CONTACT INFORMATION
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416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
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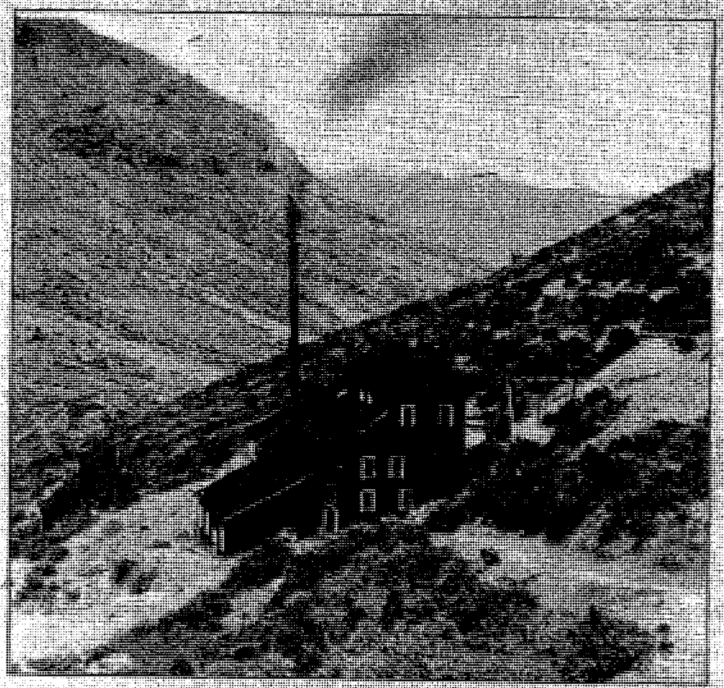
inquiries@azgs.az.gov

DRAFT ENVIRONMENTAL IMPACT STATEMENT

THE PROPOSED YARNELL MINING PROJECT

U.S. DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
PHOENIX FIELD OFFICE
PHOENIX, ARIZONA

U.S. ENVIRONMENTAL
PROTECTION AGENCY
REGION IX
SAN FRANCISCO, CALIFORNIA



Historic Yarnell Mine ca. 1892

June 1998

United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Phoenix District Office
2015 West Deer Valley Road
Phoenix, AZ 85027

In reply refer to:
3809 (024)
AZA-29237

September 27, 1995

Dear Interested Party:

The Bureau of Land Management (BLM) has received a mining proposal for the development of an open-pit gold mining operation near the town of Yarnell in Yavapai County. The Yarnell Mining Company, a subsidiary of Bema Gold (U.S.) Inc., has submitted a preliminary Mining Plan of Operations, currently being reviewed by the Phoenix District Office. The BLM will prepare an environmental impact statement (EIS) to analyze the environmental and socioeconomic impacts of the proposed mining operation, and to consider potential mitigation measures to minimize any adverse effects. No decision on the mining proposal will be made until the EIS is completed.

You are invited to attend the public scoping meetings that will be held so that the public can participate in identifying appropriate issues for the BLM to analyze during the preparation of the EIS. The enclosed scoping statement provides background information on the mining proposal, presents a listing of potential issues that may be addressed in the environmental analysis, and describes the public scoping process.

Three public meetings will take place in mid-October in Wickenburg, Yarnell, and Prescott. The enclosed scoping statement describes the agenda for the meetings. We welcome your attendance at the following locations:

October 17, 6:00 p.m. - 9:00 p.m.
Wickenburg Community Center
160 N. Valentine St.
Wickenburg, Arizona

October 18, 6:00 - 9:00 p.m.
Yarnell Senior Citizens Center
136 Broadway St.
Yarnell, Arizona

October 19, 6:00 p.m. - 9:00 p.m.
Prescott Resort Conference Center (formerly the Prescott Sheraton)
1500 Highway 69
Prescott, Arizona

If you are unable to attend one of the meetings, you can also participate by sending a written comment to us by November 20, 1995.

Public participation is an important part of the EIS process. We encourage you to attend the meetings and to send written comments regarding concerns or project alternatives that you feel are appropriate for analysis. In addition to this scoping comment period, there will be additional public comment periods and further opportunities for public participation when the draft and final versions of the EIS are published.

To be most helpful, please send your comments, postmarked no later than November 20, 1995, to Connie Stone, Project Manager, at the address shown in the scoping statement. You may also contact her for additional information at (602) 780-8090. All written comments that we have received prior to the scoping meetings will be reviewed to ensure that the environmental analysis addresses the issues and concerns identified by the public. We appreciate your interest, and involvement, in this important process.

Sincerely,

Gail Acheson

Gail Acheson
Area Manager
Phoenix Resource Area

Enclosure

PUBLIC SCOPING MEETING AGENDA

6:00 p.m.	PRELUDE	Attendees sign-in; opportunity to review maps and displays.
6:20 p.m.	INTRODUCTION	Introduction and welcome by meeting facilitator; discussion of meeting format and goals.
6:30 p.m.	WELCOME	Welcome by BLM area manager.
6:40 p.m.	EIS PROCESS	Description of EIS process by BLM project manager.
6:50 p.m.	DESCRIPTION OF PROPOSED PROJECT	Description of proposed Yarnell Project by Yarnell Mining Company representative.
7:10 p.m.	GENERAL Q & A	Opportunity for attendees to ask general questions on material presented by previous speakers.
7:30 p.m	OPEN HOUSE	Opportunity for attendees to identify scoping issues and express concerns at the specified stations.
9:00 p.m.	ADJOURNMENT	Facilitator and BLM will adjourn meeting and review public participation process and scoping comment time frames.

YARNELL PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SCOPING STATEMENT

Introduction

Yarnell Mining Company, a wholly-owned subsidiary of Bema Gold (U.S.) Incorporated, is proposing to develop the Yarnell Project, an open-pit gold mine that would be located in the Weaver Mountains of Yavapai County, Arizona. The purpose of this scoping statement is to provide information on the mining proposal and to solicit comments, concerns, and issues that need to be evaluated in an Environmental Impact Statement (EIS) that the Bureau of Land Management (BLM) will prepare for the proposed project. This scoping statement includes information describing the mining proposal, alternatives to be considered, preliminary issues to be evaluated, and the EIS process.

Project Background

Yarnell Mining Company proposes to mine the Yarnell gold deposit, located in southern Yavapai County, Arizona, approximately 26 miles north of the town of Wickenburg. The property is one mile south of the town of Yarnell, 0.75 miles southeast of the small community of Glen Ilah, and some 70 miles by road from Phoenix (Figure 1). The proposed project area is situated immediately east of State Highway 89, at the top of the Yarnell Grade.

The Yarnell gold deposit was first discovered in the late 1800's, and underground mining was conducted there from 1914 to 1942. After 1942, there was only minor activity at the Yarnell Mine. Bema Gold (U.S.) Incorporated acquired the property in 1991, and has since conducted metallurgical testing and preliminary engineering and economic evaluations to determine the feasibility of the proposed project.

Proposed Project Description

Yarnell Mining Company submitted a preliminary Mining Plan of Operations to the BLM in December, 1994. BLM is currently reviewing this plan and has requested additional technical information to be provided by the company.

The plan contains a description of the proposed mining operation. The Yarnell deposit would be mined using the conventional open-pit mining method. Mine development activities would include drilling, blasting, and ore/waste hauling; waste rock dump development; drainage and sediment control; ore crushing; and cyanide heap leaching.

The mining operation would cover approximately 160 acres. The pit would be located primarily on private (patented) land, with processing and ancillary facilities located on private lands and BLM-administered public lands. The area of disturbance would include approximately 92 acres on public land and 68 acres on private land.

Mining facilities, as proposed, would include the open pit; two or more waste rock dumps; haul roads; an ore crushing plant; a heap leaching facility, including a leach pad and collection ponds; a processing plant; and warehouse, laboratory, and office buildings. Figure 2 depicts the proposed placement of facilities. The mine would operate with approximately 90 employees.

Yarnell Mining Company proposes to obtain its water supply from an existing well on its private land and from the Antelope Creek Basin, approximately two miles southeast of the proposed project area. Exploratory drilling will be conducted to determine the sufficiency of this potential water source. The EIS will include an analysis of impacts that would be associated with the use of water sources.

The mine would be in operation for six years, with an additional two years for reclamation. Proposed reclamation activities would include closure of the facilities, the removal of buildings, neutralizing of the heap leach pad, pond removal, stabilizing of slopes, and revegetation.

The Environmental Impact Statement Process

BLM is the agency responsible for preparing the EIS on the proposed Yarnell Project. An interdisciplinary team of BLM personnel has been formed to guide preparation of the EIS. A consulting firm, P.M. De Dycker and Associates, Inc., will assist BLM in the preparation of the EIS.

The identification of significant environmental issues related to the proposed action, by BLM, other governmental agencies, and the public, is called scoping. The environmental analysis phase of the EIS will begin after scoping is completed. The Draft EIS will present an analysis of the physical, biological, and socioeconomic effects of the proposed project and its alternatives. After publication and distribution of the Draft EIS, projected to take place sometime in mid-1996, BLM will solicit public comments on the draft document. A Final EIS will address all substantive public comments.

Nature of Decisions to be Made

The EIS will disclose and analyze impacts and make recommendations on alternatives and mitigation measures developed to reduce any adverse impacts. The environmental analysis will be used by BLM in making a decision on the proposed mining project. The Yarnell Mining Company holds valid mining claims on public land

and has rights under the Mining Law of 1872 to develop these claims. The use of the subject lands for mineral operations is in conformance with BLM's resource management plans. The decision to be made is whether to approve the implementation of a proposed plan that meets BLM's requirements as well as other legal requirements; whether to approve an alternative to the proposed plan; or whether to reject the proposed plan. In making this decision, the following determinations must be made:

1. Determine if the proposed actions are in conformance with BLM policies, regulations, and approved land management direction, including the requirements of the Federal Land Policy and Management Act of 1976.

2. Determine if any additional mitigation, management restrictions, or monitoring requirements are needed if the proposed plan is implemented.

Preliminary Issues

The BLM has conducted a preliminary evaluation of environmental issues associated with the proposed mining operation. Some of these issues were identified as a result of correspondence received from the public. The main issues are summarized below.

Surface and Groundwater Quality and Quantity: Because of the nature of leaching operations, surface and groundwater quality protection is a major concern. Water quantity is also a concern because of limited water resources in the project area and possible impacts to community water supplies.

Air Quality: Atmospheric releases of fugitive dust and vehicular emissions during construction and operations are of interest. The potential drift of cyanide gas from the leach pads is also a concern.

Visual Resources: Visual impacts could result from the proximity of the project to residential areas, highways, and public lands. Visual impacts are a concern during mining operations and after closure and reclamation.

Public Safety: The effects of potential reagent spills and blasting related impacts from fly rock, air pressure and ground vibration are also a concern.

Noise: Mining activities would occur near residences of Glen Ilah and Yarnell, which could be disturbed by these activities.

Biological Resources: The proposed mine could affect vegetation, wildlife use of the area, potentially threatened or endangered species, and use of the area for livestock grazing and other purposes.

Mine Reclamation: The reclamation potential of the disturbed portions of the site is a concern due to aridity, limited soils, and the presence of the open pit.

Road Closure: Temporary closures of Highway 89 as a result of mining activities could affect access to and from Yarnell and Glen Ilah.

Alternatives

Alternative facility locations, operating procedures, and the No Action alternative have been identified to date as potential alternatives to be considered for analysis. Other alternatives identified through the process shall also be considered. Analysis of these alternatives would address associated issues and evaluate the needed levels of mitigation.

Permits and Approvals Required

It is anticipated that several permits and approvals would be required prior to the start-up of operations. These may include, but not be limited to, the following:

* Arizona Aquifer Protection Permit from the Arizona Department of Environmental Quality (ADEQ).

* Section 404 of the Clean Water Act Permit (and Section 401 certification by the State) from the U.S. Army Corps of Engineers and ADEQ.

* National Pollutant Discharge Elimination System Permit under Section 402 of the Clean Water Act from the Environmental Protection Agency and ADEQ.

* Well installation permits from the Arizona Department of Water Resources.

* Air Quality Permit to Operate from ADEQ.

* Storm water Discharge Permit from ADEQ.

* Consultation with the U.S. Fish and Wildlife Service concerning threatened or endangered species which may occur in the area.

Public Participation

An EIS will be prepared pursuant to the National Environmental Policy Act (NEPA) and in accordance with provisions agreed upon in a Memorandum of Agreement between BLM and the Yarnell Mining Company. Complete records of all phases of the environmental documentation process will be available for public review at the Bureau of Land Management, Phoenix District Office.

This Scoping Statement was prepared for mailing to all interested persons, agencies, and organizations. A news release also was issued to the media to describe the proposal and invite the public to comment. Also, a Notice of Intent (NOI) was published in the Federal Register on September 21, 1995, announcing the beginning of the EIS process and soliciting comments.

You are invited to attend any of three public meetings to submit any comments or alternatives you wish to have considered in the analysis of the proposed Yarnell mining project. The public meeting schedule is described below:

October 17, 1995
6:00 p.m. - 9:00 p.m.
Wickenburg Community Center
160 North Valentine Street
Wickenburg, Arizona

October 18, 1995
6:00 p.m. - 9:00 p.m.
Yarnell Senior Citizens Center
136 Broadway Street
Yarnell, Arizona

October 19, 1995
6:00p.m. - 9:00 p.m.
Prescott Resort Conference Center (formerly the Prescott Sheraton)
1500 Highway 69
Prescott, Arizona

Please submit any written comments you may have concerning the proposed Yarnell gold mine at one of these meetings or to the Project Manager at the address given below. For your comments to be best utilized in the analysis for this proposed project, they should be submitted to BLM by November 20, 1995.

Additional opportunities for public participation will be available during preparation of the EIS.

Responsible Officials

Ms. Gail Acheson, BLM Phoenix Resource Area Manager, and Mr. Gordon Cheniae, Phoenix District Manager, are the responsible officials for this EIS. Comments should be sent to Ms. Connie Stone, Project Manager, at the following address:

Bureau of Land Management
2015 West Deer Valley Road
Phoenix, AZ 85027

Telephone (602) 780-8090

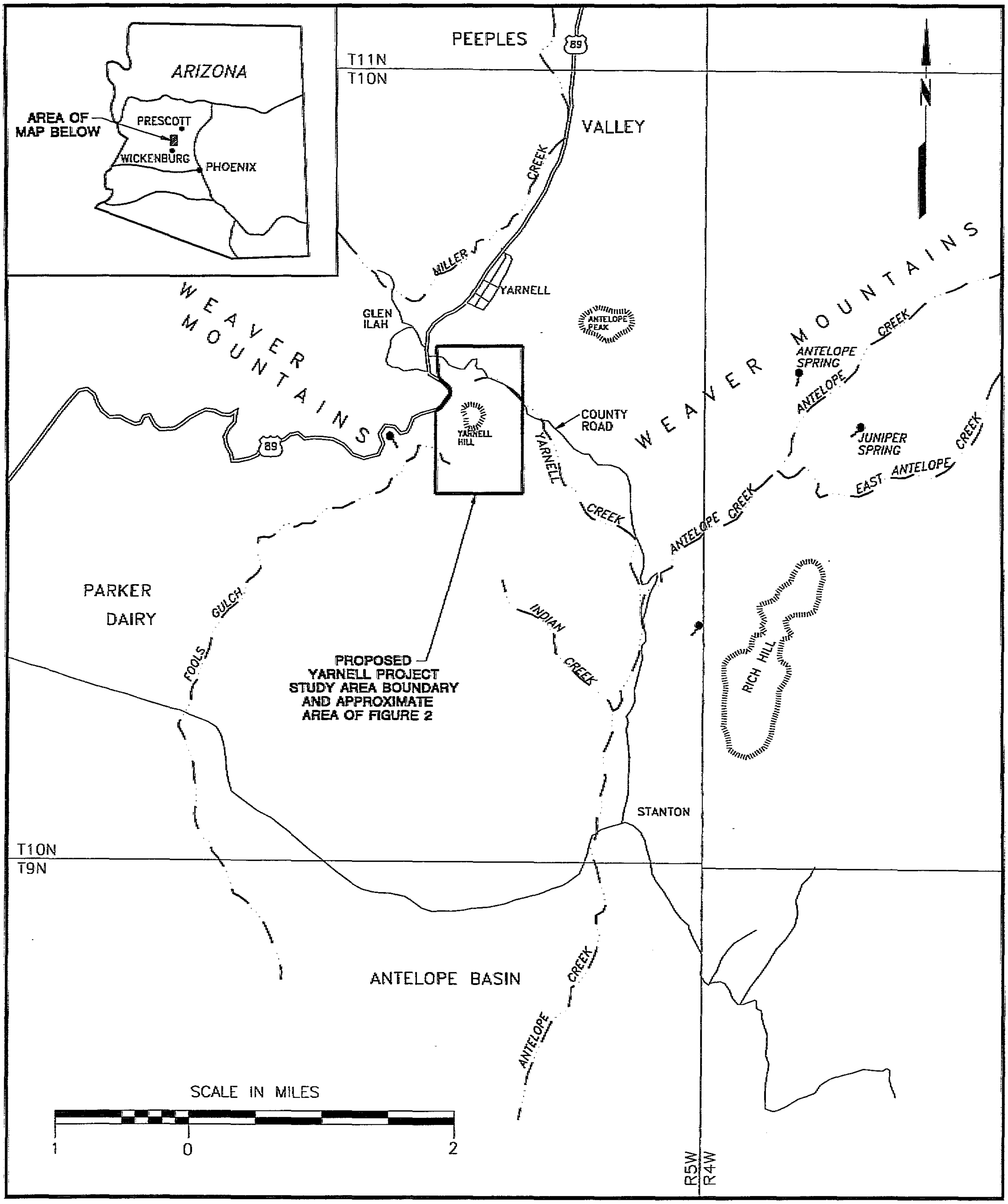


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FIGURE 1
PROPOSED PROJECT VICINITY MAP

