.122E-06	0.170E-06	0.299E-06	0.396E-06	0.198E-06	0.241E-06
5000	0.166E-07	0.449E-07	0.824E-07	0.113E-06	0.199E-06	0.255E-06	0.124E-06	0.149E-06
10000	0.508E-08	0.130E-07	0.213E-07	0.256E-07	0.463E-07	0.498E-07	0.207E-07	0.238E-07
20000	0.150E-08	0.369E-08	0.499E-08	0.470E-08	0.898E-08	0.719E-08	0.212E-08	0.201E-08
30000	0.687E-09	0.170E-08	0.204E-08	0.160E-08	0.325E-08	0.221E-08	0.496E-09	0.347E-09
40000	0.384E-09	0.969E-09	0.108E-08	0.764E-09	0.163E-08	0.105E-08	0.208E-09	0.117E-09
50000	0.241E-09	0.618E-09	0.656E-09	0.437E-09	0.967E-09	0.610E-09	0.116E-09	0.600E-10
60000	0.164E-09	0.432E-09	0.439E-09	0.281E-09	0.636E-09	0.394E-09	0.736E-10	0.388E-10
70000	0.118E-09	0.318E-09	0.310E-09	0.192E-09	0.442E-09	0.268E-09	0.497E-10	0.271E-10
80000	0.884E-10	0.242E-09	0.228E-09	0.137E-09	0.320E-09	0.189E-09	0.349E-10	0.197E-10
	S	SSE	SE	ESE	E	ENE	NE	NNE
100	0.401E-06	0.674E-07	0.319E-06	0.175E-05	0.729E-05	0.315E-05	0.401E-06	0.228E-06
500	0.467E-06	0.286E-06	0.878E-06	0.280E-05	0.622E-05	0.254E-05	0.371E-06	0.362E-06
1000	0.106E-05	0.630E-06	0.113E-05	0.209E-05	0.278E-05	0.109E-05	0.172E-06	0.163E-06
2000	0.688E-06	0.399E-06	0.656E-06	0.104E-05	0.107E-05	0.408E-06	0.667E-07	0.599E-07
3000	0.369E-06	0.216E-06	0.356E-06	0.559E-06	0.557E-06	0.208E-06	0.343E-07	0.310E-07
4000	0.216E-06	0.128E-06	0.216E-06	0.346E-06	0.347E-06	0.128E-06	0.212E-07	0.197E-07
5000	0.135E-06	0.815E-07	0.140E-06	0.231E-06	0.237E-06	0.858E-07	0.144E-07	0.137E-07
10000	0.223E-07	0.146E-07	0.284E-07	0.557E-07	0.664E-07	0.227E-07	0.396E-08	0.410E-08
20000	0.206E-08	0.152E-08	0.400E-08	0.120E-07	0.183E-07	0.584E-08	0.109E-08	0.119E-08
30000	0.386E-09	0.293E-09	0.108E-08	0.480E-08	0.852E-08	0.261E-08	0.511E-09	0.536E-09
40000	0.133E-09	0.935E-10	0.449E-09	0.258E-08	0.496E-08	0.147E-08	0.295E-09	0.296E-09
50000	0.672E-10	0.431E-10	0.239E-09	0.160E-08	0.324E-08	0.930E-09	0.190E-09	0.182E-09
60000	0.407E-10	0.247E-10	0.146E-09	0.109E-08	0.229E-08	0.647E-09	0.132E-09	0.122E-09
70000	0.266E-10	0.157E-10	0.956E-10	0.774E-09	0.170E-08	0.473E-09	0.963E-10	0.860E-10
80000	0.182E-10	0.107E-10	0.653E-10	0.572E-09	0.130E-08	0.358E-09	0.728E-10	0.630E-10

[a] STACK DIAMETER, 0.3 M; EFFLUENT VELOCITY, 4.6 M/SEC.

TABLE F.5. GROUND-LEVEL X/Q VALUES FOR PARTICULATES RELEASED NEAR GROUND LEVEL AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION.

DISTANCE (M)	X/Q TOWARD INDICATED DIRECTION (SEC/M^3)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
100	0.196E-04	0.563E-04	0.112E-03	0.166E-03	0.286E-03	0.408E-03	0.217E-03	0.267E-03
500	0.890E-06	0.245E-05	0.432E-05	0.561E-05	0.976E-05	0.119E-04	0.552E-05	0.654E-05
1000	0.229E-06	0.621E-06	0.102E-05	0.121E-05	0.212E-05	0.235E-05	0.101E-05	0.116E-05
2000	0.650E-07	0.174E-06	0.267E-06	0.293E-06	0.520E-06	0.521E-06	0.204E-06	0.225E-06
3000	0.309E-07	0.819E-07	0.120E-06	0.124E-06	0.224E-06	0.209E-06	0.763E-07	0.810E-07
4000	0.190E-07	0.499E-07	0.712E-07	0.710E-07	0.129E-06	0.115E-06	0.395E-07	0.406E-07
5000	0.130E-07	0.338E-07	0.470E-07	0.452E-07	0.831E-07	0.707E-07	0.230E-07	0.228E-07
10000	0.385E-08	0.981E-08	0.124E-07	0.103E-07	0.199E-07	0.146E-07	0.379E-08	0.314E-08
20000	0.115E-08	0.293E-08	0.333E-08	0.243E-08	0.504E-08	0.330E-08	0.677E-09	0.406E-09
30000	0.544E-09	0.140E-08	0.150E-08	0.102E-08	0.222E-08	0.141E-08	0.268E-09	0.141E-09
40000	0.312E-09	0.812E-09	0.835E-09	0.544E-09	0.123E-08	0.768E-09	0.141E-09	0.726E-10
50000	0.199E-09	0.523E-09	0.519E-09	0.327E-09	0.758E-09	0.466E-09	0.839E-10	0.430E-10
60000	0.137E-09	0.368E-09	0.351E-09	0.215E-09	0.506E-09	0.304E-09	0.544E-10	0.290E-10
70000	0.995E-10	0.272E-09	0.249E-09	0.149E-09	0.354E-09	0.207E-09	0.370E-10	0.205E-10
80000	0.749E-10	0.209E-09	0.184E-09	0.107E-09	0.256E-09	0.146E-09	0.260E-10	0.150E-10
	S	SSE	SE	ESE	E	ENE	NE	NNE
100	0.237E-03	0.136E-03	0.218E-03	0.323E-03	0.304E-03	0.117E-03	0.187E-04	0.159E-04
500	0.603E-05	0.373E-05	0.667E-05	0.113E-04	0.125E-04	0.467E-05	0.749E-06	0.722E-06
1000	0.110E-05	0.705E-06	0.135E-05	0.253E-05	0.311E-05	0.114E-05	0.184E-06	0.185E-06
2000	0.217E-06	0.146E-06	0.303E-06	0.638E-06	0.854E-06	0.305E-06	0.506E-07	0.525E-07
3000	0.798E-07	0.555E-07	0.122E-06	0.281E-06	0.399E-06	0.140E-06	0.237E-07	0.249E-07
4000	0.406E-07	0.290E-07	0.669E-07	0.166E-06	0.243E-06	0.836E-07	0.144E-07	0.153E-07
5000	0.232E-07	0.169E-07	0.410E-07	0.109E-06	0.164E-06	0.557E-07	0.978E-08	0.104E-07
10000	0.337E-08	0.266E-08	0.796E-08	0.283E-07	0.481E-07	0.154E-07	0.288E-08	0.305E-08
20000	0.461E-09	0.353E-09	0.150E-08	0.783E-08	0.146E-07	0.444E-08	0.883E-09	0.897E-09
30000	0.158E-09	0.108E-09	0.569E-09	0.364E-08	0.717E-08	0.209E-08	0.428E-09	0.416E-09
40000	0.785E-10	0.493E-10	0.288E-09	0.208E-08	0.426E-08	0.121E-08	0.250E-09	0.234E-09
50000	0.452E-10	0.270E-10	0.167E-09	0.132E-08	0.280E-08	0.770E-09	0.161E-09	0.146E-09
60000	0.286E-10	0.166E-10	0.105E-09	0.900E-09	0.199E-08	0.538E-09	0.113E-09	0.984E-10
70000	0.190E-10	0.109E-10	0.697E-10	0.644E-09	0.148E-08	0.394E-09	0.827E-10	0.697E-10
80000	0.130E-10	0.749E-11	0.478E-10	0.477E-09	0.114E-08	0.299E-09	0.624E-10	0.513E-10

TABLE F.6. GROUND-LEVEL x/Q VALUES FOR RADON-222 RELEASED NEAR GROUND LEVEL AT VARIOUS DISTANCES IN EACH COMPASS DIRECTION.