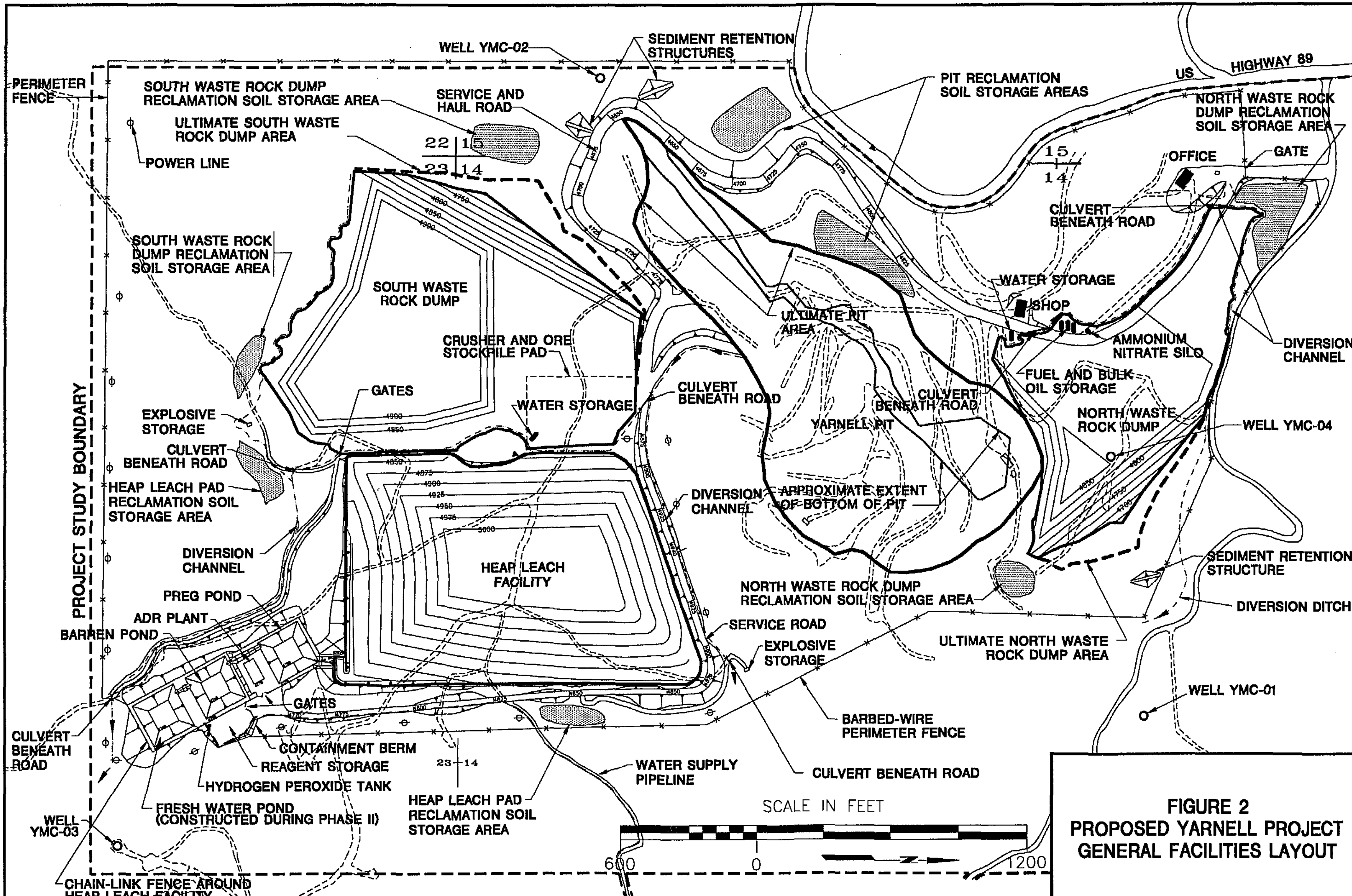

FIGURE 2
PROPOSED YARNELL PROJECT GENERAL FACILITIES LAYOUT

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United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Phoenix Field Office
2015 West Deer Valley Road
Phoenix, AZ 85027-2099

IN REPLY REFER TO:

3809 (020)
AZA-29237

June 22, 1998

Dear Reader:

The Bureau of Land Management (BLM) has prepared a draft environmental impact statement (DEIS) in response to a proposed mining plan of operations submitted to the Phoenix Field Office by the Yarnell Mining Company, a subsidiary of Bema Gold (U.S.) Incorporated. The proposed Yarnell Mining Project would consist of surface mining and ore processing facilities to recover gold near the town of Yarnell in Yavapai County. The DEIS documents the analysis of potential environmental and socioeconomic impacts of the proposed mining project.

In the past, you have indicated an interest in the proposed mine. Enclosed is a copy of the DEIS for your review and comment. We request your comments on the document. The comments most useful to us are substantive ones that address specific concerns, issues, or technical matters. Comments will be individually and collectively considered in preparing the Final EIS.

The comment period is open for 60 days, beginning on June 26, 1998. **All comments will be accepted until August 25, 1998.** Please note that comments, including names and street addresses of respondents, are available for public review and may be published as part of the Final EIS, or other related documents. Individual respondents may request confidentiality. **If you wish to withhold your name or street address from public review or from disclosure under the Freedom of Information Act, you must state this prominently in your written comment.** Such requests will be honored to the extent allowed by law. All submissions from organizations or businesses, and from individuals identifying themselves as representatives or officials of organizations or businesses, will be made available for public inspection in their entirety.

You are invited to attend public hearings to be held on the following dates:

Tuesday, July 28 in Wickenburg, Arizona at the Wickenburg Community Center, 160 N. Valentine St., 6:00 to 9:00 p.m..

Wednesday, July 29 in Yarnell, Arizona at the Yarnell Senior Center, 136 Broadway St., 4:00 to 8:00 p.m.

Thursday, July 30 in Prescott, Arizona at the Prescott Resort Conference Center, 1500 Highway 69, 6:00 to 9:00 p.m.

Written comments should be sent to Connie Stone, Project Manager, Bureau of Land Management, Phoenix Field Office, 2015 W. Deer Valley Road, Phoenix, Arizona 85027. Please call her if you have any questions at (602) 580-5517. We welcome your comments to assist us throughout the EIS process.

Sincerely,

Michael A. Taylor
Field Manager

U.S. Department of the Interior
Bureau of Land Management

U.S. Environmental Protection Agency, Region IX
Cooperating Agency

Draft
Environmental Impact Statement

for the

Proposed
Yarnell Mining Project

prepared by
the Phoenix Field Office
Phoenix, Arizona

June 1998

Denise P. Meridith
Arizona State Director

Draft Environmental Impact Statement

Proposed Yarnell Mining Project, Yavapai County, Arizona
Bureau of Land Management, Phoenix Field Office

EIS number:	BLM/AZ/PL-98/020
Lead agency:	U.S. Department of the Interior, Bureau of Land Management
Cooperating agency:	U.S. Environmental Protection Agency, Region IX, San Francisco

Abstract:

The Yarnell Mining Company (YMC), a subsidiary of Bema Gold (U.S.) Incorporated, proposes to develop the Yarnell Mining Project, which would consist of surface mining and ore processing facilities to recover gold near the town of Yarnell in Yavapai County. Facilities would include an open pit mine, two waste rock dumps, ore crushing and heap leaching facilities, a laboratory, warehouse, and offices. Water would be obtained from local and regional groundwater sources and transported to the project via two pipelines. Mining would be conducted for six years, with closure and reclamation taking an additonal seven years following the end of operations. Facilities would be constructed on 118 acres of BLM-administered land, 75 acres of private land owned by YMC, and 8 acres of state land that would be included in the water supply system. This draft environmental impact statement (DEIS) documents the analysis of potential environmental and socioeconomic impacts of the proposed Yarnell Mining Project. In addition to the proposed action, the document analyzes the no action alternative and two action alternatives which involve modifications in the placement of waste rock facilities.

DEIS comment period ends: August 25, 1998

Agency contact:

Connie L. Stone, Project Manager
Bureau of Land Management
Phoenix Field Office
2015 W. Deer Valley Road
Phoenix, Arizona 85027
Telephone: (602) 580-5517

Manager responsible for preparing this DEIS:

Michael A. Taylor
Acting Field Manager
Phoenix Field Office
Phoenix, Arizona

Official responsible for authorizing the action:

Denise P. Meridith
State Director
Bureau of Land Management
Arizona

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Phoenix Field Office of the Bureau of Land Management (BLM) received a Mining Plan of Operations (MPO) from the Yarnell Mining Company (YMC), a subsidiary of Bema Gold (U.S.) Incorporated, in December 1994. The MPO outlined the proposed Yarnell Project, which would consist of surface mining and ore processing facilities to recover gold near the town of Yarnell in Yavapai County, Arizona (see Figure S-1). In response to the BLM's requests, refined versions of the MPO were submitted in March 1996 and November 1996. The MPO and supplemental information provide the basis for the proposed action that is analyzed in this draft Environmental Impact Statement (EIS). The BLM has assigned the MPO case file number AZA-29237 in its serialized case recordation system.

This draft EIS describes the possible environmental consequences of the proposed Yarnell Project. This Executive Summary provides a summary of the proposed action, major issues, alternatives and conclusions as presented in this draft EIS.

PURPOSE AND NEED

The purpose of YMC's proposed action is to develop and operate an open-pit gold mine and ore processing facility, known as the Yarnell Project, to produce an economically marketable product. Gold is a precious metal for which there is worldwide demand. The proposed action would involve the extraction and processing of ore to produce doré bars, a marketable commodity, in a profitable manner.

Prior to construction and operation of the Yarnell Project, approval must be granted by the BLM because part of the operation, as proposed, is situated on federal lands administered by the BLM. YMC owns or controls mining claims on these and adjacent private and state lands. Under provisions of the U.S. mining laws (30 U.S. Code 21-54), the holder of valid mining claims has the statutory right to enter and use such lands for prospecting, exploration, development and processing of mineral resources in accordance with applicable regulations. YMC has the legal right to mine and process these gold resources through submittal of an MPO. The BLM cannot approve the MPO if the proposed action would result in unnecessary or undue degradation of the federal lands. Environmental impact analysis is required to make this determination. Absent a finding of "unnecessary or undue degradation," the decision to be made by the BLM would be to authorize or modify the proposed action.

THE EIS PROCESS AND SCOPE OF THIS EIS

This draft EIS documents the process used by the BLM to make a decision on the proposed mining and ore processing operations. Its purpose is to provide a full and objective disclosure of environmental impacts and to inform the decisionmakers and the public of reasonable alternatives which would reduce or avoid adverse impacts. The National Environmental Policy Act (NEPA) directs federal agencies to use a systematic and interdisciplinary approach to environmental impact analysis and requires that if any

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE S-1

PROJECT LOCATION MAP

action taken by a government agency may "significantly affect the quality of the human environment," an EIS must be prepared. Because of the proximity and potential significant impacts on the nearby community, the BLM has determined that an EIS is required to analyze possible effects from the proposed project.

Because of its specific roles and responsibilities in managing the federal lands which would be involved in the proposed action, the BLM serves as the "lead agency" for this EIS. In conjunction with its responsibilities under the Clean Water Act and NEPA, the U.S. Environmental Protection Agency (EPA) is participating as a "cooperating agency" in the preparation of this draft EIS.

The EIS process entails several steps. During scoping, the public and other government agencies are afforded the opportunity in public meetings to express concerns and identify issues to be addressed within the draft EIS. Written comments are also solicited. Following scoping, the proposed action and reasonable alternatives to the proposed action are clearly defined, based on BLM concerns and those presented by other government agencies and the public. Elements of the environment which would be affected by the proposed action and alternatives are described in the draft EIS. An analysis of the consequences (impacts) of the proposed action and reasonable alternative actions is then conducted.

The results of the analysis are documented in the draft EIS. A formal public review and comment period occurs after publication of a draft EIS, during which time written and oral comments and questions on the analysis are solicited. One or more public meetings during this comment period afford an additional opportunity for public participation. Comments and questions received during the public comment period are reviewed, analyzed and incorporated into the final EIS, as appropriate.

In a final EIS, the BLM may modify alternatives, and substantive public comments are considered and addressed. When a decision has been reached, the BLM must issue a Record of Decision (ROD) documenting the decision made and the reasons for such a decision.

The proposed Yarnell Project would include facilities on federal, state and private lands. The scope of this EIS includes all areas that could be affected by the project, regardless of land ownership. However, the BLM has the authority to regulate activities or impose mitigation measures only on federal lands.

THE PROPOSED ACTION AND SETTING

The Yarnell gold deposit is in the Weaver Mountains of Yavapai County, Arizona. The property is situated one-half mile south of the town of Yarnell and one-quarter mile southeast of the Glen Ilah subdivision, as measured from the northwest boundary of the proposed project area to the southern boundaries of Glen Ilah and Yarnell. The proposed project is located within Sections 14, 15, 22 and 23 of Township 10 North, Range 5 West.

The area has a history of mining. The Yarnell gold deposit was first discovered in the late 1800s. Underground and surface mining and associated ore processing occurred within the site at various times until 1942. Part of the proposed mining area has incurred extensive surface disturbance from historic exploration, mining and ore processing activities.

As shown on Table S-1, disturbance would include approximately 118 acres on 30 unpatented mining claims (public land) and 75 acres on five patented mining claims held by YMC and other private land. An additional 7.7 acres of state of Arizona land would be disturbed as part of the project's water supply. Total disturbance would be about 201 acres. About 14 acres (11 acres on patented claims owned by YMC and three acres of public land) of proposed Yarnell Project disturbance would occur on land previously disturbed by historic mining activities. An estimated 294 acres would be within a perimeter security fence constructed to restrict access by wildlife and the public.

The proposed project facilities are shown in Figure S-2. A project flow sheet showing the relationship of proposed project components is presented in Figure S-3. As proposed, the Yarnell ore deposit would be mined using a conventional open-pit mining method. Mining is planned to occur 24 hours per day, five days per week. Ore would be hauled directly to the crusher and either dumped directly into the primary crusher or stockpiled nearby for later feeding.

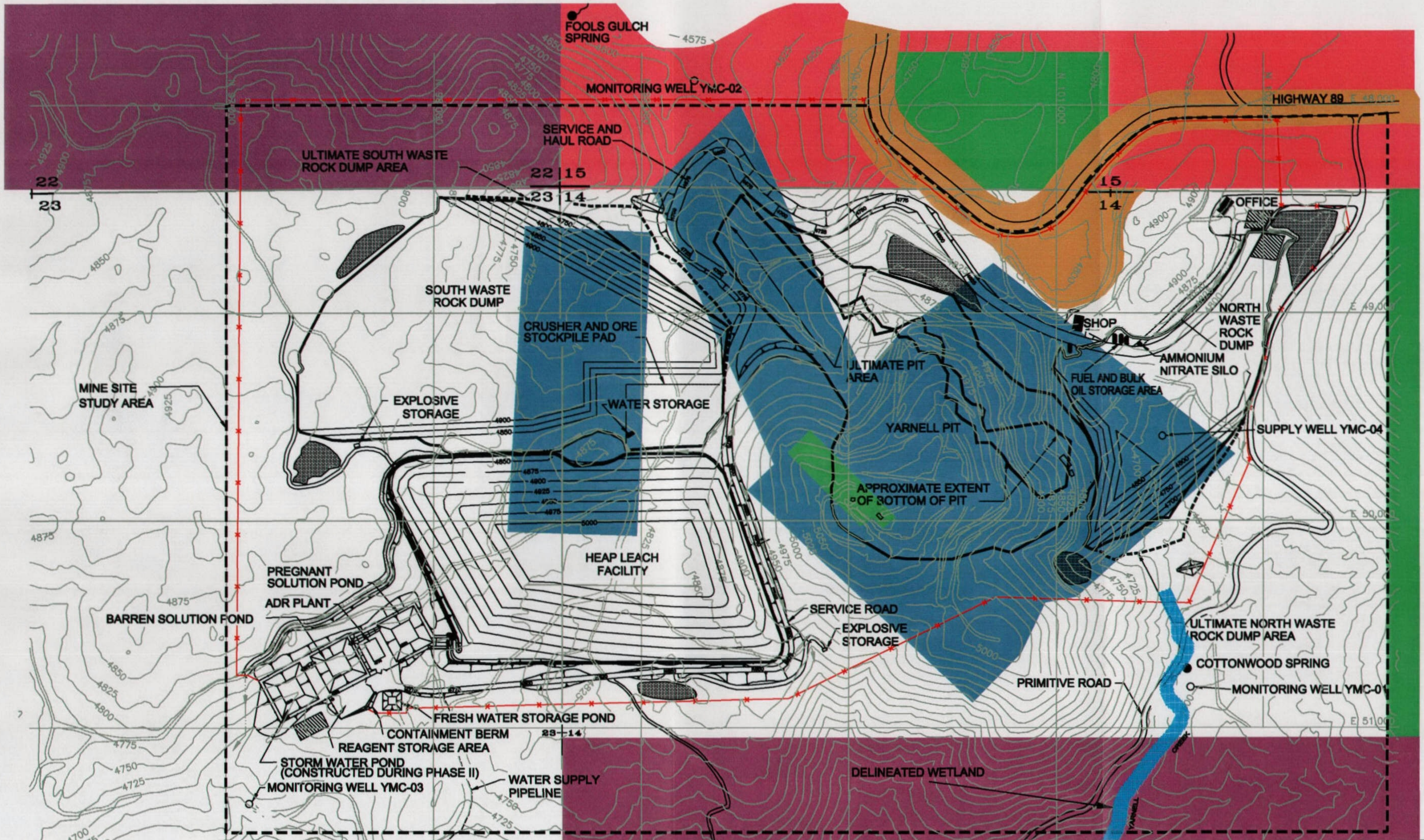
Waste rock would be hauled to either the South Waste Rock Dump (SWRD) or the North Waste Rock Dump (NWRD). Upon the completion of mining, approximately 3.7 million tons would have been hauled to the NWRD and 7.6 million tons to the SWRD for a total of 11.3 million tons. In addition, 574,000 tons of waste rock would be used for the construction of the leach pad and crusher area, bringing the total volume of waste rock to 11.9 million tons.

The ore processing facilities would consist of a two-stage crushing plant, equipment to haul crushed ore onto the heap leach pad, the pad, solution collection ditches, a pregnant solution pond, a carbon adsorption recovery plant, a barren solution pond and storm water pond. Crushing operations, together with leach pad loading, are planned for 24 hours per day, five days per week. Leaching and metal recovery activities would occur 24 hours per day, seven days per week.

The proposed project infrastructure would include an administrative office, mine shop, assay lab, warehouse facilities, power distribution and water

TABLE S-1
Yarnell Project Summary of Projected Disturbance

Project Component	Projected Disturbance Area (acres)			
	Public Land (BLM)	Public Land (State Trust)	Private Land	Total
Yarnell Pit	4.8	–	32.9	37.7
North Waste Rock Dump	11.7	–	10.1	21.8
South Waste Rock Dump	33.3	–	15.3	48.6
Heap Leach Facility	35.3	–	5.2	40.5
Solution Storage Ponds/ADR Plant	7.4	–	0.0	7.4
Roads/Buildings/Storage	18.7	–	5.6	24.3
Sediment Control/Diversion	0.3	–	0.2	0.5
Well Field/Pipeline	6.5	7.7	4.3	18.5
Microwave Stations Relocation	–	–	1.5	1.5
TOTAL	**118.0**	**7.7**	**75.1**	**200.8**



PUBLIC LAND ADMINISTERED BY BLM	PATENTED LANDS
STATE LANDS	STOCKRAISING HOMESTEAD LAND
PATENTED MINING CLAIMS OWNED BY YMC	ARIZONA DEPT. OF TRANSPORTATION RIGHT-OF-WAY

MINE SITE STUDY AREA

SCALE IN FEET
200 0 400

NOTE:
TOPOGRAPHY AND ORIGINAL FACILITIES LAYOUT TAKEN FROM MINING PLAN OF OPERATIONS 1995, UPDATED 1996.

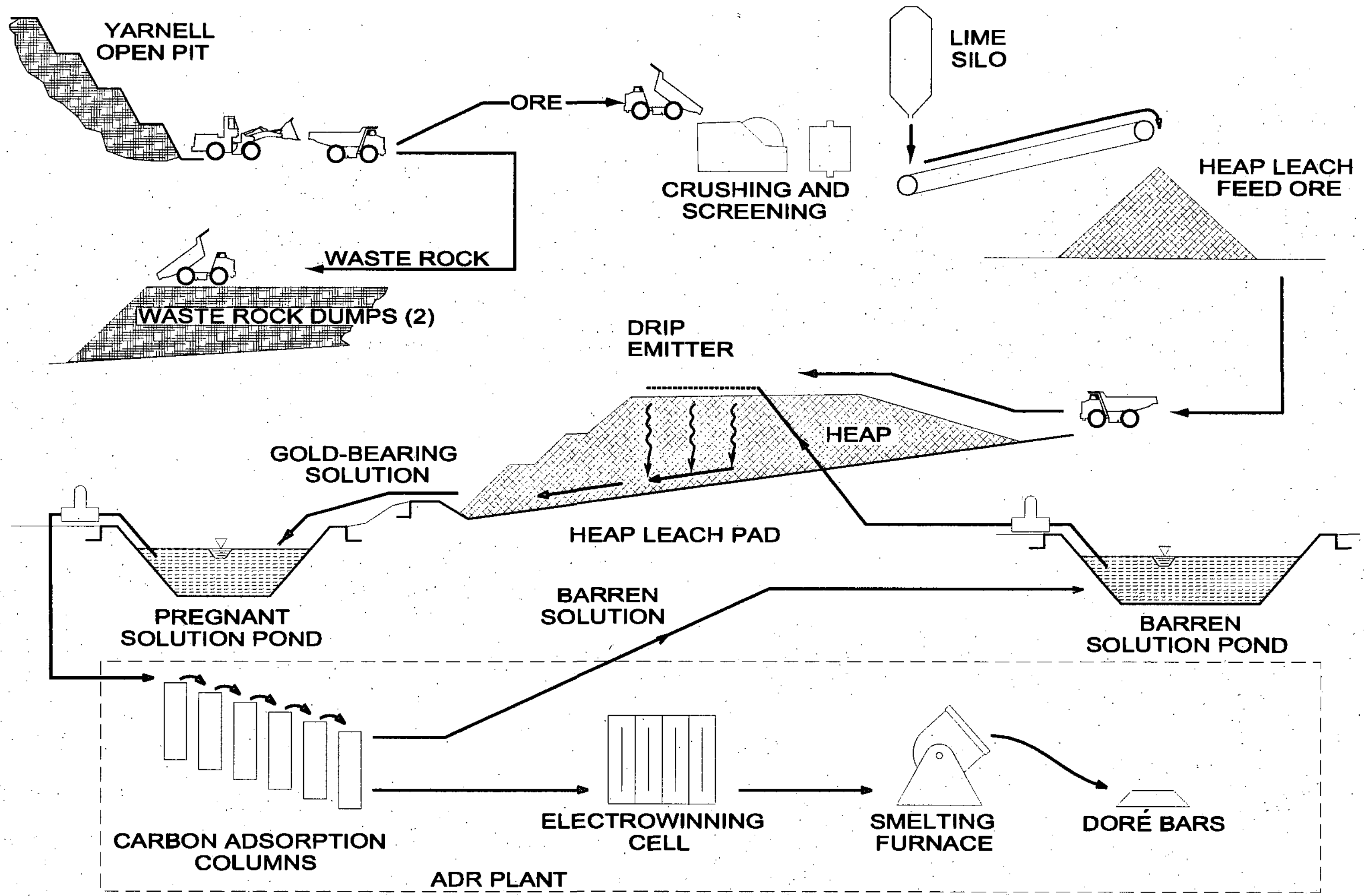
LEGEND

- RECLAMATION SOIL STORAGE AREA
- SEPTIC SYSTEM LEACH FIELD
- SEDIMENT RETENTION STRUCTURE
- DIVERSION CHANNEL
- BARBED WIRE PERIMETER FENCE

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE S-2

PROPOSED PROJECT FACILITIES



NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE S-3

PROJECT FLOW SHEET

supply facilities and access and haul roads. All facilities, except the water supply wells and the water delivery pipelines, would be at the project site. Most power requirements would be supplied by on-site generators, with power to the mine office and maintenance facility supplied by Arizona Public Service. Water would be obtained from local and regional groundwater sources and transported to the mining/processing area via proposed pipelines (see Figure S-4).

The proposed production schedule calls for mining and processing 1,200,000 tons of ore per year. Annual gold production, over an approximate six-year mine life, would average 30,100 troy ounces. Reclamation and closure activities (including monitoring) would take an additional seven years following the end of operations.

Detailed information on the proposed project is included in Chapter 2 of this draft EIS.

RELATIONSHIP TO BLM POLICIES, PLANS AND RESPONSIBILITIES

In addition to NEPA, the BLM must consider other laws, regulations, policies and plans in reviewing the Yarnell Project MPO, including:

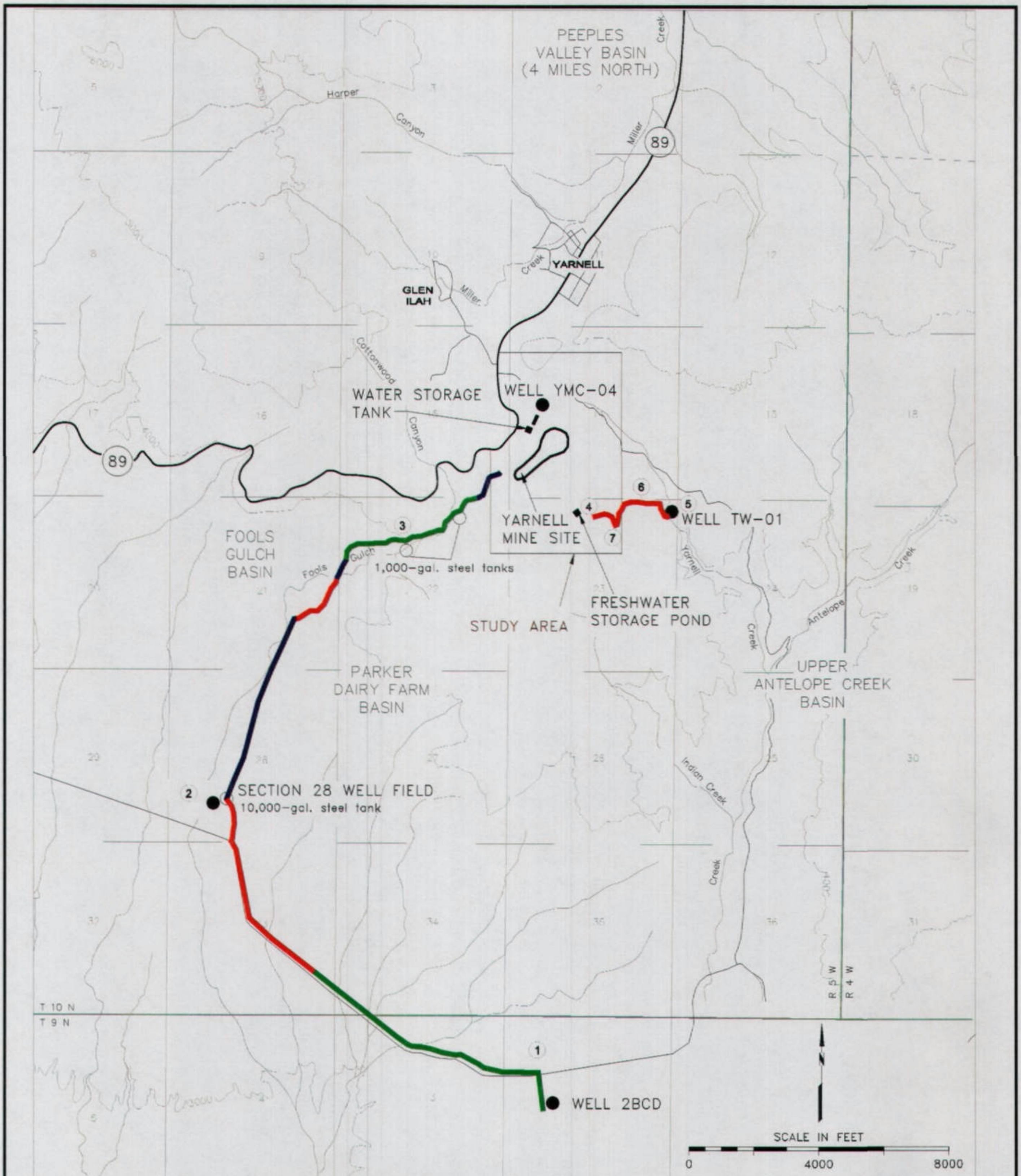
- Federal Land Policy and Management Act
- U.S. Mining Laws and BLM Mining Regulations (43 CFR Part 3809)
- BLM Land Use Plan (Lower Gila North Management Framework Plan)
- National Historic Preservation Act
- Executive Order 11990 (Protection of wetlands)
- Executive Order 12898 (Environmental justice)
- Executive Order 13007 (Indian sacred sites)
- Department of Interior Secretarial Order 3175 (Indian trust resources)
- Endangered Species Act
- Migratory Bird Treaty Act of 1918
- Use and Occupancy Regulations
- Reclamation Plan Requirements
- Cyanide Management Plan Requirements

The BLM's role and responsibilities for these laws, regulations, policies and plans are discussed in Chapter 1 of this draft EIS.

RELATIONSHIP TO OTHER GOVERNMENTAL POLICIES, PLANS AND RESPONSIBILITIES

In addition to the BLM, other federal, state and local agencies have responsibilities in reviewing the proposed Yarnell Project. These other agencies include:

- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- U.S. Mine Safety and Health Administration
- Arizona Department of Agriculture
- Arizona Department of Environmental Quality
- State Historic Preservation Office
- Arizona State Mine Inspector
- Arizona Department of Transportation
- Arizona Department of Public Safety
- Arizona Department of Water Resources
- State Fire Marshall's Office
- Arizona State Land Department



EXPLANATION

— 3000 — EXISTING CONTOUR – 1000-FT INTERVAL

○ PUMP STATION

WATER LINE CORRIDOR – PRIVATE LAND

WATER LINE CORRIDOR – BLM LAND

WATER LINE CORRIDOR – STATE LAND

NOTE: Based on Figure from Mining Plan of Operations

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE S-4

WATER SUPPLY AND PIPELINE CORRIDORS

- ♦ Arizona Game and Fish Department
- ♦ Arizona State Museum
- ♦ Yavapai County Planning Department

Specific roles, responsibilities and concerns of these agencies and other governmental requirements are discussed in Chapter 1 of this draft EIS.

SIGNIFICANT ISSUES

Scoping activities are an integral part of the environmental review process and were used to define the issues addressed in this draft EIS. Public participation in the scoping process serves to inform the public of the proposed action and to provide the public with the opportunity to identify environmental, social, cultural and economic issues and concerns.

A notice of intent (NOI) to prepare an EIS for the Yarnell Project was published in the Federal Register on September 21, 1995. Meeting announcements were placed in the Federal Register and in local newspapers, and a scoping document describing the proposed action and a meeting schedule was mailed to approximately 750 individuals, public officials and organizations. Public scoping meetings conducted in Wickenburg, Yarnell and Prescott on October 17, 18 and 19, 1995, respectively, were attended by approximately 400 people.

Public and agency comments at the scoping meetings and written comments submitted to the BLM during the scoping period generated a list of more than 300 specific concerns, comments and questions. The BLM categorized and grouped each issue according to its primary resource or topic. A scoping report was prepared to document the issue identification process.

Table S-2 provides a summary of significant issues associated with project development and locations within this EIS where these issues are addressed and analyzed.