DISTANCE (M)	X/Q TOWARD INDICATED DIRECTION (SEC/M^3)							
	N	NNW	NW	WNW	W	WSW	SW	SSW
100	0.215E-04	0.630E-04	0.134E-03	0.209E-03	0.359E-03	0.547E-03	0.307E-03	0.382E-03
500	0.115E-05	0.331E-05	0.728E-05	0.117E-04	0.201E-04	0.310E-04	0.174E-04	0.217E-04
1000	0.317E-06	0.911E-06	0.200E-05	0.319E-05	0.550E-05	0.847E-05	0.476E-05	0.593E-05
2000	0.987E-07	0.282E-06	0.629E-06	0.102E-05	0.176E-05	0.271E-05	0.152E-05	0.190E-05
3000	0.500E-07	0.142E-06	0.320E-06	0.521E-06	0.902E-06	0.139E-05	0.784E-06	0.978E-06
4000	0.327E-07	0.925E-07	0.212E-06	0.350E-06	0.606E-06	0.942E-06	0.530E-06	0.662E-06
5000	0.235E-07	0.662E-07	0.154E-06	0.256E-06	0.444E-06	0.690E-06	0.389E-06	0.486E-06
10000	0.848E-08	0.235E-07	0.566E-07	0.965E-07	0.168E-06	0.263E-06	0.148E-06	0.185E-06
20000	0.347E-08	0.947E-08	0.241E-07	0.430E-07	0.748E-07	0.118E-06	0.666E-07	0.837E-07
30000	0.207E-08	0.559E-08	0.147E-07	0.267E-07	0.465E-07	0.735E-07	0.414E-07	0.521E-07
40000	0.144E-08	0.386E-08	0.103E-07	0.189E-07	0.330E-07	0.523E-07	0.294E-07	0.370E-07
50000	0.108E-08	0.288E-08	0.782E-08	0.145E-07	0.253E-07	0.399E-07	0.224E-07	0.283E-07
60000	0.862E-09	0.229E-08	0.624E-08	0.116E-07	0.203E-07	0.320E-07	0.179E-07	0.226E-07
70000	0.710E-09	0.188E-08	0.515E-08	0.961E-08	0.168E-07	0.264E-07	0.148E-07	0.186E-07
80000	0.600E-09	0.158E-08	0.435E-08	0.814E-08	0.142E-07	0.223E-07	0.125E-07	0.157E-07
	S	SSE	SE	ESE	E	ENE	NE	NNE
100	0.335E-03	0.186E-03	0.286E-03	0.402E-03	0.351E-03	0.138E-03	0.221E-04	0.177E-04
500	0.190E-04	0.106E-04	0.162E-04	0.225E-04	0.188E-04	0.735E-05	0.119E-05	0.949E-06
1000	0.519E-05	0.290E-05	0.445E-05	0.617E-05	0.517E-05	0.202E-05	0.328E-06	0.264E-06
2000	0.166E-05	0.929E-06	0.142E-05	0.196E-05	0.161E-05	0.626E-06	0.103E-06	0.826E-07
3000	0.856E-06	0.478E-06	0.733E-06	0.101E-05	0.817E-06	0.316E-06	0.521E-07	0.419E-07
4000	0.579E-06	0.324E-06	0.495E-06	0.676E-06	0.536E-06	0.207E-06	0.343E-07	0.275E-07
5000	0.425E-06	0.238E-06	0.363E-06	0.494E-06	0.386E-06	0.149E-06	0.247E-07	0.197E-07
10000	0.162E-06	0.906E-07	0.138E-06	0.186E-06	0.140E-06	0.534E-07	0.899E-08	0.711E-08
20000	0.729E-07	0.408E-07	0.617E-07	0.821E-07	0.578E-07	0.219E-07	0.375E-08	0.288E-08
30000	0.454E-07	0.254E-07	0.384E-07	0.507E-07	0.347E-07	0.131E-07	0.225E-08	0.171E-08
40000	0.322E-07	0.180E-07	0.273E-07	0.360E-07	0.241E-07	0.907E-08	0.157E-08	0.118E-08
50000	0.245E-07	0.138E-07	0.208E-07	0.274E-07	0.182E-07	0.681E-08	0.118E-08	0.886E-09
60000	0.196E-07	0.110E-07	0.167E-07	0.220E-07	0.144E-07	0.540E-08	0.937E-09	0.703E-09
70000	0.161E-07	0.909E-08	0.138E-07	0.182E-07	0.119E-07	0.443E-08	0.770E-09	0.578E-09
80000	0.136E-07	0.768E-08	0.117E-07	0.154E-07	0.100E-07	0.373E-08	0.648E-09	0.487E-09

Table F.7. Radionuclide content of the airborne releases from the proposed Homestake Mining Pitch Project uranium ore processing facilities

Radionuclide	Release (Ci/year)			
	Ore crushing and storage	Yellow cake operation	Tailings pile	Mine
U-234	1.21E−3	2.61E−2	1.09E−4	
U-235	5.60E−5	1.20E−3	5.01E−6	
U-238	1.21E−3	2.61E−2	1.09E−4	
Th-230	1.21E−3	1.30E−3	1.49E−3	
Ra-226	1.18E−3	5.2E−4	1.57E−3	
Pb-210	1.18E−3	5.2E−4	1.57E−3	
Po-210	1.18E−3	5.2E−4	1.57E−3	
Rn-222[a]	7.4E1		2.34E2	5.50E1

[a]Radioactive decay during plume travel was taken into account. Daughters of Rn-222 produced during plume travel were calculated and added back to the source term.

Source: ER, p. 3.28, except for the radon release from the mine, which was estimated based on calculations shown in Appendix E.

Table F.8. Maximum annual doses[a] to the individual[b] living at the nearest residence to the mill (Sargents, Colorado) from the combined airborne effluents of the mill and mines

Source	Dose (millirems) to specific organs				
	Total body	Bone	Lungs	Kidney	Bronchial epithelium
Ore grinding and storage	3.3E−3	3.5E−2	7.2E−3	1.4E−2	2.8E−1
Mill	6.1E−3	7.0E−2	3.0E−1	1.9E−2	0.0
Tailings pile	1.1E−2	1.1E−1	1.0E−2	4.9E−2	1.3
Mine	4.5E−4	2.5E−3	2.6E−4	5.1E−3	2.9E−1
Total	2.1E−2	2.2E−1	3.2E−1	8.7E−2	1.9

[a]Doses represent 50-year dose commitments from exposure to effluents from one year's operation.
[b]It is assumed that all meat and produce consumed are raised at the reference locations and that the individual spends all of his time out-of-doors with no shielding.

Table F.9. Contribution of major radionuclides to the dose to the individual at the Sargents, Colorado, residence from airborne effluents

Radionuclide[a]	Dose (%) to specific organs				
	Total body	Bone	Lungs	Kidneys	Bronchial epithelium
Pb-210	3.2	8.1	0.2	17.0	
Po-210	1.6	0.6	0.2	10.6	
Pb-214	15.3	8.1	0.6	41.4	
Rn-222	0.0	0.0	0.0	0.0	100
Ra-226	64.2	60.7	5.2	15.4	
Th-230	3.4	10.3	3.0	8.1	
U-234	4.4	6.0	48.1	3.6	
U-238	7.7	6.1	42.7	3.9	

[a]Radionuclides contributing less than 1% are not included.

Table F.10. Contribution to dose by exposure mode to nearest residence (Sargents, Colorado) from airborne effluents

Exposure mode	Dose (%) to specific organs				
	Total body	Bone	Lungs	Kidney	Bronchial epithelium
Inhalation[a]	11.2	20.7	93.5	49.2	100
Submersion-in-air[b]	2.7	0.4	0.2	0.5	
Contaminated ground[b]	14.7	2.2	0.8	2.6	
Ingestion[c]	71.5	76.8	5.5	47.7	

[a]An inhalation rate of 23 m^3 of air per day is assumed.

[b]Calculations are based on exposure for 100% of the time with no shielding.

[c]It is assumed that all meat and produce consumed are raised at the reference location and that daily intakes are 0.3 kg of beef and 0.25 kg of vegetables.

Table F.11. Maximum annual doses[a] to the individual[b] living at the nearest potential future residence (fee land, 1.8 mile east of the mine) from the combined airborne effluents of the proposed Homestake Mining Pitch Project

Source	Dose (millirems) to specific organs				
	Total body	Bone	Lungs	Kidney	Bronchial epithilium
Ore grinding and storage	4.8E−4	4.5E−3	2.2E−3	3.9E−3	5.6E−2
Mill	8.0E−4	7.1E−3	1.1E−1	2.2E−3	0.0
Tailings pile	4.8E−4	3.9E−3	5.6E−4	5.2E−3	9.7E−2
Mine	9.5E−3	5.3E−2	5.1E−3	1.1E−1	1.5
Total	1.1E−2	6.9E−2	1.2E−1	1.2E−1	1.7

[a]Doses represent 50-year dose commitments from exposure to effluents from one year's operation.

[b]It is assumed that no produce or meat is raised at the reference location but that the individual spends all of his time out-of-doors without shielding.