DEVELOPMENT OF ALTERNATIVES TO THE PROPOSED ACTION

Council on Environmental Quality (CEQ) regulations (Section 1502.14) require that an EIS include an examination of reasonable alternatives to the proposed action. Potential alternatives consist of reasonable modifications to various elements of the MPO. These alternatives fall into two main categories – those that modify the location of the proposed facilities and those that modify the methods and procedures to be employed in the operation. Some potential alternatives to the proposed action were eliminated from detailed study for reasons relating to purpose and need, technical and economic feasibility, and environmental consequences. Alternatives to the proposed action chosen for detailed study in this draft EIS were developed after a detailed review of the MPO and a consideration of scoping comments provided by the public and other agencies. Alternatives to the proposed action which are analyzed in this draft EIS are summarized below.

- ♦ Alternative 1 – No Action. The no action alternative serves as the baseline for evaluation of the potential effects of all other project alternatives. Under this alternative, the proposed action or other action alternatives presented within this draft EIS would not occur.

TABLE S-2
EIS Sections Containing Discussions of Significant Issues Raised During Scoping Process

Issue Category	Issues	Chapter 3	Chapter 4	Chapter 5
Water Resources	Impacts on the quality of surface waters in the watershed, both during the life of the mine and after the mine closes	3.2.3	4.1.4.3	5.2.3
	Potential changes to the quantity of surface water flows as a result of groundwater pumping by the mine	3.2.2	4.1.4.2	5.2.3
	Impacts on the quality of groundwater and water in wells In Glen Ilah, Yarnell and the surrounding area, both during the life of the mine and after the mine closes	3.2.6	4.1.4.5	5.2.3
	Potential for depletion of the water table and wells as a result of groundwater pumping	3.2.5	4.1.4.4	5.2.3
	Potential accumulation of water in the mine pit and the quality of that water during the life of the mine and after the mine closes	3.2.5; 3.2.6	4.1.4.2 through 4.1.4.5	5.2.3
Air Quality	Impacts resulting from dust, fumes and chemical emissions	3.4.2	4.1.7.2	5.2.5
	Potential for cyanide emission release	3.4.2.5	4.1.7.2	5.2.5
	Public health issues associated with airborne transmission of illnesses	N/A	4.1.7.2	5.2.5
Blasting	Impacts on the stability of natural features including boulders and aquifer systems	3.1; 3.2	4.1.14.2	5.2.1
	Potential for damage to residences, utility lines and roads	N/A	4.1.14.2	5.2.1
Noise	Impacts on public health and the quality of life in nearby communities	3.9.2; 3.9.3	4.1.13.2	5.2.9
Visual Resources	Impacts on views from residences and Highway 89 during the life of the mine and after the mine closes	3.6.2	4.1.9.2	5.2.10
	Effects of night lighting on the visibility of the sky and stars	N/A	4.1.9.2	5.2.10
Public Safety and Transportation	Potential hazards created by truck traffic and the transport and storage of hazardous materials	3.8.2	4.1.12.2; 4.1.15.2	5.2.8
	Potential hazards to motorists from blasting	N/A	4.1.14.2	5.2.11
	Effect of road closures on access to medical and emergency services by area residents	3.8.1; 3.10.6.3	4.1.16.2; 4.1.12.2	5.2.11
Socioeconomic Conditions	Impacts on property values	3.10.5	4.1.16.2	5.2.12
	Impacts on employment and income	3.10.3	4.1.16.2	5.2.12
	Impacts on local businesses	3.10.2	4.1.16.2	5.2.12
	Impacts on tourism	3.10.2	4.1.16.2	5.2.12
	Impacts on tax revenues	3.10.7	4.1.16.2	5.2.12
	Impacts on crime rates	3.10.6.3	4.1.16.2	5.2.12
	Potential for increased demand on local services from possible influx of mine employees	3.10.6	4.1.16.2	5.2.12
	Disruption of quality of life from noise, visual impacts, night lighting or other aspects of the mine operation	3.10.1	4.1.16.2	5.2.12
Closure and Reclamation	Adequacy of bonding to ensure completion of reclamation	Bond amount not yet determined		
	Effectiveness of proposed reclamation plan and monitoring measures	N/A	Chapter 4	N/A
Biological Resources	Impacts to wildlife and wildlife habitats	3.3.2	4.1.6.2	5.2.4
	Impacts to threatened or endangered species	3.3.1.2; 3.3.2.2	4.1.5.2; 4.1.6.2	5.2.4
	Potential wildlife mortality from exposure to hazardous substances	N/A	4.1.6.2	5.2.4
	Impacts on vegetation including riparian zones along Antelope Creek and Hassayampa River	3.3.1.1	4.1.5.2	5.2.4
Cultural Resources	Impacts on prehistoric or historic sites and roads	3.7.2	4.1.10.2	5.2.7
Land Use	Impacts on livestock grazing, other land uses and access routes	3.5.2; 3.8.1	4.1.8.2	5.2.6

- Alternative 2 – Elimination of the SWRD and consolidation of waste rock into the north dump site. This alternative would eliminate the south dump and confine waste rock disposal to the north dump site. Other elements of the MPO would remain the same under Alternative 2.
- Alternative 3 – Elimination of the NWRD and consolidation of waste rock into the south dump site. This alternative would eliminate the NWRD and confine waste rock disposal to the south dump site. Other elements of the MPO would remain the same under Alternative 3.

Further information on these alternatives is included in Chapter 2 of this draft EIS.

AGENCY PREFERRED ALTERNATIVE

The BLM will not reach a final decision to select a specific agency-preferred alternative at this early stage of analysis. Section 1502.14(e) of the CEQ regulations requires that the agency identify its preferred alternative in the final EIS. However, Department of the Interior policy (516 DM 4.10A) requires the identification of a preferred alternative in the draft EIS, unless another law prohibits such an expression. Among the three action alternatives, the proposed action is the BLM's preliminary identification of its preferred alternative.

AFFECTED ENVIRONMENT

Chapter 3 of this draft EIS describes the existing environmental and socioeconomic condition of the area that would be affected by the proposed Yarnell Project. The chapter is organized by elements of the human and physical environment including:

- physiography, topography, geology and soils
- water resources
- biological resources (vegetation and wildlife)
- air resources
- land use
- visual resources
- cultural resources
- transportation
- noise
- socioeconomic conditions

The environmental study area for each resource encompasses the area within which potential direct and indirect effects to a specific resource would be expected to occur. Elements of the human environment such as areas of critical environmental concern, farmlands, wild and scenic rivers and wilderness do not exist in the study area and are therefore not discussed in this draft EIS.

CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

An analysis of the potential environmental and socioeconomic consequences (impacts) that could result from implementation of the proposed action or the alternatives is provided in Chapter 4 of this draft EIS. Table S-3 provides a summary of potential impacts organized by resource for the proposed action and alternatives.

An environmental impact is defined as a modification of the existing environment or as it is anticipated to be in the future as a result of the proposed action or alternatives. Environmental impacts can occur as a result of the action (direct) or as a secondary result (indirect), and can be long-term (greater than 10 years) or short-term (less than 10 years) in duration. Generally, impacts are identified in the context of the project area, and the extent these impacts are perceptible beyond the project area.

Quantitative measurements of impacts for assessment of impact magnitudes are discussed where possible. Where numerical measurements are not possible or readily available, qualitative criteria are used to assess levels of effect based on agency guidelines and professional evaluations.

Mitigation refers to measures designed to reduce, avoid or rectify specific or potential impacts. As part of its proposed action, YMC has proposed some mitigation measures through project design and management procedures. When potentially significant impacts would remain after these design measures and best management practices have been applied, additional mitigation measures are proposed where feasible. These measures are recommended by the BLM, within the limits of their authority, and are not part of YMC's MPO. Final mitigation measures would be identified after public review of this draft EIS and in consultation with other agencies and YMC. Impacts which would remain after mitigation measures have been applied are termed residual effects. Table S-3 also summarizes mitigation measures and residual effects. If the MPO were approved, the BLM would identify mitigation measures as required conditions or stipulations in the ROD.

CUMULATIVE IMPACTS

As discussed in Chapter 5 of this draft EIS, cumulative impacts are defined as the sum of all past, present and reasonably foreseeable future impacts (including the proposed action) resulting from other activities in the study areas for each element of the human and physical environment. Past, present and reasonably foreseeable future activities considered in the cumulative analysis include:

- Past activities and disturbances associated with the lands in and around the Yarnell Project area have traditionally been associated with mining. Because of the direct relationship of these historical disturbances with the proposed project activities, these past activities were considered in the project-specific impact analysis (Chapter 4).
- The major current activity on the proposed project site is exploration conducted by YMC for purposes of defining the geologic reserve proposed for mining and processing. Even with the historical and current mining/exploration activities on proposed project lands, much of the project area contains natural vegetation and serves as open space and wildlife habitat.
- To be "reasonably foreseeable," a project must have been formally planned, proposed and announced to the public. With regard to the proposed project area, immediately adjacent lands and the Yarnell/Glen Ilah community, there are no known specific proposals that have been formally proposed and/or announced to the public.

Given that past, present and reasonably foreseeable future activities in addition to the proposed action are minimal, the major source of cumulative impact to the environment is from the proposed Yarnell Project.

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

The Phoenix Field Office (formerly the Phoenix District Office until 1997) of the Bureau of Land Management (BLM) received a proposed Mining Plan of Operations (MPO) from the Yarnell Mining Company (YMC), a subsidiary of Bema Gold (U.S.) Incorporated, in December 1994. The MPO outlined the Yarnell Project, which would consist of surface mining and ore processing facilities to recover gold near the town of Yarnell in Yavapai County, Arizona (see Figure 1-1). In response to the BLM's comments, refined versions of the MPO were submitted in March 1996 and November 1996. The BLM has assigned the MPO case file number AZA-29237 in its serialized case recordation system.

This draft Environmental Impact Statement (EIS) describes the possible environmental consequences of the proposed Yarnell Project. The MPO and other supporting documents and letters represent the proposed action analyzed in this EIS. This chapter includes an explanation of the purpose and need for the project and for agency preparation of the EIS, a brief description of the proposed action, descriptions of the roles of the major regulatory agencies in the environmental analysis or permitting process and a summary of the potentially significant issues and concerns expressed by the public during project scoping.

1.1 PURPOSE AND NEED

The purpose of YMC's proposed action is to develop and operate an open-pit gold mine and ore processing facility, known as the Yarnell Project, to produce an economically marketable product. Gold is a precious metal for which there is worldwide demand. The proposed action would involve the extraction and processing of ore to produce doré bars, a marketable commodity, in a profitable manner. Over the proposed six-year mine life, the project would produce approximately 180,000 troy ounces of gold.

Prior to construction and operation of the Yarnell Project, approval must be granted by the BLM because part of the proposed operation is on federal land administered by the BLM. YMC owns or controls mining claims on these lands. Under provisions of the U.S. mining laws (30 U.S. Code 21-54), the holder of valid mining claims has the statutory right to enter and use such lands for prospecting, exploration, development or processing of mineral resources in accordance with applicable regulations. YMC has the legal right to mine and process these gold resources through submittal of an MPO. The BLM cannot approve the MPO if the proposed action would result in "unnecessary or undue degradation" of the federal land. An environmental impact analysis is required to make this determination. Absent a finding of "unnecessary or undue degradation," the decision to be made by the BLM is to authorize or modify the proposed action.

1.2 THE EIS PROCESS

This draft EIS documents the process used by the BLM to make a decision on the proposed mining and processing operation. Its purpose is to provide a full and objective disclosure of environmental impacts and to inform the decisionmakers and the public of

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 1-1

PROJECT LOCATION MAP

reasonable alternatives which would reduce or avoid adverse impacts. The National Environmental Policy Act (NEPA) directs federal agencies to use a systematic and interdisciplinary approach to environmental impact analysis and requires that if any action taken by a governmental agency may "significantly affect the quality of the human environment," an EIS must be prepared. Because of proximity to and potentially significant impacts on the nearby community, the BLM has determined that an EIS is required to analyze possible effects from the proposed project.

This draft EIS has been prepared to meet the regulations to implement NEPA adopted by the Council on Environmental Quality (CEQ) (40 CFR Parts 1500-1508), BLM Manual 1790 and policies and procedures adopted by the BLM to implement NEPA as described in its NEPA Handbook (BLM Handbook H-1790-1).

As summarized in Figure 1-2, the EIS process entails several steps. During scoping, the public and other governmental agencies are afforded the opportunity in public meetings to express concerns and identify issues to be addressed in the draft EIS. Written comments are also solicited. Following scoping, the proposed action and reasonable alternatives to the proposed action are clearly defined, based on BLM concerns and information presented by other agencies and the public. Elements of the environment which would be affected by the proposed action and alternatives are described in the EIS. An analysis of the consequences (impacts) of the proposed action and alternative actions is then conducted.

The results of the analysis are documented in the draft EIS. A formal public review and comment period occurs after publication of a draft EIS, during which time written and oral comments and questions on the analysis are solicited. One or more public meetings during this comment period afford an additional opportunity for public participation. Comments and questions received during the public comment period are reviewed, analyzed and incorporated into the final EIS as appropriate.

In a final EIS, the BLM may modify alternatives, and substantive public comments are considered and addressed. When a decision has been reached, the BLM must issue a record of decision documenting the decision made and the reasons for such a decision.

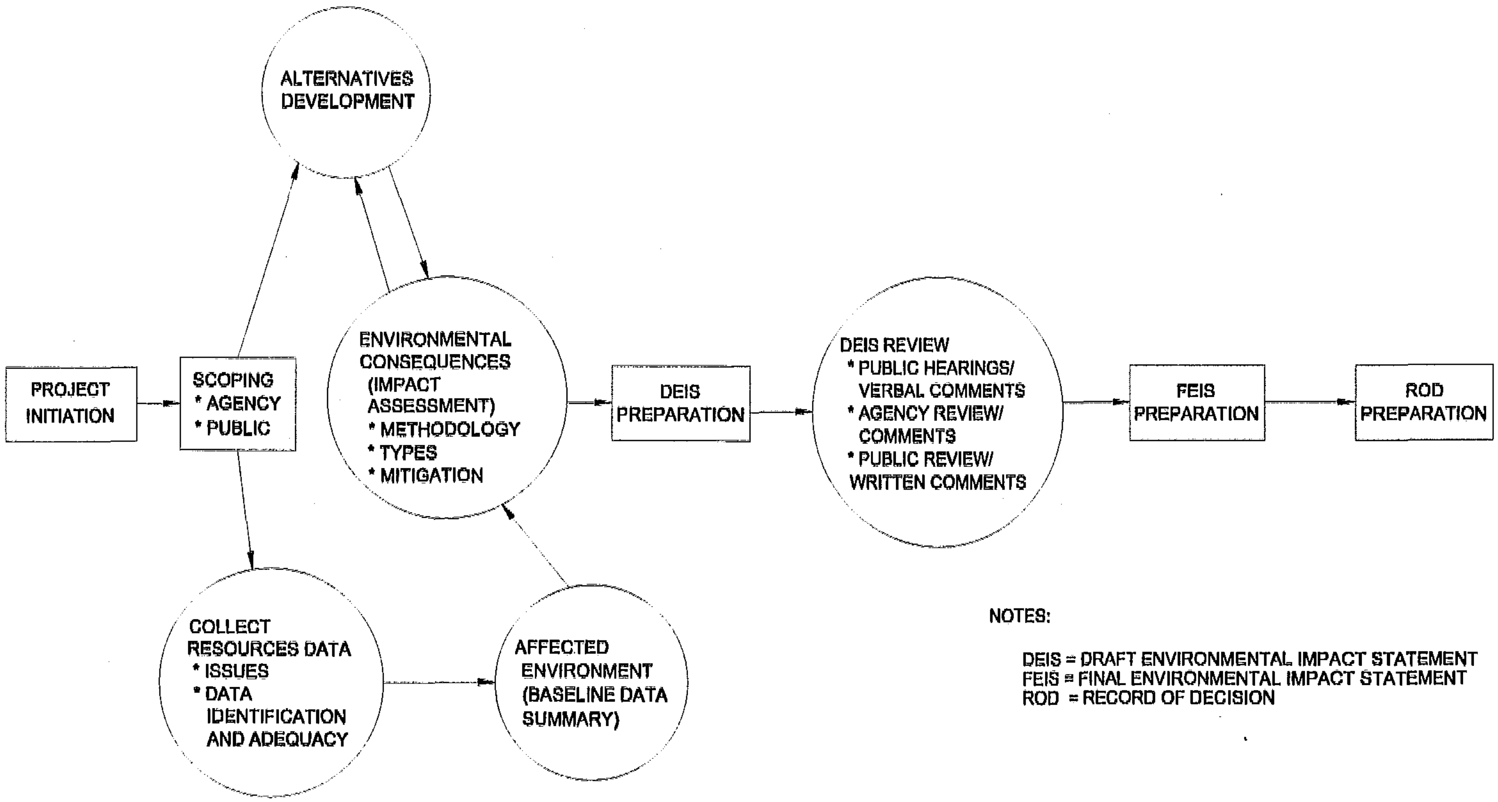
The proposed mining operation would include facilities on federal, state and private lands. The scope of this EIS includes all areas that could be affected by the project, regardless of land ownership. However, the BLM has authority to regulate activities or impose mitigation measures only on federal land.

1.3 THE PROPOSED ACTION AND SETTING

The Yarnell deposit is in the Weaver Mountains of Yavapai County, Arizona. The property is one-half mile south of the town of Yarnell and one-quarter mile southeast of the Glen Ilah subdivision, as measured from the northwest boundary of the proposed project area to the southern boundaries of Glen Ilah and Yarnell. The proposed project is in sections 14, 15, 22 and 23 of Township 10 North, Range 5 West. The average elevation of the project area is about 4,800 feet above mean sea level (MSL), with a range of elevations from about 3,200 feet to 6,000 feet MSL.

MAJOR PHASES OF THE EIS PROCESS

FIGURE 1-2



NOTES:

DEIS = DRAFT ENVIRONMENTAL IMPACT STATEMENT
FEIS = FINAL ENVIRONMENTAL IMPACT STATEMENT
ROD = RECORD OF DECISION

The area has a history of previous mining activity. The Yarnell gold deposit was first discovered in the late 1800s. By 1914, underground development had progressed to 160 feet below the surface and approximately 250,000 tons of ore had been delineated. The mine was temporarily closed in 1916. By 1936, a 70-ton-per-day flotation and cyanide mill was operating on site. The mill capacity was increased to 125 tons per day in 1940. Mining ceased in 1942, due to passage of the War Measures Act. For the next 40 years or so, there was only minor activity at the Yarnell Mine. The proposed mining area has incurred extensive surface disturbance from these historic exploration, mining and ore processing activities.

As shown in Table 1-1, disturbance would include approximately 118 acres on 30 unpatented claims (public land) and 75 acres on five patented claims held by YMC and other private land. An additional 7.7 acres of state of Arizona land would be disturbed as part of the water supply. Total disturbance would be about 201 acres. About 14 acres (11 acres on patented claims owned by YMC and three acres of public land) of proposed Yarnell Project disturbance would occur on land previously disturbed by historic mining operations. An estimated 294 acres would be within a perimeter fence constructed to restrict access by wildlife and the public.

As proposed by YMC, the Yarnell deposit would be mined using a conventional open-pit mining method. Mining activities are planned to occur 24 hours per day, five days per week. Blasting would occur twice each week during daylight hours on weekdays. Mined ore would be hauled from the Yarnell pit directly to the crusher and ore stockpile area adjacent to the east side of the heap leach facility. Ore would be fed to a two-stage crushing plant or stockpiled and crushed later. The crushed ore would be either hauled to the heap leach pad and stacked in 20-foot lifts or stockpiled near its crusher for later transport to the leach pad. Waste rock would be hauled to either the North Waste Rock Dump (NWRD) or the South Waste Rock Dump (SWRD).

Additional proposed facilities include storage ponds and the adsorption, desorption and recovery (ADR) plant. The storage ponds include pregnant and barren

TABLE 1-1
Yarnell Project Summary of Projected Disturbance

Project Component	Projected Disturbance Area (acres)			
	Public Land (BLM)	Public Land (State Trust)	Private Land	Total
Yarnell Pit	4.8	--	32.9	37.7
North Waste Rock Dump	11.7	--	10.1	21.8
South Waste Rock Dump	33.3	--	15.3	48.6
Heap Leach Facility	35.3	--	5.2	40.5
Solution Storage Ponds/ADR Plant	7.4	--	0.0	7.4
Roads/Buildings/Storage	18.7	--	5.6	24.3
Sediment Control/Diversion	0.3	--	0.2	0.5
Well Field/Pipeline	6.5	7.7	4.3	18.5
Microwave Stations Relocation	--	--	1.5	1.5
TOTAL	**118.0**	**7.7**	**75.1**	**200.8**

solution ponds and a storm water pond. The ADR plant would be between the pregnant and barren solution ponds. As planned, the ADR plant includes the adsorption circuit, along with stripping, acid washing, electrowinning and smelting facilities. Crusher operations, together with pad loading, are planned for 24 hours per day, five days per week. Leaching and metal recovery activities would occur continuously.

Proposed project infrastructure and support facilities include an administrative office, mine shop, assay lab, warehouse and storage facilities, power distribution and water supply facilities, haul roads and access roads. Sediment control and diversions include diversion channels and sediment retention structures at the NWRD and SWRD. Other proposed facilities include the well field and pipelines.

All facilities, except water supply wells and the water transport pipelines, would be at the project site. Most power requirements would be supplied by on-site generators, with power to the mine office and maintenance facility supplied by Arizona Public Service. Water would be obtained from local and regional groundwater sources and transported to the mining/processing area via proposed pipelines.

The proposed production schedule calls for mining and processing 1,200,000 tons of ore per year. Annual gold production, over an approximate six-year mine life, would average 30,000 troy ounces. Reclamation and closure activities (including monitoring) would take seven years following the end of operations.

1.4 REGULATORY FRAMEWORK

The BLM, other federal agencies, state agencies and Yavapai County have regulatory responsibilities in reviewing and approving the proposed Yarnell Project. Applicable permit and regulatory compliance responsibilities are summarized below and in Table 1-2.

1.4.1 RELATIONSHIP TO BLM POLICIES, PLANS AND RESPONSIBILITIES

In addition to its NEPA responsibilities as discussed above, the BLM must consider other policies, plans and responsibilities in reviewing the Yarnell Project MPO, as summarized below.

1.4.1.1 Federal Land Policy and Management Act

The lands to be affected by the proposed project include public land administered by the BLM. The BLM policies, plans, programs and responsibilities, based on the Federal Land Policy and Management Act (FLPMA) of 1976, as amended, recognize that public lands are an important source of the nation's mineral and energy resources. The BLM is responsible for making public land available for a wide range of uses, including the orderly and efficient development of mineral and energy resources.

1.4.1.2 Conformance with Existing Land Use Plan

The proposed Yarnell Project is in the area addressed under the BLM's Lower Gila North Management Framework Plan (MFP) (BLM 1981). The BLM conducted a planning process designed to accommodate appropriate uses and to describe allowable uses in the planning area. Mineral resource development on the site of the proposed Yarnell Project

Table 1-2
Applicable Permit and Regulatory Compliance Summary for the Yarnell Project

Regulatory Agency	Law, Regulation, Permit, Document	Requirements
U.S. FEDERAL AGENCIES		
U.S. Bureau of Land Management (BLM)	Federal Land Policy and Management Act	Approved operations conform to FLPMA requirements
	Mining Plan of Operations (MPO)	Approval by the BLM and reclamation bonding
	Use and Occupancy Regulations	Concurrence with regulations
	Reclamation Plan Requirements	Development, approval of reclamation plans and financial security
	Cyanide Management Plan 1992	Compliance with operational guidelines; required inspections
	NEPA Environmental Analysis	EIS prepared by the BLM as lead agency and Record of Decision on MPO
	Authorization of water supply facilities on federal land	Approval as part of the MPO
	Endangered Species Act	Biological assessment and consultation with U.S. Fish and Wildlife Service
	Migratory Bird Treaty Act of 1918	Protection of migratory birds
	Executive Order 11990	Protection of Wetlands
	National Historic Preservation Act	Evaluation and consideration of project effects on properties eligible for the National Register of Historic Places, Native American consultations
	Executive Order 12898	Environmental justice in minority and lower income populations
	Executive Order 13007	Consideration of project effects on Indian sacred sites
	Department of Interior Secretarial Order 3175	Consideration of project effects on Indian Trust Resources
U.S. Environmental Protection Agency (EPA)	National Pollutant Discharge Elimination System (NPDES) Permit (Clean Water Act)	Permit required to discharge to surface water from point sources other than process areas using cyanide
	NPDES Storm Water Discharge Permit (Clean Water Act)	Permit and Storm Water Pollution Prevention Plan required for monitoring and best management practices to reduce storm water pollution discharge
	Section 404 Permit (Clean Water Act)	Consultation and oversight responsibilities with COE
	NEPA Environmental Analysis	Cooperating agency in preparation of EIS
	40 CFR 112 Spill Prevention Control and Countermeasures (SPCC)	SPCC Plan required for inspection of petroleum storage and dispensing facilities and actions to be taken in the event of a release of oil or fuel on-site
	Clean Air Act	Review and concurrence of state issued permit
U.S. Army Corps of Engineers (COE)	Section 404 Permit	Wetland and jurisdictional waters delineation, protection and mitigation
U.S. Fish and Wildlife Service (USFWS)	Endangered Species Act	Threatened or endangered species evaluation
	Fish and Wildlife Coordination Act	Consultation with COE on Clean Water Act Section 404 Permit
Mine Safety and Health Administration (MSHA)	Health and safety regulations	Training and compliance during operations

Table 1-2 (continued)
Applicable Permit and Regulatory Compliance Summary for the Yarnell Project

Regulatory Agency	Law, Regulation, Permit, Document	Requirements
STATE OF ARIZONA AGENCIES		
Department of Environmental Quality (ADEQ) Air Quality Division	Air Installation Permit/Permit to Operate (Clean Air Act)	Permit related to construction and operational activities
Aquifer Protection Permit unit	Clean Water Act	Section 401 Water Quality Certification
	Aquifer Protection Permit	Permit specifying process solution containment features and monitoring requirements for groundwater protection
		Contingency Plan required for actions to take in the event of a release of chemicals or process water from site facilities
Department of Agriculture	Salvage or Removal Permit	Salvage or removal of protected native plants
State Historic Preservation Office (SHPO)	National Historic Preservation Act	Evaluation of project effects on cultural and historic resources
Mine Inspector's Office	Arizona Mining Code	Training and operations to conform to regulations
	Mined Land Reclamation Act	Reclamation/mine closure/bonding
Department of Transportation	Use Permit	Detailed traffic control plan to coordinate emergency services
Department of Public Safety	Notification required for state highway closure	Notification to State Patrol required to stop traffic on Highway 89 for blasting
Department of Water Resources (ADWR)	Well Construction Permit	Permit for well completion and decommissioning
	Arizona Revised Statutes	Well Registration, Surface Water Rights and Dam Safety Regulation
State Fire Marshal's Office	Uniform Fire Code (UFC)	Buildings used for storage of hazardous materials to conform to UFC regulations
State Land Department (ASLD)	Lease/auction process	Permit to use water from ASLD well and right-of-way easement
Game and Fish Department	Jurisdiction over native wildlife	Coordination with the BLM and USFWS
State Agencies	Executive Orders 89-16 and 91-6	Protection of streams and riparian resources
Arizona State Museum	A.R.S. 41-865	Notification to the State Museum and consultations with Native American tribes if graves are discovered on private land
YAVAPAI COUNTY AGENCIES		
Planning Department Zoning Department	Use Exemption	Zoning regulation exempt for mining or metallurgy projects
Environmental Services	Conventional Septic System Permit	Permit for septic system construction and operation
County Sheriff	Notifications and Coordination	Contingency planning and notifications regarding traffic control plans

would be in conformance with the MFP. MFP recommendation M-2.1 states that the area should be left open for potential mineral exploration and development.

1.4.1.3 U.S. Mining Laws and BLM Regulations

U.S. mining laws (General Mining Law of 1872, Multiple Use-Sustained Yield Act of 1960 and Mining and Mineral Policy Act of 1970) and the regulations by which they are enforced recognize the statutory right of mining claim holders to develop mineral resources on federal land. The responsibilities for reviewing an MPO are spelled out in BLM regulations (43 CFR Part 3809; Surface Management Under the General Mining Laws). Submission of an MPO for the Yarnell Project initiated the NEPA compliance process which requires the BLM, the lead federal agency, to evaluate environmental concerns during review of the MPO.

The BLM is required by federal regulations to approve an MPO if it would not cause "unnecessary or undue degradation" to the public land (43 CFR 3809.0-6). Unnecessary or undue degradation was not defined in FLPMA, but is defined in the BLM mining regulations at 43 CFR 3809.0-5(k). Generally, unnecessary or undue degradation applies under one or more of the following conditions.

- surface disturbance greater than what would normally result when activity is being accomplished by a prudent operator in usual, customary and proficient operations of similar character;
- failure to initiate and complete reasonable mitigating measures to reduce adverse impacts to surface resources on public land, or failure to provide for effective reclamation; or
- failure to comply with applicable environmental statutes and regulations.

The BLM must consider both the inherent right to mine under the mining laws and the right to mine under FLPMA subject to the prevention of unnecessary or undue degradation of the land. These laws also recognize that the standard mining practices of the industry for a certain mineral commodity are "necessary and due" in terms of their surface disturbance. The BLM must allow mining operations to proceed as long as the operator can demonstrate that the operation does not cause unnecessary or undue degradation. Plans of operation cannot be approved if undue or unnecessary degradation cannot be successfully mitigated.

Overall, the BLM's role in evaluating the proposed action is to ensure that mineral development needs (as expressed in the General Mining Law) are met in a manner that prevents undue or unnecessary degradation (as expressed in FLPMA) to the lands involved. The BLM may place operating conditions on the project to minimize environmental impacts on public lands. A final determination as to the adequacy of the proposed mine plan, or a preferred alternative, in preventing unnecessary or undue degradation will be made by the BLM in its Record of Decision (ROD).

1.4.1.4 Reclamation Requirements

The Mining and Mineral Policy Act of 1970 (MMPA) states that the federal government should promote the "development of methods for the disposal, control, and reclamation of mineral waste products, and the reclamation of mined land, so as to lessen any adverse impact of mineral extraction and processing upon the physical environment that may result from mining or mineral activities."

The BLM's long-term reclamation goals are to shape, stabilize, revegetate or otherwise treat disturbed areas to provide a self-sustaining, safe and stable condition that conforms to the approved land-use plan for the area. The BLM (1992a) has prepared a Solid Minerals Reclamation Handbook (H3042-1) to provide consistent reclamation guidelines for all surface-disturbing activities, including mineral activities, conducted under BLM authority. The BLM will review the reclamation portion of the Yarnell Project MPO to ensure that the BLM's environmental protection responsibilities are carried out and will monitor reclamation activities on public land.

BLM regulations state that no mine operator or claimant shall initiate operations under a plan of operations without providing a financial guarantee for reclamation. The financial instrument must consist of cash, a cash equivalent (i.e., highly-rated securities or a surety bond) or an irrevocable letter of credit. In the case of the latter instrument, the bank or issuing entity would examine the financial health of the company before issuing such a letter. Before a company can begin operations, it must submit one of these types of financial guarantees. If the company cannot do so, it is not permitted to begin operations. The reclamation bond amount for the Yarnell Project has not yet been determined. Calculation of the amount must be certified by a third-party professional engineer registered to practice in Arizona.

1.4.1.5 Cyanide Management Plan Requirements

The BLM must assure that operations are in accordance with the BLM Cyanide Management Plan for the state of Arizona (BLM 1992b). A minimum of four compliance inspections would be conducted annually by the BLM. Management plan considerations include the protection of surface and groundwater from leaks or spills of hazardous or toxic materials, the stability of operational components such as the waste rock dump and heap leach facility, and the protection of wildlife from exposure to cyanide. Additionally, regular inspections would ensure that the mining operation is in compliance with the approved MPO, the BLM's Surface Management Regulations (43 CFR 3809), and regulations (43 CFR 3715) regarding use and occupancy under the mining laws.

1.4.1.6 Concurrence with Use and Occupancy Regulations

YMC is proposing a watchman, storage facilities and fencing of the property. These actions are governed by use and occupancy regulations at 43 CFR 3715. The BLM's concurrence that YMC's plans conform with these regulations is a federal action which must be considered in the NEPA analysis. To conform with these regulations, YMC must propose the uses and occupancy to the BLM. The BLM would review this proposal and determine if the use and occupancy meet the regulatory provisions.

All uses and occupancies must conform to all applicable federal, state or local environmental standards. Further, the occupancy must meet all Mine Safety and Health Administration (MSHA), Occupational Safety and Health Administration (OSHA) and state mine safety rules. Mining and reclamation permits, to the extent that they are necessary for the activity at hand, must be in place.

1.4.2 RELATIONSHIP TO OTHER GOVERNMENTAL POLICIES, PLANS AND RESPONSIBILITIES

In addition to the BLM, other federal, state and local agencies have responsibilities in reviewing the proposed Yarnell Project. Non-BLM reviews, permits and approvals necessary for Yarnell Project implementation are described below.