Table F.12. Dose conversion factors used in radiological assessment of uranium mills for exposure of specific organs to various radionuclides inhaled from mill effluents

Radionuclide	Dose conversion factors				
	Total body	Bone	Lungs	Kidney	Bronchial epithelium
	Yellow cake stack effluents (rems/μCi)				
Pb-210	9.7E−1	3.0E1	1.7E1	2.5E1	
Po-210	1.7E−1	7.1E−1	4.9E1	5.2	
Ra-226	2.4E1	2.4E2	1.3E2	2.4E1	
Th-230	3.1E1	1.0E3	5.7E2	3.1E2	
U-234	3.0E−1	4.9	5.8E2	1.2	
U-235	2.9E−1	4.7	5.6E2	1.0	
U-238	2.7E−1	4.5	5.1E2	1.0	
	Ore crushing and storage effluents (rems/μCi)				
Pb-210	1.4	4.2E1	6.0	3.5E1	
Po-210	2.6E−1	1.1	1.7E1	7.9	
Ra-226	4.0E1	3.9E2	4.7E1	4.0E1	
Th-230	1.6E1	5.2E2	2.0E2	1.6E2	
U-234	1.5E−1	2.4	2.1E2	5.7E−1	
U-235	1.4E−1	2.3	2.0E2	5.4E−1	
U-238	1.3E−1	2.2	1.8E2	5.0E−1	
	Tailings pile effluents[a] (rems/μCi)				
Pb-210	1.4	4.2E1	3.2	3.5E1	
Po-210	2.6E−1	1.1	9.1	7.9	
Ra-226	4.0E1	3.9E2	2.5E1	4.0E1	
Th-230	1.2E1	3.7E2	1.1E2	1.2E2	
U-234	9.0E−2	1.8	1.1E2	3.9E−1	
U-235	8.4E−2	1.7	1.1E2	4.0E−1	
U-238	7.8E−1	1.7	9.4E1	3.4E−1	
	Releases from combined operations (millirem/year per picocurie per cubic meter of air)				
Rn-222 and daughters					1

[a]These factors are calculated based on the assumption that releases for tailing are expressed as two particle-size distributions; 33% are 5 μm and 67% are 3.5 μm in diameter.

Table F.13. Some parameters and conditions[a] used in the radiological assessment of the proposed Homestake Mining Company Pitch Project uranium ore processing facilities

Parameter	Alkaline leach process circuit
Ore quality	0.2% U_3O_8
Plant operating time	365 days/year
Ore process rate	600 tons/day
Extraction efficiency	93%
Operating life of mill	20 years
Height of mill stack	21.3 m
Diameter of mill stack	0.3 m
Stack velocity	4.6 m/sec
U-238 radioactivity feed rate	0.256 μCi per pound of ore

[a]Source: ER, pp. 3-17 and 6-24.

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Appendix G

CALCULATIONS OF BACKGROUND RADON EMANATION, TAILINGS PILE RADON EMANATION, AND TAILINGS EMANATION ATTENUATION

Appendix G

CALCULATIONS OF BACKGROUND RADON EMANATION, TAILINGS PILE RADON EMANATION, AND TAILINGS EMANATION ATTENUATION

The radon-222 flux through the ground surface may be calculated from data on radium-226 concentration and soil properties. The applicant has reported radium concentration in soils in and around the project area as shown in Table G.1.

Table G.1. Radium-226 concentration in soils at selected locations near the proposed Homestake Mining Pitch Project site

Location	Ra-226 (pCi/g)
Mill site (DM1)	1.81
Hale Gulch (DM2)	0.99
Marshall Creek drainage near Chester (DM3a)	3.30
Indian Creek drainage (DM3b)	2.03
Existing Pinnacle open pit (DM4)	89.2

Source: ER Suppl., Table 2.9-7, p. 2-215.

The figures shown in Table G.1 are unweighted averages of data from Table 2.9-7 of the Supplemental Environmental Report. The average of the above concentrations (excluding the open pit), 2.0 pCi/g of radium-226, gives the expected average concentration within the project boundaries.

The radon flux at the earth's surface can be estimated as follows (ref. 1):

$$J_0 = -E(D_e/v)[C_v\sqrt{\lambda/(D_e/v)}] , \qquad (G.1)$$

where

J_0 = radon flux across a spatial area (μCi/cm^2·sec),

E = emanation rate of radon-222 into void spaces in soil,

D_e = effective diffusion coefficient for radon through the fluid (air, water, etc.) in the void spaces between the solid particles (cm^2/sec),

v = void fraction of soil; the fraction of the total volume that is not occupied by solid particles,

C_v = concentration of radon in soil (pCi/cm^3),

λ = decay constant of radon-222 = 2.1×10^{-6} sec^{-1}.

Values for these parameters are highly dependent upon soil type, moisture content, soil compaction, and other soil characteristics. Estimates for these variables have been made for some specific soil types and characteristics.

D_e/v = 8.0 x 10^{-3} cm^2/sec for loam soils (ref. 1, Table 9.29).

E = 0.2; emanation factor for Grand Junction, Colorado, tailings sands.[2] Soils at the site may vary from this value.

C_v = 3.2 pCi/cm^3. (The radium-226 concentration from soil sampling data, 2.0 pCi/g, multiplied by 1.6 g/cm^3, the bulk density of sand and clay loam soils.)

Substituting these values into Eq. (G.1) yields

J_0 = 0.83 $pCi/m^2 \cdot sec$

This value is low compared with experimental values obtained by Kaner, et. al.,[3] for a soil with radium concentration of 1.1 pCi/g. Their value was reported as 0.82 $pCi/m^2 \cdot sec$ of radon-222 per picocurie radium-226 in the soil or, for this case, 1.6 $pCi/m^2 \cdot sec$. However, as the soil in the tailings area is classified by the applicant as being clayey, the lower diffusivity and radon flux are justified.

The tailings pile will contain wastes from the 0.20% grade ore processed. Assuming secular equilibrium, this ore would contain approximately 566 pCi/g of radium-226. After processing, tailings with this radium concentration would release radon at a rate dependent upon tailings characteristics, including moisture content, amount of compaction, and type of particles. Because the effluent discharge system will produce a section near the tailings dam containing mostly nonslimes and a section away from the tailings dam containing mostly slimes, two different radon flux rates are applicable. Using an average radium-226 concentration in the tailings of 564 pCi/g and assuming 53% of the tailings will be slimes containing approximately 85% of the radioactivity, the radium-226 concentrations in the tailings slimes and sands are estimated to be 904 pCi/g and 180 pCi/g respectively. Conversion factors of 1 $pCi/m^2 \cdot sec$ of radon-222 per picocurie of radium-226 per gram of the tailings slimes and 1.6 $pCi/m^2 \cdot sec$ of radon-222 per picocurie of radium-226 per gram of the tailings sands can be used to obtain radon fluxes for these areas of 904 $pCi/m^2 \cdot sec$ and 288 $pCi/m^2 \cdot sec$ respectively.

The applicant has proposed to lower the magnitude of this release by application of a clay-overburden-topsoil cover in the proportions shown in Table G.2.

Table G.2. Composition of tailings coverings

Material	Thickness			
	Slimes area		Nonslimes area	
	m	ft	m	ft
Compacted clay	1.2	4	0.6	2
Overburden	1.5	5	1.5	5
Topsoil	0.23	0.75	0.23	0.75

The formula used in calculations of thickness of cover materials required to attenuate radon is

$$J_x = -E(D_e/v)[C_v\sqrt{\lambda/(D_e/v)}] \exp\left\{-[\sqrt{\lambda/(D_e/v)}]x\right\} ,$$

where the D_e/v in the exponent is the value for the covering material and x is the thickness of the covering. If J_p is the flux from the planar surface of the source material, evaluated as J_0, then

$$J_x = J_p \exp\left\{-[\sqrt{\lambda/(D_e/v)}]x\right\} \quad .$$

For a sequence of n individual coverings,

$$J_x = J_p \exp\left\{-\sum_{i=1}^{n}\left\langle[\sqrt{\lambda/(D_e/v)_i}]x_i\right\rangle\right\} \quad ,$$

where i defines the particular cover material of the multicomponent sequence and $(D_e/v)_i$ and x_i are evaluated individually for each of the n layers of covering.

The following effective diffusion coefficients are assumed:

D_e/v for the clay cover = 6.6×10^{-4} cm^2/sec: the geometric average of the diffusion coefficient for montmorillonite clay with 30% moisture (6.2×10^{-5}) and the diffusion coefficient for "varved clays" (7.0×10^{-3}).

D_e/v for the overburden = 3.6×10^{-2} cm^2/sec.

D_e/v for the topsoil = 8.0×10^{-3} cm^2/sec.

The radon attenuation factor for the 0.6 m (2 ft) of compacted clay is calculated to be 0.032.

$$J_x/J_p = \exp[-(\sqrt{2.1 \times 10^{-6}/6.6 \times 10^{-4}})(30.48)(2)] = 0.032 \ .$$

The attenuation factor for 1.2 m (4 ft) of packed clay would be 0.032 x 0.032 = 1.024×10^{-3}.