1.4.2.1 Federal Agency Responsibilities

Environmental Protection Agency. In conjunction with its responsibilities under the Clean Water Act and NEPA, the Environmental Protection Agency (EPA) is participating as a "cooperating agency" in the preparation of this EIS. The EPA administers the National Pollutant Discharge Elimination System (NPDES) program for Arizona. This program, developed as part of the Clean Water Act, requires that industrial facilities that discharge storm water directly into surface waters of the U.S. obtain a permit from the EPA's Region IX office in San Francisco, California. YMC has applied for an individual NPDES permit for discharge of mine drainage (storm water that would contact pit and waste rock) and for coverage of storm water discharges associated with an industrial activity under the multi-sector general permit for industrial activities.

Required storm water provisions include practices to monitor, report and prevent storm water pollution. The effluent limitation guidelines are described in 40 CFR Part 440 and include New Source Performance Standards.

Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers (COE) to issue permits "for the discharge of dredged or fill materials into navigable waters." COE responsibilities for Section 404 permits are addressed below. Guidelines promulgated by the EPA under Section 404(b)(1) generally prohibit the discharge of dredged or fill materials into "waters of the United States" unless it can be shown that the discharge is the least environmentally damaging practicable alternative to achieve the basic purpose of the proposed action. The EPA is responsible for reviewing the consistency of COE's proposed 404 action with Section 404(b)(1) guidelines.

Additionally, the EPA is responsible for reviewing the state-issued air quality permit pursuant to the Clean Air Act. A spill prevention control and countermeasures (SPCC) plan required by 40 CFR 112 will be prepared and placed on file at the facility for on-site EPA review.

U.S. Army Corps of Engineers. As mentioned above, the discharge or placement of dredged or fill material into waters of the U.S. is prohibited by Section 301 of the Clean Water Act unless carried out under a permit issued by the COE under Section 404 of the Act. Waters of the U.S. include drainages with a defined bed and bank and wetlands adjacent or tributary to waters of the U.S. The proposed project would affect waters of the U.S. and a 404 permit would be required. Prior to issuing a permit, the COE must consult with the EPA, the U.S. Fish and Wildlife Service (USFWS) and the State Historic Preservation Office (SHPO).

U.S. Fish and Wildlife Service. The USFWS administers the Endangered Species Act. If necessary, the BLM would prepare a biological assessment to comply with Section 7 of the Act. However, when there are no threatened or endangered species in the project area, no formal assessment is required. Consultation between the BLM and the USFWS could occur on other issues such as proposed threatened and endangered species or designated or proposed critical habitat areas. Consultation could also be required for future listings of threatened or endangered species if the mine was approved and in operation.

Mine Safety and Health Administration. Regulations to protect worker health and safety are set forth by MSHA and OSHA. Other health and safety considerations include the protection of surface and groundwater from leaks or spills of hazardous or toxic materials and the stability of operational components such as the waste rock dumps and heap leach facilities. In addition, MSHA requires rigid employee training on the handling of reagents and process solutions and includes provisions for monitoring worker exposure levels.

1.4.2.2 State Agency Responsibilities

Arizona is one of several states that does not have a formal mine permitting process which includes analysis of a proposed mining operation. The state regulatory agencies responsible for specific issues, i.e., air and water quality, are discussed below.

Arizona Department of Agriculture. The Arizona Department of Agriculture has jurisdiction over the salvage or removal of plants protected by the Arizona Native Plant Law.

Arizona Department of Environmental Quality. The Air Quality Division (AQD) of the Arizona Department of Environmental Quality (ADEQ) has jurisdiction over air quality aspects of mining projects. YMC has submitted a Class II Air Installation Permit (AIP) application for the Yarnell Project to AQD-ADEQ. This application required identification of all applicable local, state and federal air quality regulations; the description of all potential air emission sources, emission control measures and an inventory to measure emission levels; the prediction of potential air quality impacts using dispersion modeling techniques; the evaluation of potential impacts with respect to the applicable standards and regulations; and the development of a compliance plan to certify compliance with all permit conditions, limitations and requirements. Upon issuance, the AIP will specify emission controls, limitations and standards as well as requirements for monitoring, record keeping and reporting.

Water quality issues for mine developments in Arizona fall under the jurisdiction of the ADEQ. The ADEQ is responsible for ensuring that the proposed mineral processing operation is adequately designed to prevent contamination of groundwater. YMC has submitted an application and Facility Design Report for an Aquifer Protection Permit (APP). Detailed baseline geochemical information on groundwater quality, as well as the acidification potential, leachability and chemical characteristics of ore and waste, were included with the APP application. In addition, the associated Facility Design Report included detailed geotechnical engineering reports and drawings specifying the design of the systems, the materials to be used, the construction methods to be employed and the quality control and assurance programs to be implemented. Upon issuance, the ADEQ would specify the design, operational, monitoring and closure requirements for the project.

Finally, the ADEQ is also responsible for protecting surface water quality and, under the provisions of the Clean Water Act, would require a 401 certificate describing any impacts to streams during construction and operation of the proposed project. This permit must describe the potential impact and present mitigation measures designed to protect water quality during operation and following closure of the proposed mine.

The ADEQ has guidelines for Best Available Demonstrated Control Technologies (BADCT), as outlined in ADEQ (1996), to define appropriate engineered controls on facilities for containment of process solutions and minimization of impact on groundwater. The design of containment features associated with the Yarnell Project would be required to meet or exceed ADEQ BADCT prescriptive design standards.

State Historic Preservation Office. The BLM consults with the SHPO when an undertaking could affect archaeological or other cultural resources that are eligible for listing on the National Register of Historic Places (NRHP). Under Section 106 of the National Historic Preservation Act, evaluations of NRHP eligibility and effect are required. If the proposed action or an alternative is approved, the BLM would consult with the SHPO regarding the implementation of appropriate mitigation measures. The BLM would oversee compliance with mitigation measures.

Arizona State Mine Inspector. Yarnell Project operations would need to comply with the Arizona Mining Code. These regulations have safety requirements that are separate from federal MSHA requirements. The Arizona Mining Code requires that supervisors and employees who work where cyanide is used or stored be trained in a cyanide safety course conducted by the State Mine Inspector. The State Mine Inspector also oversees blasting and related safety procedures. The State Mined Land Reclamation Bill, administered by the Mine Inspector's Office, prescribes reclamation and financial assurance requirements for mining operations on private land. Final regulations went into effect in April 1997.

Arizona Department of Transportation. YMC proposes to stop traffic on State Highway 89 during proposed blasting operations as a public safeguard. The Arizona Department of Transportation (ADOT) would require a permit to use the highway right-of-way. The permit would be issued by the ADOT Prescott District office and would include a detailed traffic control plan coordinating emergency services from Wickenburg to the town of Yarnell.

Arizona Department of Water Resources. All wells drilled and completed for a project water supply, groundwater characterization or groundwater monitoring would be permitted with the Arizona Department of Water Resources (ADWR). These wells would be constructed and decommissioned according to ADWR guidelines.

Arizona State Land Department. One proposed water supply well is on State Trust land, while a portion of the water supply pipeline (extending from water supply wells south of the mining area to the mining/processing area) is planned across State Trust land. YMC must obtain approval from the State Land Department to purchase and withdraw water for mineral processing prior to any use. YMC must also obtain rights-of-way easement approvals from the State Land Department to access the proposed water supply well on State Trust land and to construct the pipeline corridor across State Trust land.

Arizona Game and Fish Department. The Arizona Game and Fish Department (AGFD) has jurisdiction over native fish and wildlife species. The BLM is coordinating with the AGFD Region IV office in evaluating project impacts and appropriate mitigation measures.

1.4.2.3 Yavapai County Responsibilities

Yavapai County would have review and approval authority over some aspects of Yarnell Project development and operation including flood control and solid waste management. The County Planning Department would be the responsible agency for these elements.

In accordance with state guidelines, YMC would file a Land Use Exemption with Yavapai County stipulating that property used for mining or metallurgy would be exempt from Yavapai County zoning requirements. Remaining permits to be obtained from Yavapai County would be limited to building permits for structures that are subject to the Uniform Building Code, but are not excluded as part of the Land Use Exemption.

1.5 SIGNIFICANT ISSUES

Scoping activities are an integral part of the environmental review process and were used to define the issues addressed in this EIS. Public participation in the scoping process serves to inform the public of the proposed action and to provide the public with the opportunity to identify environmental, social, cultural and economic issues and concerns.

Public and agency comments at three scoping meetings and written comments submitted to the BLM during the 60-day scoping period generated a list of more than 300 specific comments and questions contained within about 200 letters and comment forms. The BLM prepared a scoping report (BLM 1996) to document the issue identification process. The scoping report included tables organizing the comments within issue categories. Comments received after the end of formal scoping were reviewed to determine if they raised new issues or concerns that could be identified as significant issues. The list of significant issues in Table 1-3, expressed largely in terms of potential impacts, was generated from the analysis of scoping comments and from resource-specific concerns identified by interdisciplinary team specialists.

The regulations governing the EIS process require that lead agencies determine "the significant issues to be analyzed in depth in the environmental impact statement" and "identify and eliminate from detailed study the issues that are not significant" (40 CFR 1501.7).

Significant issues are evaluated in relation to several factors, including the potential severity of impacts; the duration or geographic scope of effects; the potential to violate environmental protection laws or regulations; and the degree of public interest in and conflict over the proposed project. The BLM identified the potentially significant issues for the proposed Yarnell Project through review of the public and agency comments on the proposal and discussions at a series of interdisciplinary team meetings in 1995 and 1996.

TABLE 1-3
Significant Issues Raised During the Scoping Process

Issue Category	Issues
Water Resources	• Impacts on the quality of surface waters in the watershed, both during the life of the mine and after the mine closes • Potential changes to the quantity of surface water flows as a result of groundwater pumping by the mine • Impacts on the quality of groundwater and water in wells in Glen Ilah, Yarnell and the surrounding area, both during the life of the mine and after the mine closes • Potential for depletion of the water table and wells as a result of groundwater pumping • Potential accumulation of water in the mine pit and the quality of that water during the life of the mine and after the mine closes
Air Quality	• Impacts resulting from dust, fumes and chemical emissions • Potential for cyanide emission release • Public health issues associated with airborne transmission of diseases, dust or emissions
Blasting	• Impacts on the stability of natural features including boulders and aquifer systems • Potential for damage to residences, utility lines and roads
Noise	• Impacts on public health and the quality of life in nearby communities
Visual Resources	• Impacts on views from residences and Highway 89 during the life of the mine and after the mine closes • Effects of lighting on the night sky
Public Safety and Transportation	• Potential hazards created by truck traffic and the transport and storage of hazardous materials • Potential hazards to motorists from blasting • Effect of road closures on access to medical and emergency services by area residents
Socioeconomic Conditions	• Impacts on property values • Impacts on employment and income • Impacts on local businesses • Impacts on tourism • Impacts on tax revenues • Impacts on crime rates • Potential for increased demand on local services from possible influx of mine employees • Disruption of quality of life from noise, visual impacts, night lighting or other aspects of the mine operation
Closure and Reclamation	• Adequacy of bonding to ensure completion of reclamation • Effectiveness of proposed reclamation plan and monitoring measures
Biological Resources	• Impacts to wildlife and wildlife habitats • Impacts to threatened or endangered species • Potential wildlife mortality from exposure to hazardous substances • Impacts on vegetation including riparian zones along Antelope Creek
Cultural Resources	• Impacts on prehistoric or historic sites and roads
Land Use	• Impacts on livestock grazing, other land uses and access routes

1.6 ISSUES BEYOND THE SCOPE OF THIS EIS AND ELIMINATED FROM FURTHER DISCUSSION

The scope of this EIS was established by the BLM's understanding of the proposed action and technical concerns, as well as the issues identified through verbal and written comments received from the public and commenting agencies during scoping. Some issues raised in the public scoping sessions are not addressed in this draft EIS for various reasons. Several items beyond the regulatory domain of the BLM are not within the scope of the EIS. They include generalized opinion (pro or con) about the proposed action without substantive comment on the potential effects of the action, the perceived need to change the Mining Law of 1872 and the perception that a foreign company would be exploiting American resources and moving the profits out of the U.S.

The issue of federal mineral policy and regulation is beyond the scope of this EIS because, in the absence of Congressional action regarding the nation's existing minerals policy, the BLM must manage public land in compliance with current laws and regulations. With regard to mining corporations based in other countries conducting business in the U.S., the BLM cannot legally deny operations by a company based in another country if the operations comply with current laws and regulations.

1.7 ORGANIZATION OF THE EIS

This EIS is organized as follows.

- Chapter 2 fully describes the proposed action and reasonable alternatives to the proposed action (including the no action alternative),
- Chapter 3 describes the physical, biological and human resources that could be affected by the proposed action (information is based on field surveys, state permit applications and associated technical reports, the BLM and other agency files, interviews with BLM and other agency personnel and existing literature),
- Chapter 4 analyzes the potential environmental consequences of development of the proposed action and reasonable alternatives to the proposed action, the significance of these consequences, potential mitigation measures to alleviate consequences, and residual effects after mitigation measures are applied,
- Chapter 5 describes potential cumulative effects of the proposed project added to other past, present or reasonably foreseeable actions,
- Chapter 6 consists of other analyses required by NEPA and/or CEQ regulations including unavoidable adverse impacts, irreversible and irretrievable commitments of resources and a comparison of short-term use versus long-term productivity of the proposed action,
- Chapter 7 is a list of EIS preparers and their qualifications,
- Chapter 8 provides a summary of consultation and coordination activities conducted for this EIS process,
- Chapter 9 is a list of references used in the EIS,
- Chapter 10 is a glossary of terms and acronyms used in this EIS and
- Chapter 11 is an index of key words within this document.

CHAPTER 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the proposed action by YMC, three feasible alternatives including the no action alternative and a number of alternatives that are considered infeasible. It also includes a comparative summary of environmental impacts for the proposed action and the feasible alternatives; detailed analysis of those impacts is presented in Chapter 4. Additional details concerning the engineering and design of the proposed Yarnell Project are contained in the following technical documents: (1) the mining plan of operations (MPO) and (2) technical reports submitted to the Arizona Department of Environmental Quality (ADEQ) for the aquifer protection permit (APP) and the air emissions permit. Significant changes to the mining operations described in this EIS and above-referenced technical documents must be approved by the BLM or ADEQ. Changes may require additional NEPA-related environmental analysis.

2.1 THE YARNELL PROJECT AS PROPOSED BY YMC

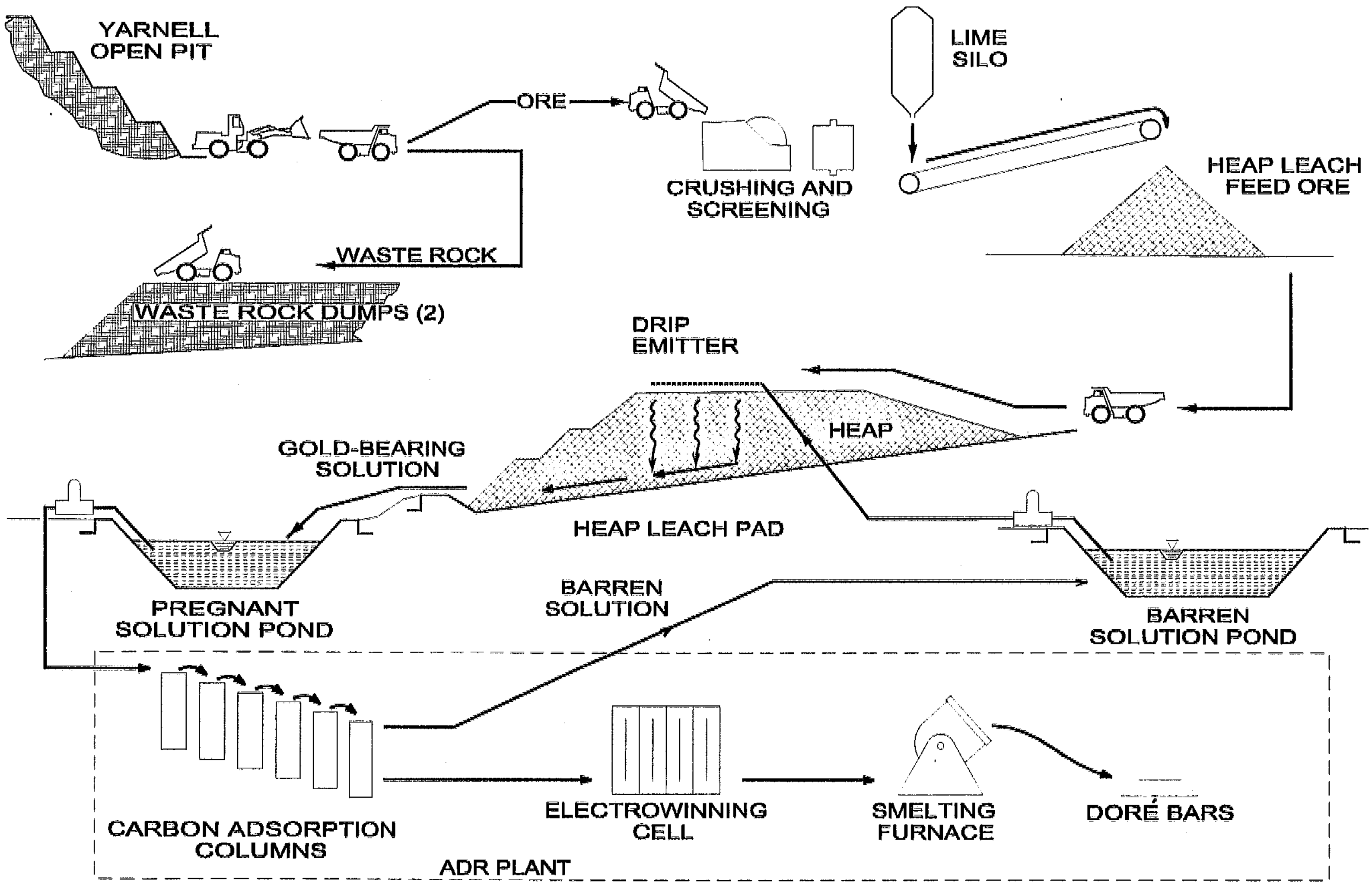
This section describes the major features of the proposed Yarnell Project. Major features include:

- mine development, including drilling, blasting and ore/waste hauling,
- waste rock dump development,
- drainage and sediment control,
- ore crushing and treatment,
- water supply and transport system,
- heap leaching, including the process solution application and recovery system,
- solution processing and a gold recovery system,
- gold refining,
- access and haul roads,
- buildings and miscellaneous facilities,
- explosives, fuel and reagent storage,
- fencing and security,
- lighting and
- closure/reclamation

The projected disturbance area associated with the Yarnell Project was shown in Table 1-1. A project flow diagram is shown in Figure 2-1, with the proposed layout of facilities shown in Figure 2-2. Current land ownership among federal, state and private interests is also shown in Figure 2-2. Annual gold production would be about 30,000 troy ounces.