The radon attenuation factor for the 1.5 m (5 ft) of compacted overburden is calculated to be 0.312.

$$J_x/J_p = \exp[-\sqrt{2.1 \times 10^{-6}/3.6 \times 10^{-2}}\ (30.48)(5)] = 0.312 \ .$$

The radon attenuation factor for the 0.75 ft of topsoil is estimated to be 0.690.

$$J_x/J_p = \exp[-\sqrt{2.1 \times 10^{-6}/8.0 \times 10^{-3}}\ (30.48)(0.75)] = 0.690 \ .$$

Overall, the effective radon attenuation factors for the slimes and nonslimes areas are estimated to be 2.2×10^{-4} and 6.9×10^{-3} respectively.

For the slimes area,

$$J_x/J_p = (1.024 \times 10^{-3})(0.312)(0.690) = 2.2 \times 10^{-4} \ .$$

For the nonslimes area,

$$J_x/J_p = (0.032)(0.312)(0.690) = 6.9 \times 10^{-3} \ .$$

Using the attenuation factor for the slimes area, the radon flux is found to be 0.2 Ci/m^2 sec.

$$J = 2.2 \times 10^{-4} \times 904 \text{ pCi/m}^2\cdot\text{sec} = 0.2 \text{ pCi/m}^2\cdot\text{sec} \ .$$

By a similar calculation, the radon flux in the nonslimes area is 2 pCi/m^{2}sec.

$$J = 6.9 \times 10^{-3} \times 288 \text{ pCi/m}^2\cdot\text{sec} = 2.0 \text{ pCi/m}^2\cdot\text{sec} .$$

Therefore, the covering scheme proposed by the applicant is expected to reduce the radon emanation rate over the nonslimes section to 2 pCi/m^2·sec, which is 2.4 times the estimated background of 0.83 pCi/m^2·sec. Since the overburden and topsoil will contain natural concentrations of radium, they may be considered to contribute to the radon releases also. If the entire tailings area were covered with 0.9 m (3 ft) of packed clay, 1.5 m (5 ft) of overburden and 0.23 m (9 in.) of topsoil, the slimes and nonslimes sections would have radon fluxes of 1.12 pCi/m^2·sec and 0.36 pCi/m^2·sec respectively. Should any sands be spread over the slime area in preparation for clay cap emplacement, the slimes section radon release would be lower than the cited estimate. This modification of the proposed diffusion barrier [application of a uniform 0.9-m-thick (3-ft) clay cap over the pile] would theoretically reduce the sands and slimes areas fluxes to less than, or equal to, background. This meets the requirement to reduce the flux from the pile to twice background.

REFERENCES FOR APPENDIX G

1. R. E. Blanco et al., *Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing "as Low as Practicable" Guides — Milling of Uranium Ores*, Report ORNL/TM-4903, vol. 1, Oak Ridge National Laboratory, Oak Ridge, Tenn., May 1975.

2. M. V. J. Culot, A. G. Olson, and K. J. Schiager, *Radon Progeny Control in Buildings*, Final Report on EPA Grant ROI-EC00153 and AEC Contract AT (11-)-2273, Colorado State University, Fort Collins, Colo. (May 1973), pp. 47-81.

3. H. W. Kaner, G. L. Schroeder, and R. D. Evans, "Measurements of the Effects of Atmospheric Variables on Radon-222 Flux and Soil-Gas Concentrations," pp. 191-215 in *The Natural Radiation Environment*, J. A. S. Adams and W. M. Lowder, Eds., University of Chicago Press, Chicago, 1964.

Appendix H

CALCULATIONS OF TAILINGS PILE GAMMA RADIATION ATTENUATION

Appendix H

CALCULATIONS OF TAILINGS PILE GAMMA RADIATION ATTENUATION

Assuming soil to be composed mainly of SiO_2, the mass attenuation coefficient for 1-2 MeV gamma ray is 0.0518 cm^2/g.[1] (Most of the dose rate from a typical natural emitter is in this range.[2]) Assuming the gamma radiation from the uncovered tailings pile to be approximately 12 R/year (same as for Bear Creek project) and the bulk density of the soil to be 1.5 g/cm^3, the effect of the 1.75 m (5.75 ft) of overburden and topsoil proposed (excluding the clay caps) would reduce the gamma radiation to approximately 15 μR/year.

$$I/I_o = \exp[-(\mu_{en}/\rho)\rho x] = \exp[-(0.0518\ cm^2/g)(1.5\ g/cm^3)(175\ cm)] = 1.24 \times 10^{-6}$$

$$I = (1.24 \times 10^{-6})(12\ R/year) = 15\ \mu R/year$$

The background radiation dose as measured by the applicant is 211.7 mR/yr. Of this dose about 110 mR/yr is attributed to the radionuclide content of the soil and 100 mR/yr is attributed to cosmic radiation and fallout at the elevation of the site (ER, p. 2-202).

REFERENCES FOR APPENDIX H

1. U.S. Department of Health, Education, and Welfare, *Radiological Health Handbook*, U.S. Government Printing Office, Washington, D.C., January 1970, p. 139.

2. H. May and L. D. Marinelli, "Cosmic Ray Contribution to the Background of Low Level Scintillation Spectrometry," Chap. 29 in *The Natural Radiation Environment*, J. A. S. Adams and W. M. Lowder, Eds., University of Chicago Press, Chicago, 1964.

Appendix I

WATER QUALITY STANDARDS

Table I.1. Proposed Colorado water quality standards

PARAMETER	Primary Contact (Ingestion)	Secondary Contact (Recreational other than Primary)	Cold Water Biota	Warm Water Biota	Irrigation & Stock	Municipal & Private Ground Water Supplies (1)	For Municipal Potable Surface Water (Raw Water) (2)
Physical							
D.O. (mg/l)	x	x	7.0	5.0	x	x	---
pH (S.U.)	6.5 - 9.0	x	6.5 - 9.0	6.5 - 9.0	x	x	5.0 - 9.0
Suspended Solids (3) (mg/l)	x	x	25 (3)	25 (3)	x	x	---
Temperature (^{o}C)	x	x	Max. 20^{o} C (4) w/3^{o}C Change	Max. 30^{o} C (4) w/3^{o}C Change	x	x	---
TDS (mg/l)	x	x	x	x	x (5)	x (5)	x (5)
Pollutional Indicators (6) (Levels indicated here represent pollution warnings calling for special investigation to identify sources.)							
Total Ammonia/Ammonium (7) as $NH_3 + NH_4^+$ (mg/l as N)	5.0	5.0	5.0	5.0	---	x	5.0
BOD_5 (mg/l) (8)	5.0	5.0	5.0	5.0	---	x	5.0
Nitrate (mg/l as N) (9)	4.0	4.0	4.0	4.0	x	x	4.0
Total Phosphorus (mg/l as P)	.025 Lake 0.1 Stream	.025 Lake 0.1 Stream	.025 Lake 0.1 Stream	.025 Lake 0.1 Stream	x	1.0	1.0 Stream

(1) Ground water supplies where there is no treatment except for disinfection before use for drinking water purposes. Assume aquifers are directly recharged by surface streams, such as South Platte River, Clear Creek, Bear Creek, Arkansas River, etc.

(2) These water supplies normally receive cogulation, sedimentation, filtration, and disinfection prior to use in the municipal system.

(3) 25 mg/l for stream segment attributable to municipal, industrial, agricultural, construction (including highways), and reservoir draining

(4) Temperature shall maintain a normal pattern of diurnal and seasonal fluctuations with no abrupt changes and shall have no more than a 3^{o}C change from the naturally occurring temperature, attributable to municipal, industrial, or other discharges or agricultural practices. The maximum shall not be exceeded by other than natural causes.

(5) Due to varying TDS content of stream and ground water used for irrigation in Colorado, the return flow and therefore concentration of TDS in return flow vary. Concentration limits of TDS in discharges shall be related to agricultural practices deemed to be satisfactory by the Commission for that locality.

(6) These parameters in the given use classes are pollutional indicators. Should the parameters reach the indicated levels in the waters of Colorado, it is probable that environmental degradation is occurring. The numerical levels should not be construed as stream standards but as indications of problems requiring investigation to determine the cause and effect upon the waters.

(7) While ionized ammonium is not toxic, total ammonia is an indicator of pollution which should be a basis for signaling need for pollution control.

(8) The listed BOD_5 value of 5 ppm nears the minimum reproducible value and takes into consideration the built-in systematic errors of the procedure.

(9) A level of NO_3 - Nitrogen above 4.0 mg/l is an indication of pollution sources which would signal the need for some detailed investigation

Table I.1 (continued)

PARAMETER	RECREATIONAL: Primary Contact (Ingestion)	RECREATIONAL: Secondary Contact (Recreational other than Primary)	AQUATIC LIFE [3]: Cold Water Biota	AQUATIC LIFE [3]: Warm Water Biota	AGRICULTURE: Irrigation & Stock	WATER SUPPLY: Municipal & Private Ground Water Supplies [1]	WATER SUPPLY: For Municipal Potable Surface Water (Raw Water) [2]
Toxic Metals							
Aluminum	X	X	0.1	0.1	---	---	---
Arsenic	X	X	0.05	0.05	0.1	0.01	.01
Beryllium	X	X	0.011	0.011	0.1	0.1	0.1
Cadmium	X	X	0.0004	0.0004	0.01	0.01	0.01
Chromium	X	X	0.3	0.3	0.1	0.05	0.05
Copper	X	X	0.01	0.01	0.2	0.5 - 1.0	0.5 - 1.0
Iron	X	X	0.5	0.5	---	0.3 Soluble	0.3 Soluble
Lead	X	X	0.004	0.004	0.1 Stock 5.0	0.05	0.05
Manganese	X	X	1.0	1.0	0.2	0.05 Soluble	0.05 Soluble
Mercury	X	X	0.00005	0.00005	0.01 Stock ---	0.002	0.002
Molybdenum	X	X	X	X	0.5 Stock ---	---	---
Nickel	X	X	0.05	0.05	0.1	---	---
Selenium	X	X	0.05	0.05	0.05 Stock ---	0.01	0.01
Silver	X	X	0.0001	0.0002	---	0.05	0.05
Thallium	X	X	0.015	0.015	---	---	---
Zinc	X	X	0.05	0.05	2.0	0.6 - 5.0	0.6 - 5.0

(1) Ground water supplies where there is no treatment except for disinfection before use for drinking water purposes. Assume aquifers are directly recharged by surface streams, such as South Platte River, Clear Creek, Bear Creek, Arkansas River, etc.

(2) These water supplies normally receive coagulation, sedimentation, filtration, and disinfection prior to use in the municipal system.

(3) For stream water hardness of 0 to 100 mg/l. See attached Table No.0 A for limits for hardness from 100 mg/l to 400 mg/l.

Table I.1 (continued)

PARAMETER	RECREATIONAL: Primary Contact (Ingestion)	RECREATIONAL: Secondary Contact (Recreational other than Primary)	AQUATIC LIFE: Cold Water Biota	AQUATIC LIFE: Warm Water Biota	AGRICULTURE: Irrigation & Stock	WATER SUPPLY: Municipal & Private Ground Water Supplies (1)	WATER SUPPLY: For Municipal Potable Surface Water (Raw Water)
Other Toxics							
Ammonia (mg/l as N)	X	X	0.02 un-ionized	0.02 un-ionized	---	0.5	X
Chlorine Total Residual (mg/l)	X	X	0.002	0.002	---	X	X
Cyanide (FREE) (mg/l)	X	X	0.005	0.005	0.2 Stock	0.2	0.2
Fluoride (mg/l)	X	X	---	---	2.0	2.0	(3)
Nitrite (mg/l as N)	X	X	0.05	0.5	---	1.0	1.0
Oil & Grease	No Visible Sheen					FF	FF
Sulfide (TOTAL) (mg/l)	FF	FF	0.002 (4)	0.002 (4)	FF	FF	FF
Nitrate (mg/l as N)	X	X	-----	-------	100 mg/l	10	10
Inorganic Minerals							
Boron (mg/l)	---	---	---	---	0.75	---	---
Chlorides (mg/l)	X	X	---	---	---	250	250
Magnesium (mg/l)	X	X	---	---	---	125	125
Sodium Absorption Ratio	X	X	X	X	4	X	X
Sulfate (mg/l)	X	X	X	X	X	250	250

FF Free From

(1) Ground water supplies where there is no treatment except for disinfection before use for drinking water purposes. Assume aquifers are directly recharged by surface streams, such as South Platte River, Clear Creek, Bear Creek, Arkansas River, etc.

(2) These water supplies normally receive coagulation, sedimentation, filtration, and disinfection prior to use in the municipal system.

(3) Fluoride limits vary; dependent upon average annual maximum daily air temperatures for a minimum of 5 years as specified in the "Public Health Services Drinking Water Standards".

(4) Undissociated H_2S

Table I.1 (continued)

PARAMETER	RECREATIONAL: Primary Contact (Ingestion)	RECREATIONAL: Secondary Contact (Recreational other than Primary)	AQUATIC LIFE: Cold Water Biota	AQUATIC LIFE: Warm Water Biota	AGRICULTURE: Irrigation & Stock	WATER SUPPLY: Municipal & Private Ground Water Supplies (1)	WATER SUPPLY: For Municipal Potable Surface Water (Raw Water)
Organics (mg/l)							
Chlorinated Pesticides							
Aldrin	---	---	0.000003	0.000003	---	---	---
Chlordane	---	---	0.000050	0.000050	---	---	---
Dieldrin	---	---	0.000003	0.000003	---	---	---
DDT	---	---	0.000001	0.000001	---	---	---
Endrin	---	---	0.000010	0.000010	---	0.0002	0.0002
Heptachlor	---	---	0.000010	0.000010	---	---	---
Lindane	---	---	0.000010	0.000010	---	0.004	0.004
Methoxychlor	---	---	0.000020	0.000020	---	0.05	0.05
Mirex	---	---	0.000001	0.000001	---	---	---
Toxaphene	---	---	0.000010	0.000010	---	0.005	0.005
Orthophosphate Pesticides							
Demeton	---	---	0.000100	0.000100	---	---	---
Endosulfan	---	---	0.000003	0.000003	---	---	---
Guthion	---	---	0.000010	0.000010	---	---	---
Malathion	---	---	0.000100	0.000100	---	---	---
Parathion	---	---	0.000100	0.000100	---	---	---
Herbicides 2, 4-D	---	---	---	---	---	0.1	0.1
Herbicides 2,4,5 - TP	---	---	---	---	---	0.01	0.01
PCB (Polychlorinated Biphenyls)	---	---	0.000001	0.000001	---	---	---
Phenol	---	---	0.001	0.001	---	0.001	0.001

(1) Ground water supplies where there is no treatment except for disinfection before use for drinking water purposes. Assume aquifers are directly recharged by surface streams, such as South Platte River, Clear Creek, Bear Creek, Arkansas River, Etc.

(2) These water supplies normally receive coagulation, sedimentation, filtration, and disinfection prior to use in the municipal system.

Table I.1 (continued)

PARAMETER	RECREATIONAL: Primary Contact (Ingestion)	RECREATIONAL: Secondary Contact (Recreational other than Primary)	AQUATIC LIFE: Cold Water Biota	AQUATIC LIFE: Warm Water Biota	AGRICULTURE: Irrigation & Stock	WATER SUPPLY: Municipal & Private Ground Water Supplies[1]	WATER SUPPLY: For Municipal Potable Surface Water (Raw Water)[2]
Radiological[3]							
Alpha, corrected for uranium	---	---	15	15	15	15	15
Beta	---	---	50	50	50	50	50
Cesium, 137	---	---	160	160	160	160	160
Plutonium, 38 & 39	---	---	(4)	(4)	(4)	(4)	(4)
Radium, 226 & 228[5]	---	---	5	5	5	5	1
Strontium, 90[5]	---	---	2	2	2	2	2
Thorium, 230 & 232	---	---	<15	<15	<15	<15	<15
Tritium[5]	---	---	(6)	(6)	(6)	(6)	(6)
Uranium	---	---	---	---	---	0.075 mg/l	0.075

(1) Ground water supplies where there is no treatment except for disinfection before use for drinking water purposes. Assume aquifers are directly recharged by surface streams, such as South Platte River, Clear Creek, Bear Creek, Arkansas River, etc.

(2) These water supplies normally receive coagulation, sedimentation, filtration, and disinfection prior to use in the municipal system.

(3) Concentrations given are maximum permissable concentrations above naturally occurring or "back ground" concentrations except where otherwise noted.

(4) Free from detectable concentration from fixed man-made sources.

(5) Maximum permissable concentrations including naturally occurring or "back ground" contributions.

(6) Tritium shall not be increased by more than 3,000 pCi/l above the natural-occurring concentration.

Table I.1 (continued)

PARAMETER	RECREATIONAL: Primary Contact (Ingestion)	RECREATIONAL: Secondary Contact (Recreational other than Primary)	AQUATIC LIFE: Cold Water Biota	AQUATIC LIFE: Warm Water Biota	AGRICULTURE: Irrigation & Stock	WATER SUPPLY: Municipal & Private Ground Water Supplies (1)	WATER SUPPLY: For Municipal Potable Surface Water (Raw Water)
Aesthetics							
Bottom Sludges	FF	FF	FF	FF	---	X	FF
Floating Matter	FF	FF	FF OBJ	FF OBJ	X	X	FF
Odor	FF OBJ Odor	FF OBJ Odor	FF OBJ Odor	FF OBJ Odor	X	X	FF OBJ Odor
Tainting Substances	FF	FF	FF	FF	---	FF	FF
Biological							
Algae	FF OBJ Algae	FF OBJ Algae	FF OBJ Algae	FF OBJ Algae	X	X	FF
Fecal Coliforms per 100 ml (Geometric Mean)	200	1,000	X	X	1,000	0 (3)	1,000
Viruses	(4)	(4)	---	---	---	(4)	(4)

(1) Ground water supplies where there is no treatment except for disinfection before use for drinking water purposes. Assume aquifers are directly recharged by surface streams, such as South Platte River, Clear Creek, Bear Creek, Arkansas River, etc.