As described in the Facilities Design Report (Section 3.4), specific procedures were used by YMC to site the key project facilities (e.g., the heap leach and waste rock dumps) associated with the proposed action. Areas outside a two-mile radius from the ore body were excluded from consideration due to excessive haul distance which would result in high fuel use, high water use for dust suppression and high haulage costs. Within the two-mile radius, YMC excluded the following areas for consideration as major facility locations.

- The communities of Yarnell and Glen Ilah.
- Areas that would require haulage through the communities of Yarnell and Glen Ilah or on State Highway 89.
- Areas of steep topography with extensive slopes in excess of 33 percent.

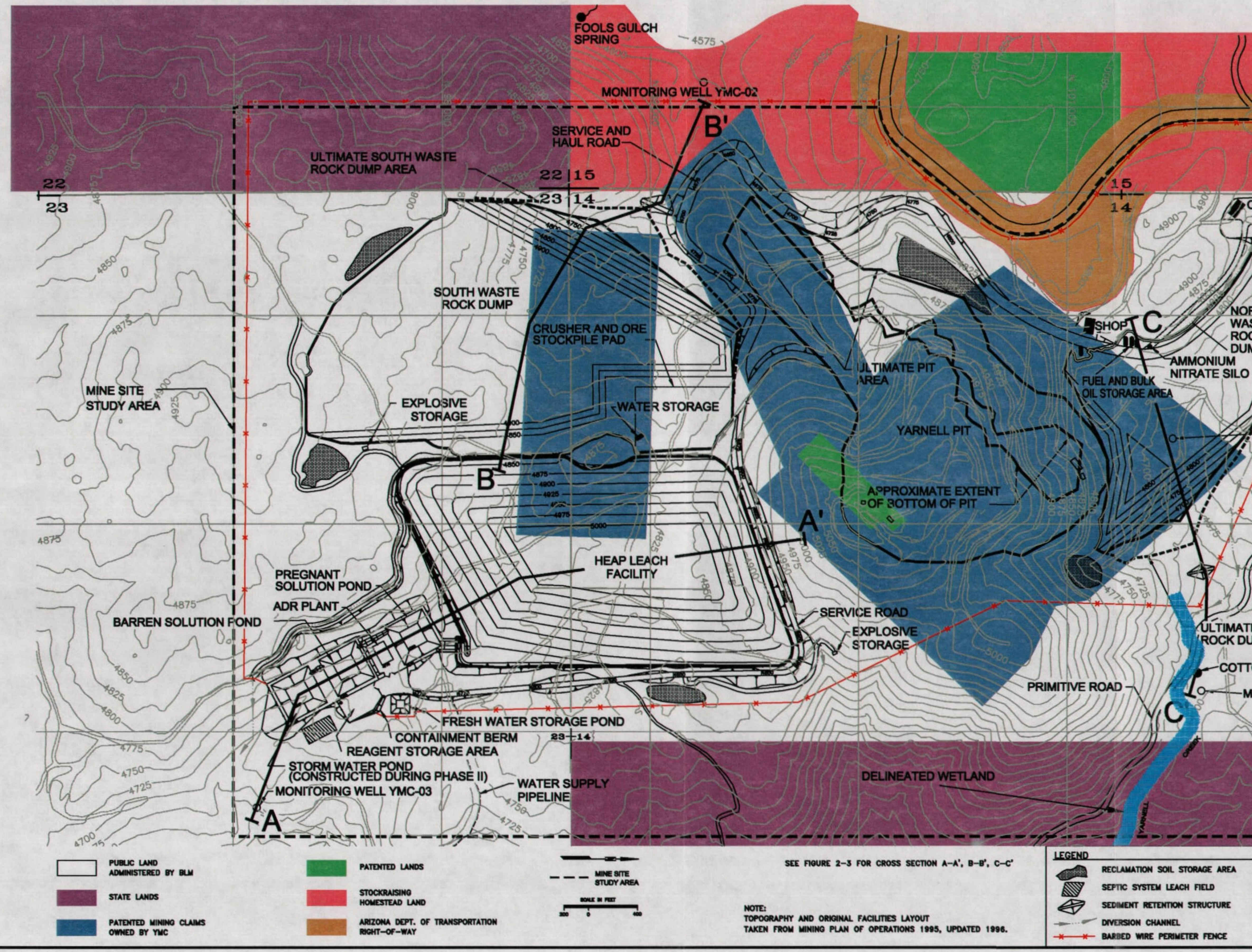


NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 2-1

PROJECT
FLOW SHEET



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 2-2

PROPOSED PROJECT FACILITIES

- The bottoms of major washes such as Yarnell Creek, Antelope Creek and Fools Gulch.
- The delineated wetland along Yarnell Creek.
- Privately owned surface lands.

This process resulted in possible facility sites generally near the proposed mine site and to the south. Within this area, the following three sites were identified by YMC for detailed consideration as heap leach and waste rock dump sites.

- A north site at the upper portion of the Yarnell Creek drainage basin, north of the mine site with a capacity to contain approximately 3.7 million tons of material. Capacity is limited by the elevation of the north end of the proposed pit, an existing gravel road and the delineated wetland in Yarnell Creek.
- A south site at the head of Fools Gulch, southwest of the mine site, with the capacity for more than eight million tons of material.
- A site at the head of a gently-sloping valley southeast of the mine, with the capacity for more than eight million tons of material.

These three sites would be close to the proposed mine and would require relatively short roads and haulage, and runoff diversion and sediment control would be simplified since they are essentially at the head of the drainages.

YMC conducted detailed engineering analyses of the suitability of the three sites as waste rock dumps or heap leach facilities. The southeast site with its shallow slopes was selected for the heap leach as it would facilitate leach pad construction and provide natural topographic containment for solutions. Disposal of all waste rock in the south site was feasible, but would create a large visual impact. Use of the north site would cover existing mill tailings and disturbance from previous mining activity and would provide a flat area for parking and other facilities. Therefore, YMC is proposing disposal of waste rock at both sites. Based on the location of the heap leach facility and waste rock dumps, the remaining support facilities were sited by YMC as shown in Figure 2-2.

2.1.1 MINING

The Yarnell ore deposit would be mined using conventional open-pit mining methods that include drilling (to create holes for blasting), blasting (to loosen ore and waste rock) and loading and hauling the waste rock and ore. Planned mining equipment includes a blast-hole drill, one front-end loader, four haul trucks, one motor grader, one water truck, one track dozer and support equipment. An additional haul truck and a second dozer and front-end loader would support crushing and pad loading activities. The mining operation as proposed would operate 24 hours per day, five days per week. Ore would be hauled directly to the crusher area and either dumped directly into the primary feed or stockpiled for later feeding by a loader or dozer. Equipment requirements are shown in Table 2-1.

The pit would be developed in "benches," which are long, narrow, relatively level terraces breaking the continuity of a slope. Equipment used to collect, load and haul ore can be set, moved or operated on each bench. A 20-foot bench height and a maximum slope of 53 degrees were established as the primary pit design criteria. The 20-foot bench height was chosen to maximize the efficiency of the mining fleet. The Yarnell Mine, as proposed by YMC, would be developed with 29 benches in the pit. As described in

TABLE 2-1
Proposed Project Equipment

Equipment	Quantity
Front-end loaders	
Caterpillar 990 wheel loader	1
Caterpillar 988F wheel loader	1
Haul trucks	
Caterpillar 773B end dump	4
Caterpillar 769C end dump	1
Dozers	
Caterpillar D8N track-type tractor	2
Motor grader	
Caterpillar 16-G	1
Rotary blasthole drill	
Driltech D40K (5-3/4 inch to 6-3/4 inch diameter)	1
Water truck	
5,000 gallons	1
Backhoe	
Caterpillar 426	1
Maintenance vehicles	
Mechanic 2-½ ton	1
Utility flatbed	1
Steam cleaner	1
Tool carrier	
Caterpillar IT 28B	1
Pickup trucks	11
Crusher	
Jaw and cone	1
Light plants	
6 kW - Diesel	5
Generators	
820 kW	1
365 kW	2
113 kW	1
25 kW	1

Note: Equivalent equipment makes and models may be used.

the MPO, the planned final dimensions of the pit would be about 1,000 feet wide at the widest point and about 2,200 feet long at its longest dimension. The deepest part of the pit would be at about the 4,620-foot elevation.

Stability analyses were conducted by YMC for the pit geometry described above. These analyses were made using typical rock mass properties based on available descriptions of rock type, rock strength, weathering and the likely fracture orientation that would be encountered in the pit. Slope stability of both the hanging wall and foot wall was analyzed and the minimum static factor of safety was 2.07 and 1.94, respectively (see Chapter 10 for definitions of static and pseudostatic safety factors).

The seismic stability of the mine pit was analyzed using pseudostatic methods. A pseudostatic coefficient of 0.10 g was used (where g is the acceleration of gravity). This coefficient represented seismic conditions in excess of a 250-year recurrence interval earthquake (or a more than 90 percent probability that an earthquake of larger magnitude would not occur within 250 years). The resulting pseudostatic analysis factors of safety (1.67 for the foot wall and 1.55 for the hanging wall) were above accepted criteria.

2.1.1.1 Mineable Reserves

The Yarnell Project mineable reserve estimate was calculated using a rough approximation of the floating cone technique, with Datamine software used to assist with pit extrapolation and to tabulate reserves from the geological block model. Table 2-2 summarizes the deposit's recoverable reserves.

The average strip ratio of the proposed pit is 1.69 tons waste to one ton of ore. However, due to the approximate need for 574,000 tons of construction material, the operating strip ratio is effectively reduced to 1.61 to 1.

2.1.1.2 Production Schedule

Mine production has been forecast to meet the ore processing schedule of 1.2 million tons per year as summarized in Table 2-3.

Ore production has been scheduled from the top down, i.e., ore mining would begin at the highest bench level in the pit and proceed down to each succeeding bench. Waste production would coincide with ore production on each bench.

2.1.1.3 Haul Roads

The majority of haul roads would be contained within the perimeter of the open pit. The gentle slope along the footwall provides access to the lower benches without increasing the volume of waste rock to be stripped. All haul roads would be 55 feet wide with a maximum 10 percent to 12.5 percent grade with safety berms and diversion ditches constructed where required. Haul roads would be constructed with waste rock. The haul road locations were shown in Figure 2-2.

Access to the pit's upper benches would be via a 55-foot-wide haul road which would be constructed in cut material in the pit area, and in predominantly fill material outside of the pit perimeter. The road would be "mined-in" by the mine production crews from the bottom up at a constant 10 percent to 12.5 percent grade. Topsoil would first be stripped and stockpiled. Waste rock stripping would commence at the pit's southern end below the main haul road and would (1) provide construction fill material for the leach pad and crusher site and (2) reduce stripping ratios in years two

TABLE 2-2
Estimated Mineable Reserves

Ore tons (1000s)	Gold grade (ounces per ton)	Gold ounces	Waste tons (1000s)	Strip ratio
Proven/probable 5,412	0.036	196,440		
Possible 1,583	0.034	50,390		
Total 6,995	0.035	246,830	11,818	1.69

TABLE 2-3
Production Summary

Year	Ore (tons)	Waste (tons)	Construction waste (tons)	Total (tons)
1	1,200,000	2,389,000	574,000	4,163,000
2	1,200,000	2,519,000	0	3,719,000
3	1,200,000	2,695,000	0	3,895,000
4	1,200,000	2,074,000	0	3,274,000
5	1,200,000	1,290,000	0	2,490,000
6	995,000	277,000	0	1,272,000
Total	6,995,000	11,244,000	574,000	18,813,000

and three. Most in-pit road segments would be designed at 10 percent grade with the exception of the bottom two benches which are at 20 percent and 15 percent. Uphill waste haul speeds would be limited to 18 miles per hour (mph) maximum and, for safety, all other speeds would not exceed 30 mph.

Initial access to the North Waste Rock Dump (NWRD) would require a short segment of in-pit haul road to be constructed from the proposed maintenance facility area up to the 4,900-foot bench, where it would connect with the haul road to the crusher. Access to the upper benches requires a sharp in-pit switchback at this intersection. Removing the initial haul road as benches are mined out would provide the remaining access to the NWRD.

Trucks hauling waste rock to the South Waste Rock Dump (SWRD) would share the main haul road that accesses the ore crusher. Waste rock from the upper benches would be hauled to the dump's elevation of 4,850 feet. Waste rock from the lower benches may be hauled to a lower lift to reduce uphill hauls. Near the end of mining, dumping of waste rock may increase to 4,900 feet elevation.

No pullouts are planned by YMC for the proposed haul roads. This is due to the limited truck traffic and the planned width of haul roads (more than three times wider than truck width).

2.1.1.4 Blasting

Pit rock would be broken by blasting, using standard industry practices and materials. Conventional ammonium nitrate and fuel oil (ANFO) explosives would be used. Blasting supplies would be stored in accordance with MSHA and Arizona State Mine Inspector regulations. Blasting would be conducted weekdays, during daylight hours and under strict safety procedures. Overall mine safety practices would conform to Article 2 of the Arizona Mine Safety Code and MSHA regulations. Explosives would be delivered by licensed haulers and stored on site in approved storage facilities.

The following blasting plan outlines the general design elements and precautions that YMC would use to control rock movement, ground vibration and airblast from proposed surface blasting operations. It also discusses methods to stop traffic on State Highway 89 during certain parts of the blasting operation. YMC would continually review the blast results of the initial blasting designs and adjust future designs based on observed results.

Development Drilling. A blasthole drill would be used for drilling. Initial blastholes would be eight inches in diameter and 24 feet deep. Blast hole diameters would vary depending on the pounds of explosive per ton blasted. This hole depth includes four feet of subdrill below the 20-foot bench grade. Development drill results would document any conditions such as mud seams, voids, soft rock and ground faults encountered, so that special precautions can be taken when loading these areas. Typical drill patterns would be staggered with a 12-foot-by-12-foot dimensional spacing. Powder factors up to one pound of explosives per ton would be used, with an average of approximately 0.7 pounds per ton.

Hole Loading Procedures. Before loading commences, all drill holes would be inspected and measured. Short holes would be re-drilled, if necessary, before loading any holes in the pattern. Dry blast holes would be loaded with ANFO. Wet holes or wet portions of holes would be loaded with a packaged emulsion blasting agent.