(2) These water supplies normally receive coagulation, sedimentation, filtration and disinfection prior to use in the municipal system.

(3) For drinking water with or without disinfection.

(4) For limitations and control measures of viruses obtain information from the Water Quality Control Division.

FF "Free From" means free from substances introduced by other than natural sources.

FF OBJ "Free From Objectionable" levels of pollutants or characteristics.

Table I.2. Drinking water standards

Chemical Constituents	U.S. Public Health Service 1962 — Recommended Limit mg/l[a]	U.S. Public Health Service 1962 — Tolerance Limit mg/l[b]	Recommended EPA National Primary Drinking Water Regulations 1975 — Maximum Contaminant Level mg/l
Alkyl Benzene Sulfonate (ABS)	0.5	--[c]	--[c]
Arsenic (As)	0.1	0.05	0
Barium (Ba)	--	1.0	1.0
Boron (B)	1.0	--	--
Cadmium (Cd)	--	0.01	0.01
Carbon Chloroform Extract (CCE)	0.2	--	--[c]
Chloride (Cl)	250	--	--
Chromium, Hexavalent (Cr^{+6})	--	0.05	0.05
Coliform, Total			1 colony per 100 ml[d]
Copper (Cu)	1.0	--	--
Cyanide (CN)	0.01	0.2	--[c]
Fluoride (F)	0.8-1.7[d]	1.4-2.4[d]	1.4-2.4[e]
Iron, Total (Fe)	0.3	--	--
Lead (Pb)	--	0.05	0.05
Manganese (Mn)	0.05	--	--
Mercury (Mg)	--	0.005	0.002
Nitrogen (N)	10.0	--	--
Nitrate (N)	--	--	10.0
Phenols	0.001	--	--
Selenium (Se)	--	0.01	0.01
Silver (Ag)	--	0.05	0.05
Sulfate (SO_4)	250	--	--
Total Dissolved Solids (TDS)	500	--	--
Turbidity (Turbidity Unit)	--	--	1.0
Zinc (Zn)	5	--	--
Radium 226–228 (combined)	--	--	5 pCi/l[f]
Gross Alpha Activity	--	--	15 pCi/l[f]

[a] Recommended Limit: Concentrations which should not be exceeded where more suitable water supplies are available. Concentrations measured in milligrams per liter unless otherwise indicated.

[b] Tolerance Limit: Concentrations greater than these shall constitute grounds for rejection of the supply. Concentrations measured in milligrams per liter unless otherwise indicated.

[c] No limits or levels established.

[d] When membrane filter technique used the arithmetic mean of samples examined per month.

[e] Fluoride: Dependent on annual average maximum daily air temperature over not less than a 5-year period. Where fluoridation is practiced, minimum recommended limits are also specified.

[f] Drinking Water Regulations, Part II, 1976. Radionuclides including radium-226 but excluding radon and uranium.

Appendix J

HOMESTAKE PITCH MINE REVEGETATION PROGRAM
PHILOSOPHY AND CURRENT STATUS

ATTACHMENT A

HOMESTAKE PITCH MINE REVEGETATION PROGRAM

PHILOSOPHY AND CURRENT STATUS

by

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Philosophy and Background

In 1976, when it became reasonable to assume there might be a productive uranium mine near Sargents, Homestake Mining Company invited the Western State College Ecology Program to become involved in anticipating some of the potential reclamation needs. It was assumed the project would enable a person or persons to create a plan, to do the research, and then to have the opportunity to carry out the revegetation program. Upon completion of any program segment, a monitoring program would be initiated.

The Dames & Moore Environmental Report (ER) and the U.S. Forest Service Draft Environmental Statement provide a considerable background of information utilizable for a revegetation program. As a subcontractor to Dames & Moore, Western State College provided the field work and data for the vegetation portion of the ER. This means the people working on revegetation are familiar with the work done to date, are familiar with the species which make up the native vegetation, and have had an opportunity to note how natural processes relate to succession after disturbance.

All parties concerned recognize there are several types of revegetation which need to be accomplished:

1. Cosmetic, i.e., situations where disturbance is minimal, but is unattractive to the observer. It poses the least problems, but the untrained observer will often note what he sees and will use it as a judgement of the overall revegetation program. Often involves landscaping. Examples of such sites are the entrance to the mine, parking lots, and other locations of human attention.

2. Natural environments which have been rearranged, but natural succession processes may be expected to be initiated, and the reclamation merely speeds up the natural processes. Heavy machinery traffic, drill pads, temporary structures, are examples of such sites.

3. Surface alteration which provides sufficient change to produce surfaces which are natural, but which previously had not been exposed. Quite often, as a first course of action, it is imperative to get these surfaces stabilized. Roadsides and surface disturbances due to structures are the best examples.

4. New habitats:

   a. Exposure of new surfaces which do not resemble natural sites. Example: pit wall.

b. New materials which do not resemble natural surfaces. Example: overburden deposits.

c. Normal surfaces placed in a new situation. Example: tailings ponds where top soil will be underlaid by relatively foreign material, and at a higher elevation.

In looking at a site to be revegetated, several courses of action should be considered:

1. Immediate surface stabilization to reduce the potential of erosion or drastic site alteration. At this point, grass and legume mixtures provide the main thrust. Little concern is given to the use of native species under these conditions, although with everything else equal, native species are selected. Considerable management may be necessary.

2. Once stabilization is achieved, the next thrust should be for plant growth which will not require management. The attempt is made to intercede with some normal successional stage which can be speeded up. If new surfaces are provided, it is recognized new ecosystems will eventually occupy the site. The objective, therefore, it to determine which native plants can be used. In many cases, new niches will not have native species to occupy them, and efforts must be made to introduce species from nearby ecosystems, or perhaps from far-removed ecosystems.

<u>Progress to Date</u>

In 1976, when the philosophy became established, it was recognized that once a site became available for revegetation there would be no time for trial and error efforts. All the lead time available should be used to develop information which could be used to produce successful efforts. Also, it was felt the most immediate concerns were associated with situations where new habitats are developed. Most new habitats will not need to be revegetated for some years and it was decided to stress research efforts on these sites in the potential stress environments. To expedite solutions, several test sites were established:

1. <u>Proposed mill site</u> (lodgepole pine forest): Trees were marked for cutting and were removed to allow a bulldozer to remove the stumps in a manner similar to what is anticipated in the proposed park-like region around the proposed mill and associated buildings. Approximately one acre was fenced to exclude cattle and each tree in the plot was marked. Representative trees outside the plot also were marked. A bulldozer removed the stumps inside the plot, and in the process, considerable ground and surface roots were torn up. The consequence of that action is being monitored.

   In the center of the plot, six treatments were established: control, water, fertilizer, sawdust, rock, and slash.

   In the summer of 1977, at the height of a drought, transplants were made of eleven species. Two grass mixtures obtained from Mile High Seed Co. (Dr. John Ericson) were seeded in separate 1m x 1m plots (Table 1).

Results: A few trees have shown negative response to the bulldozer activitiy, but none have died. The transplants thrived. Natural regeneration around the test plots and in the test plots is so extensive, the transplant-seeding portion of the project has been abandoned. Broadcast grass seeding was carried out because we are considering developing a park-like atmosphere.

2. Tailings site (in the immediate vicinity of the proposed tailings pond dam): The objective of this study is to determine what plants may successfully grow in this environment, without attempting to duplicate the proposed tailings pond deposition stratification. The soil on the test site is similar to what will be used for the top dressing when the tailings pond is completed.

   The one-acre site was a level sagebrush community. The vegetation was analyzed and productivity noted for future reference. A bulldozer removed the sagebrush and completed the surface leveling. The area was fenced to exclude cattle. The center portion of the plot was divided into six treatments, as earlier stated for the mill site. The treatment area was spaded, raked, and in 1977, transplants were introduced; in 1978, various seeds were introduced. The summer of 1978 was almost moistureless.

   Results: The transplants were successful, and despite being planted at the height of the 1977 drought, only occasional plants died. The best response was associated with the rock treatment (lower soil temperature and reduced moisture loss) and appeared to discourage wildlife grazing. In the fall of 1977, an elk entered the plot and neatly grazed a row of sedge down to the ground level and provided the greatest negative impact of the summer. At the end of the 1978 growing season, the transplants had survived two unusually dry summers and one winter with an unusually deep snowpack. The plants proceeded in their normal seasonal growth patterns. Biennials completed their life cycles, evergreens put on another year of growth, and other plants had prolific blooming and seed production.

   Approximately 70 different species (Table 1) were seeded in each of the six treatments. Some seeds were selected because they were native; some were from native species but from commercial sources; some were of species which could conceivably grow in the area; some represented the ingredients of seed mixtures currently in use for roadside revegetation (seed obtained from Mile High Seed Co., Grand Junction); some were planted because we happened to have them in stock and were curious to see if they would respond. Mile High Seed Co. provided some special varieties of corn, peas and lettuce which helped provide insights regarding general soil mineral conditions.

   Results: Approximately 70% of the seeds germinated. Many of the seeds did not germinate due to the intense drought. Testing will continue with each growning season yielding additional information which can be applied to the reclamation program.

3. Overburden site (approximately one-quarter mile from one planned deposition point and one-half mile from a second site): The experimental site has had approximately six feet of overburden deposited in a clearing where previously a sawmill operated. The overburden originated from the pilot mining operation located at the site where mineral development will be continued. From the best information available, the overburden is typical of what may be expected in the future. However, the test plot is flat, whereas the planned overburden sites are on west- and south-facing slopes.

   The overburden deposit was leveled with a bulldozer into a rectangular three-fourths-acre plot, fenced to exclude cattle. The center portion was subdivided into the six treatments as noted for the mill and tailings sites. No further soil treatment was provided because we were interested in establishing data from engineering specifications, and there was no treatment of the surface with top soil. The surface around the plot was observed to note any natural successional patterns.

   The species transplanted on the mill site and the tailings site were also transplanted on the overburden site during the summer of 1977. In 1978, the same species as used on the tailings site were seeded.

   Results: In the spring of 1978, all of the transplants were well represented with survivors. During the summer of 1978, many seeds germinated, but the number was less than on the tailings site (approximately 50%). As in the case of the tailings site, additional data will be obtained in subsequent growing seasons. At this point, it appears the overburden conditions decreased the germination and decreased the growth and vigor of the seedlings and transplants. The overburden provides a dark body effect and develops a hard surface.

Conclusions

Because there has been considerable success, with minimal management, in raising transplants and seeds on disturbed surfaces, it is assumed revegetation at the Pitch site will not pose insurmountable problems. It is recognized that additional surface treatment will be necessary for revegetating overburden, but easily available surface additives should resolve the problems. The specifics of applying these amendments will be addressed in subsequent tests. Thus far, it appears transplants are superior to seeding. With the small acreages to be revege- tated per year, the transplant method can be utilized and perhaps incorporated with some broadcast grass seeding.

Table J.1

Species Used in the Test Plots

Transplants

Symphoricarpos oreophilus
Fragaria ovalis
Artemisia tridentata
Chaenactis douglassii
Cares sp.
Antennaria microphylla
Pnstemon strictus
Abies concolor
Juniperus virginiana
Pinus ponderosa
Pseudotsuga menziesii

Seeds

Agropyron trachycaulum
Melilotus officinale
Zea mays (var. Sunglow)
Pisum sativum (var. Little Marble)
Trifolium pratense
Robinia pseudoacacia
Agropyron smithii
Lonicera tatarica
Cowania stanburyana
Picea pungens glauca
Hilaria Jameskii
Penstemon palmeri
Alopecurus pratensis
Medicago sativa (var. Ladak)
Oryzopsis hymenoides
Cicer lutana
Phleum pratense (var. Climax)
Medicago sativa (var. Nomad)
Sporobolus airoides
Trifolium fragiferum
Festuca rubra (Var. Pennlan Creeping Red)
Ailanthus altissima
Sporobolus cryptandrus
Bromus inermis (var. Manchar)
Atriplex canescens
Elymus sp.
Trifolium repens
Betula papyrifera
Poa pratensis (var. Certified Troy Kentucky)
Yucca glauca
Bouteloua gracilis
Caragana arborescens
Festuca ovina (var. Duruscula)
Elymus sp. (Russian Wild Rye)
Bromus sp (Meadow Brome Cert. Regan)
Agropyron cristatum
Bromus inermis (var. Lincoln)
Agropyron smithii (var. Arriba)
Lactuca sp. (var. Grand Rapids)
Sporobolus sp.
Dactylis glomerata (var. Potomac)
Agropyron sp. (Long-tall Wheatgrass)
Muhlenbergia montana
Agropyron cristatum
Elymus cinereus
Agropyron dasystachyum
Eschscholzia
Agropyron elymus
Penstemon strictu
Auilegia coerulea
Lobularia maritima
Helianthus annuus
Epilobium angustifolium
Aster tenacetifolius
Cichorum intybus
Rudbeckia hirta
Coreopsis tinctoria
Anagallis arvensis (var. coerulea)
Achillea millefolium
Gilia leptantha sp. purpurea
Iberus semperflorous
Linaria maroccana

Appendix K

DEVELOPMENT AND EXTRACTION PERMIT
MINED LAND RECLAMATION BOARD

Permit No. __________

MINED LAND RECLAMATION BOARD
Department of Natural Resources

1313 Sherman Street, Room 723
Denver, Colorado 80203 Telephone: 892-3567

DEVELOPMENT AND EXTRACTION MINING PERMIT

THIS PERMIT is issued this day of by the Mined Land Reclamation Board, Department of Natural Resources, State of Colorado.

W I T N E S S E T H :

WHEREAS, Homestake Mining Company desires to conduct an open pit and underground uranium mining operation, known as the Pitch Project, for the purpose of extracting uranium-bearing ores and associated minerals; and

WHEREAS, the Mined Land Reclamation Board has received an application, a reclamation plan and map and the required fee for a permit for an open pit and underground mining operation and a milling operation with a tailings pond for the processing of the uranium-bearing ores and associated minerals mined from the mine; and

WHEREAS, the Mined Land Reclamation Board has been requested to consider at this time only portions of the application which are applicable to the open pit and underground mine, and associated and supporting facilities for such mine, and the Mined Land Reclamation Board has received surety for these portions of the application; and

WHEREAS, the Mined Land Reclamation Board has been requested to defer its consideration of the portions of the application which are applicable to construction of the mill until after the Draft Environmental Impact Statement which pertains to the Pitch Project, and is now being prepared by the U. S. Forest Service, shall have been completed, and after Homestake Mining Company obtains whatever authorization from the Colorado Department of Health then may be lawfully required for such construction; and

WHEREAS, the Mined Land Reclamation Board has been requested to defer its consideration of the portions of the application which are applicable to the operation of the mill and to construction and operation of the associated mill tailings disposal facilities until after the final version of that Environmental Impact Statement shall have been completed, and after the Colorado Department of Health grants whatever authorization or license then may be required by law for such operation and construction; and

WHEREAS, that Final Environmental Impact Statement may be considered to determine what changes or modifications, if any, should be made to the reclamation plan, this permit and any amendments thereto, but Homestake Mining Company shall have the opportunity and right to contest any such proposed changes and modifications; and

WHEREAS, the Mined Land Reclamation Board has made a finding, for the purposes of issuing this permit, that:

1) this permit, as granted and conditioned, complies with the requirements of the Colorado Mined Land Reclamation Act and all applicable local, state and federal laws; and
2) the operation will not adversely affect the stability of any significant, valuable, and permanent man-made structures located within two hundred feet of the affected land, except where there is an agreement between Homestake Mining Company and the persons having an interest in the structure that damage to the structure is to be compensated for by Homestake Mining Company; and
3) the proposed mine and reclamation to which this permit is applicable can be carried out in conformance with the requirements of §34-32-116, C.R.S. 1973, as amended (1976 Sess. Laws - H.B. 1065); and

WHEREAS, for the purposes of issuing this permit, Homestake Mining Company made a satisfactory showing to the Mined Land Reclamation Board that it will employ procedures during and after mining which are reasonably designed to minimize disruption to the environment, and that it will provide for the rehabilitation of the affected land through rehabilitation of plant cover, soil stability, water resources, and other reasonable measures appropriate to the subsequent beneficial use of such mined and reclaimed lands, and Homestake Mining Company, in the event of the failure of its proposed reclamation plan, will take whatever reasonable measures which may be necessar and required by the Mined Land Reclamation Board, or its successor, pursuant to its statutory authority, in order to assure the success of reclamation of the affected land; and

WHEREAS, for the purposes of issuing this permit, the applicable portions of the application setting forth the mining and reclamation plans and maps for underground and open pit uranium mining are hereby incorporated, not including those portions of the reclamation plan which are applicable to the milling and tailings disposal facilities.

NOW, THEREFORE, pursuant to the authority set forth in the Colorado Mined Land Reclamation Act, Article 32 of Title 34, C.R.S. 1973, as amended (1976 Sess. Laws - H.B. 1065), the Mined Land Reclamation Board of the State of Colorado hereby issues a life of the mine permit to Homestake Mining Company to engage in underground and open pit uranium mining for the purpose of extracting uranium-bearing ores and associated minerals on the parcels of ground set forth in Appendix A attached hereto, and as indicated on the maps constituting final Exhibits B, C, D and F of the application, subject to the following special conditions:

1) Homestake Mining Company agrees that the recitations set forth in the introductory clauses are acceptable to it.
2) The technical, operational provisions prescribed in Appendix B shall be applicable.
3) The Final Environmental Impact Statement referred to in the recitations of this permit may be considered to determine what changes or modifications, if any, should be made to the reclamation plan, this permit and any amendments thereto, but Homestake Mining Company shall have the opportunity and right to contest any such proposed changes and modifications.
4) During the course of operations authorized by this permit, Homestake Mining Company shall not allow the total disturbed acreage of the affected land at any single time to exceed the following limitations without approval by the

Mined Land Reclamation Board, and except as provided in Appendix B such disturbed acreage shall not include a mill or associated mill tailings disposal facilities until the reclamation plan for such mill or facilities has been approved by the Mined Land Reclamation Board:

Major Disturbance 415 acres

Moderate Disturbance 569 acres

Minor Disturbance 0 acres

For purposes of this condition, disturbed acreage shall not include that for which all reclamation requirements of the permit have been completed, and major disturbance, moderate disturbance, and minor disturbance are defined as follows:

Major Disturbance - that area of a mining operation which includes excavations, overburden spoils, and topsoil stockpiles.

Moderate Disturbance - that area of a mining operation which is a result of backfilling of the open cut, the levelling of overburden spoils, the smooth grading and the distribution of topsoil or other suitable, approved plant growth medium.

Minor Disturbance - that area of a mining operation which is undergoing preparation immediately prior to planting, or seeding, is being planted or seeded, or has been planted or seeded as to which there has not been full completion of all reclamation requirements as set forth in the permit.

This permit does not include construction and operation of mill and associated tailings disposal facilities, nor the reclamation plan applicable thereto. However, such exclusion shall not preclude core drilling and surface and subsurface sampling and testing for the purposes of any environmental monitoring and pre-construction analyses, and construction and use of roads, offices, shops, warehouses, sanitary facilities and change house, parking lots, assay laboratory, utility systems (water, electricity, sewage, and communication), storage facilities for fuels and explosives, and directly supportive facilities for the mine, which may be undertaken within the parcels of land set forth in Appendix A to which this permit is applicable, including the area designated as "Mill Site" on the maps constituting Exhibits C and D of the application, and which would be built whether or not the Pitch Project would include a milling and tailings disposal operation.

This permit is issued subject to all applicable requirements of the Colorado Mined Land Reclamation Act and all applicable rules, regulations and standards now in force and any which may in the future be promulgated by the Mined Land Reclamation Board or its successor. The Board, upon application or its own initiative, from time to time, may amend this permit. This permit may be revoked or suspended for noncompliance therewith, in accordance with the Act.

MINED LAND RECLAMATION BOARD

By: ______________________________

APPENDIX B

1. Homestake Mining Company will monitor infiltration of water through waste and overburden dumps. Should such monitoring show that leaching of contaminants is occurring as a result of infiltration, Homestake will take all reasonable measures to minimize such infiltration.

2. Homestake will prepare a geotechnical program for identifying and solving known or reasonably expected stability problems of mine dump construction prior to such construction and will obtain Mined Land Reclamation Division approval for that program. Homestake will also conduct a regular annual geotechnical inspection of the mine dumps in accordance with that program until all dumps have been completed, and it will make such adjustments in construction activity as the program and these inspections indicate to be appropriate.

3. Homestake will construct waste or overburden dumps so that "pockets" of radioactive ore or toxic waste materials are not buried beneath designed drainage patterns across the surface of the finished dumps, are not buried above designed drainage channels under the finished dumps, and are not otherwise located so that radioactive or toxic materials will enter designed drainage patterns of finished dumps.

4. Where monitoring or other testing of drainage or other discharge from the dumps has an exceedance of applicable standards for contaminant it will treat all such discharge to assure compliance with those standards.

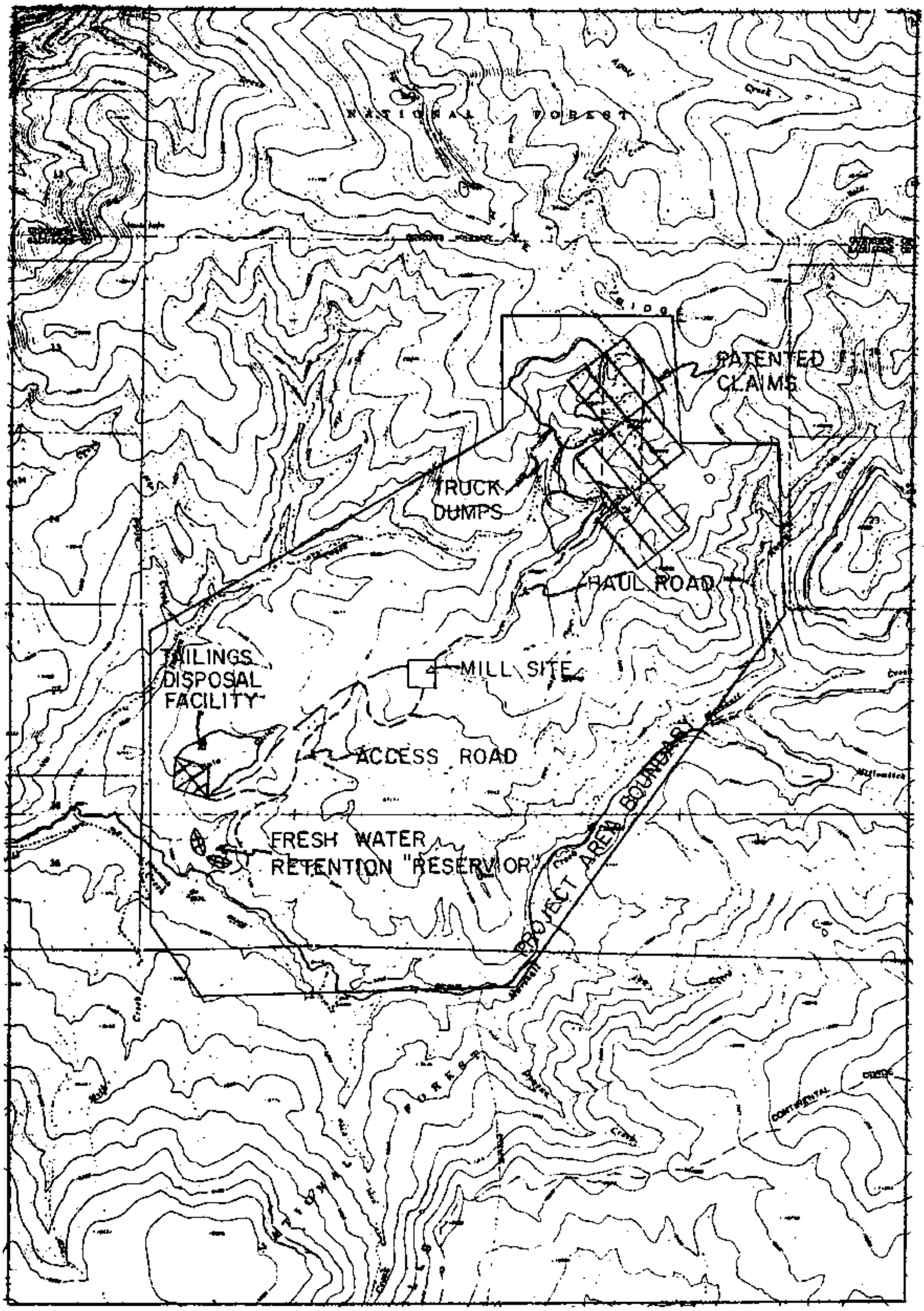
5. Homestake will site and locate stockpiles of ore only in those portions of the mine area where runoff water can be diverted from such stockpiles, or where contaminated water from such stockpiles can be collected and treated to assure compliance with applicable standards prior to discharge.

6. In the event a lake does not form in the mined pit area, Homestake will treat all waters in the mined pit area to assure compliance with applicable standards of the Colorado Department of Health or its successors, before such waters are discharged. Homestake will also take such actions as are necessary to assure that all applicable ground water standards of the Colorado Department of Health are met. In the event a lake does form in the pit, Homestake will take all steps required to meet water quality requirements for the projected use of the lake.

7. Homestake will not initiate physical site preparation or other construction activity in the area designated as "Mill Site" in Exhibits C and D of the application until the company has submitted and the Mined Land Reclamation Division has approved a detailed site plan, which plan shall specify the extent and nature of disturbance in the "Mill Site" area as a result of construction of mine-related structures and facilities.

Appendix L

MAP OF PATENTED LAND WITHIN PROJECT AREA



Map of Patented Land Within Project Area