All blast holes would be primed with a one-pound high-explosive charge or booster at the bottom of the hole. Millisecond delay, nonelectric detonators would be used to provide sequential in-hole delay timing. Boosters and detonator primer assemblies would be "made up" at the hole, just prior to loading. Unused primers would be disassembled before transporting the booster and detonator components to their respective and separate magazines. All holes would be stemmed (backfilled) with five feet minimum of minus 3/4-inch crushed rock topped with six feet of drill cuttings.

Initiation System Hookup Procedure. Detonators in the hole, with detonating cord and detonators on the surface, would be used to create two-path sequential timing. All shots would be initiated by a lead-in line, spliced to a detonator, attached to the first hole to fire. All blasting would be accomplished by the use of millisecond delay detonators to control seismic vibration and compensate for geologic anomalies that could result in flyrock and airblast.

Clearing and Guarding Procedures. The Blasting Supervisor would be responsible for all shot area clearing and guarding procedures, as follows.

- The Blasting Supervisor would coordinate blasts with emergency authorities (e.g., the County Sheriff's Office). One blast would be initiated two days each week under an approved blasting schedule.
- A safe area around the shot area would be cleared and guards would be placed to prevent entry.
- Traffic would be delayed for approximately 10 minutes per blast on State Highway 89 by YMC personnel prior to entering the stretch of highway adjacent to the mine.
- When the area is secure, the lead-in line initiator would be connected to the shot and the shot would be fired when all traffic and persons, including the shot-initiator, are in a safe location.
- The Blasting Supervisor would inspect the shot area after a blast is fired and relieve all guards and give the all clear signal only when no existing hazards result from the blast.

If lightning is detected, these same procedures would be used to clear and secure the area until the hazard has passed. Signs would be placed along State Highway 89 to warn motorists that they are entering an area adjacent to blasting activities.

Shot Initiation. Once a pattern has been loaded and all detonators are connected, the Blasting Supervisor would perform a final inspection of the blast area to verify that all unused explosives have been removed and all detonators have been properly connected. After final inspection, the blast area would be considered operational and no personnel or equipment would be allowed within 50 feet of a loaded hole without permission from the Blasting Supervisor.

When the blast area is secure, a lead-in line initiator would be attached to the shot initiation point. The detonator would be fired from a safe location.

Blast Initiation and All Clear Signal. After blasting, the Blasting Supervisor would inspect the shot area for any hazardous conditions before allowing traffic and work to resume in the area. Loose rock conditions or misfired explosives hazards would be corrected before any work is allowed in the immediate area.

When the blast area is free of hazards, the Blasting Supervisor would give the all clear signal. Under no circumstances would any traffic or work proceed in the area until this signal is given by the Blasting Supervisor.

Vibration Monitoring Plan. YMC would comply with current Office of Surface Mining (OSM) blasting regulations for control of vibration and airblast. These regulations are found at 30 CFR Section 816 (816.61 through 816.68). Scaled distance formulas would be used to determine the maximum explosive charge weights per delay for all blasts. Initially, the prescribed scaled distance formula in the OSM regulations would be used. Nearby structures not owned by YMC (two residences and a communications tower) were monitored during a test blast to evaluate the proposed blasting plan.

YMC would use seismographs to monitor ground and air vibrations at the three structures noted above, and at one location in Glen Ilah. Seismic data would be collected and used to modify blast designs according to current OSM regulations, using ground vibration as the controlling factor. All designs would be planned to keep vibration levels well below the surface mining limits for the state of Arizona.

Airblast and Flyrock Control. Airblast would be controlled as prescribed in current OSM regulations. YMC would use drill cuttings and 3/4-inch crushed rock initially to prevent blowouts, high airblast and excessive rock movement. Moreover, hole-by-hole sequential timing would be used to control shot movement and direction.

Schedule. YMC would blast an average of 63,000 tons of ore and waste rock material each week. Blasts would be initiated two days each week under an approved blasting schedule, weekdays only, during daylight hours (e.g., 9 am to 6 pm) and under strict safety procedures. Due to variances in mining production, weekly blasting schedules may vary. Weekly schedules would be subject to change depending on mechanical availability, weather conditions and other uncontrollable factors. Schedules for blasting and associated road closures would be submitted to ADOT on a weekly basis. These schedules would be made available to the public.

Traffic Control. YMC plans to stop traffic during blasting operations as a public safeguard on State Highway 89 and Mina Road, which runs along the north side of the proposed project boundary and intersects with State Highway 89. Traffic would be delayed approximately 10 minutes. Northbound traffic would be stopped approximately 300 feet north of Milepost 275 and 2,000 feet from the proposed blasting area. Southbound traffic would be stopped approximately 1,850 feet north of Milepost 276 and 1,500 feet from proposed blasting. This location would not block the main access to Glen Ilah from State Highway 89. Traffic would not be released until the Blasting Supervisor gives the all clear signal. As previously mentioned, blasting operations would be carried out in such a manner to control rock movement, ground vibration and airblast.

Once the blast pattern has been drilled, loaded and hooked up, the Blasting Supervisor would initiate a 10-minute warning via a siren and a two-way radio announcement. The shot area would be cleared and guarded to a safe distance, and personnel would be stationed on the road.

A five-minute warning again by siren and radio announcement would be made and the Blasting Supervisor would request radio silence except for emergency communication. Personnel stopping traffic would be in direct radio contact with the Blasting Supervisor. When traffic has been stopped and the blast area secured, a lead-in line initiator would be attached to the shot initiation point. Personnel would drive the segment of road between the stop points to assure that all traffic had cleared. A siren and radio announcement would warn all personnel that a blast would be initiated in three minutes, followed by a similar one-minute warning. At 20 seconds before the shot is initiated, a rhythmic siren would be sounded. After the blast, the Blasting Supervisor would inspect the shot area for hazardous conditions before allowing traffic and work to resume in the area. The all clear signal would be given normally within five minutes after the blast, and traffic would be released.

A detailed traffic control plan specifying sign placement and procedures for stopping traffic would be submitted to ADOT. The traffic control plan would include a procedure to coordinate emergency services from Wickenburg to the town of Yarnell and surrounding communities. The Blasting Supervisor would be able to see the entire segment of State Highway 89 adjacent to the blasting area and would be in radio contact at all times during the blasting. In emergency situations requiring the highway to be open, YMC personnel stopping traffic would notify the Blasting Supervisor to hold the blast until further notification from the appropriate authority. Emergencies would always take precedence over blasting operations. Schedules for highway closure (blasting schedule) would be submitted to ADOT.

2.1.1.5 Pit Water Management

Of the 96 exploration holes drilled in the mine area, 19 holes intercepted groundwater. This is typical of a fractured rock groundwater system where groundwater levels show local variability and yield depends on fracture continuity and structure. Groundwater may be encountered in specific fractures in the pit. Based on the measured yield from area wells, it is anticipated that yield from fractures would be low. A borehole in the northern portion of the proposed pit was drilled in March 1996 and used as a groundwater observation point during a long-term pump test of Well YMC-04, an existing water supply well (shown in Figure 2-2). The static water level was about 4,640 feet. Wells about 600 feet southwest of the proposed pit and 300 feet north of the pit have groundwater elevations of about 4,580 feet and 4,650 feet, respectively. Based on measured water levels in the vicinity of the proposed pit, groundwater levels are anticipated to be at or slightly below the proposed pit bottom of 4,620 to 4,660 feet. Groundwater resources in the MSA are described in Section 3.2.5.2. Groundwater discharge to the pit is anticipated to be limited to minor seepage and any water encountered during mining would be diverted to a pit sump and used for dust control or other beneficial use. Backfilling portions of the pit would promote drainage of groundwater and/or storm water through the southwest end of the pit. These actions would result in a post-closure pit bottom elevation ranging from 4,640 to 4,660 feet.

2.1.2 WASTE ROCK DUMPS

YMC proposes to use two sites for the disposal of overburden and rock that contain no or low levels of gold mineralization. The uneconomical rock is referred to as "waste rock" and must be removed from the open pit to access the economical gold-bearing ore. The two proposed waste rock sites (north and south dumps) are shown in Figure 2-2.

The waste rock dumps would generally not be used concurrently. YMC proposes to use the initial waste rock for construction of the crusher pad and the first phase of the heap leach pad. Subsequently, waste rock would be hauled to the NWRD for disposal until the site is full. The remaining (and majority) of waste rock would next be hauled to the SWRD. Plans call for the placement of 3.7 million tons of waste rock in the NWRD and approximately 7.6 million tons of waste rock in the SWRD.

2.1.2.1 Site Development and Operation

The NWRD would be developed from the 4,825-foot elevation, starting from the north side of the mine pit and advancing to the north and east. This would create a maximum single lift dump height of about 150 feet and cover approximately 22 acres. The initial portion of the NWRD would be used for shop, storage and laydown areas.

The NWRD would cover the existing mill tailings, the small crushed ore leach pile and other disturbed areas. An existing water supply well, YMC-04, is within the NWRD and would be covered with about 125 feet of waste rock. During development, waste rock would be carefully placed around the well casing, and the well casing and associated pump equipment would be extended upward as needed. This would be accomplished by maintaining a mound of waste rock around the well casing that is above the level of surrounding waste rock near the well. The well head would be barricaded, as necessary, to protect it from vehicular traffic.

The SWRD would be developed by end-dumping from the 4,850-foot elevation, starting from the southwest end of the mine pit and advancing to the south and west. This would create a maximum single lift dump height of about 200 feet and cover approximately 49 acres. Near the end of mining, dumping of waste rock may be required above the 4,850-foot elevation. The area at the northeast corner of the SWRD would be used for the crushing plant foundation and an area for ore stockpiles.

Cross sections showing the development of the NWRD and SWRD are illustrated in Figure 2-3 (cross section locations are shown in Figure 2-2). Actual dump area advancement may differ from that shown in these figures. Due to the elevation of the pit above the elevation of the waste rock dump sites, downhill hauling of waste rock to the dumps is proposed during the initial stages of mining. During initial mine development, the top of the waste rock dump would be at a slight grade (generally sloping upward to the edge of the dump face) and the advancing face of the dump would be at the angle of repose of the waste rock. At the ultimate toe of the dump, a sediment retention structure would be constructed to retain sediments that may be generated from the dump face and from nearby stripped and disturbed areas that have not yet been covered with waste rock.

2.1.2.2 Hazard and Runoff Control

End-dumping the waste rock would lead to some particle size segregation. The potential hazard of rolling boulders and minor slides would be mitigated by restricting access to the toe areas of the dumps. Furthermore, both waste rock dump sites would be in valleys. By end-dumping the waste rock, any large boulders rolling down the slope would accumulate along the bottom of the valley. Access to the areas below the toe of the dumps would be restricted and controlled by YMC. The sediment retention structure downstream from the ultimate toe of each dump would also serve as a barrier (containment berm) to any large boulders rolling down the slopes and into the bottom of the valley.

Waste dump stability was analyzed by YMC both during projected operations and after regrading to slopes of 50 percent. During operation, the waste would be dumped at the angle of repose and the safety factor on the dump face would be 1.0. Further into the dump, the static safety factor would increase to 1.30. After reclamation, the static safety factor for the dump face would be 1.35. Minimum pseudostatic safety factors were above the 1.15 minimum acceptable stability criteria set by YMC.

Additional analyses were conducted by YMC to evaluate any effect of the existing mill tailings on stability of the NWRD. Analyses of operating stability resulted in static safety factors ranging from 1.11 to 1.31, and pseudostatic safety factors ranging from 1.01 to 1.21. After reclamation, pseudostatic safety factors would range from 1.34 to 1.44, and static safety factors would range from 1.5 to 1.6.

Runoff control would be handled by sloping the top surface of the waste rock dumps and constructing diversion channels, as shown in Figure 2-4. The channels have been designed to keep runoff from undisturbed areas separate from waste rock and disturbed areas. The NWRD and SWRD diversion channels around the waste rock dumps are permanent structures and have been designed to withstand and convey peak runoff from the 100-year, 24-hour storm (4.8 inches of precipitation) as outlined in ADEQ-BADCT guidelines (ADEQ 1996). During operations, runoff from disturbed areas would be contained in the temporary sediment retention structures shown in Figure 2-2. The capacity of these structures has been sized to contain the cumulative undiverted runoff from the 25-year, 24-hour storm (3.8 inches of precipitation). Upon reclamation, the sediment retention structures would be filled with waste rock and stabilized to minimize erosion.

Nine storm water outfalls (SWO) have been identified in YMC's NPDES/Storm Water Permit application and are shown in Figure 2-4. Three outfalls (SWO-02, 04 and 07) are storm water discharge points and would be authorized under the general Multi-Sector Permit. These discharges would be subject to visual examination. The other six outfalls (SWO-01, 03, 05, 06, 08 and 09) drain storm water that would come into contact with waste rock. These six outfalls would be authorized under an individual permit for mine drainage and discharge and would be subject to effluent limitation guidelines.

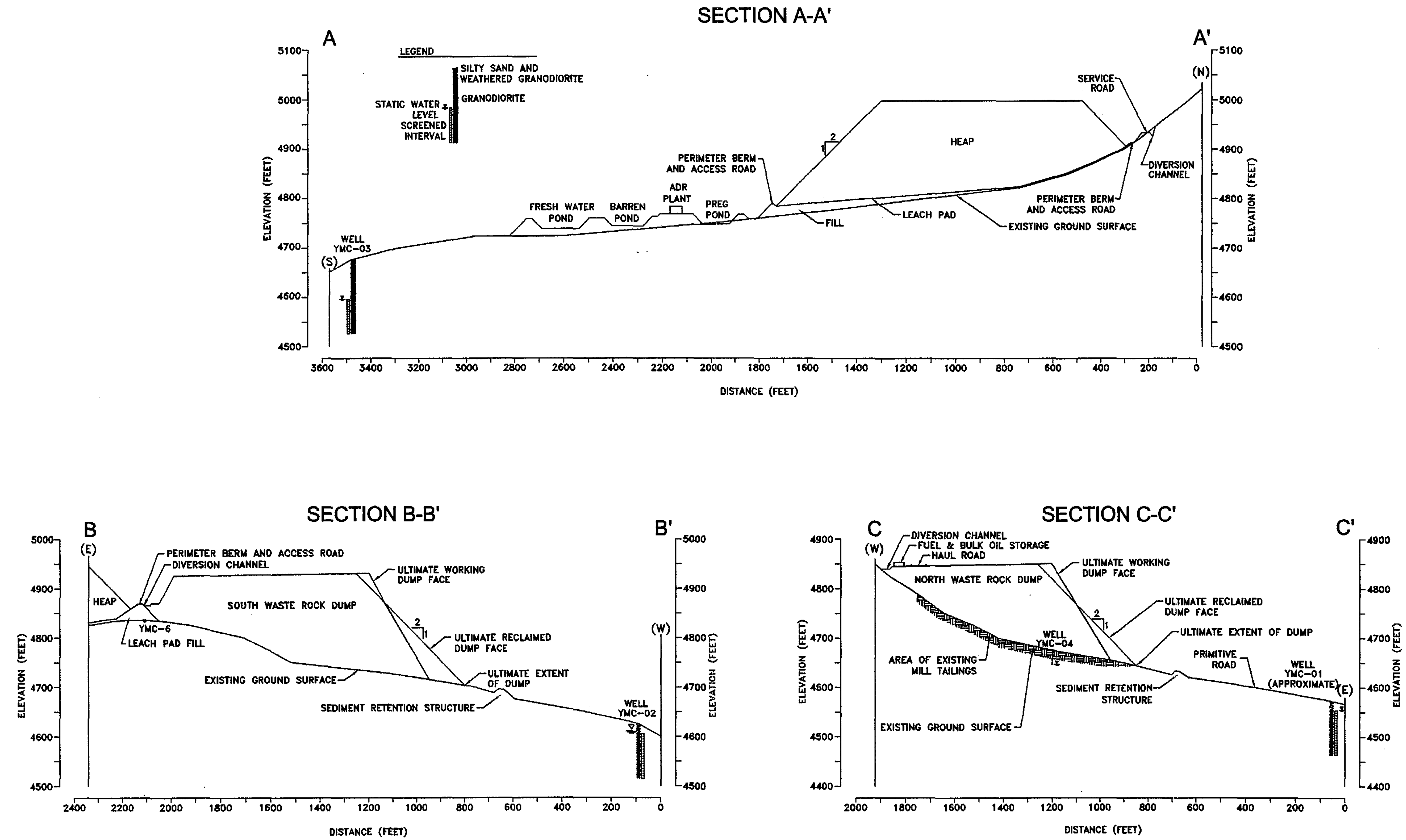
The SWRD and crusher pad would be drained by SWO-01. SWO-01 would flow into SWO-02, which would drain an undisturbed area and a topsoil stockpile. Outfalls SWO-03 and SWO-04 would drain the initial and future phases of the heap leach pad. Outfalls SWO-05 and 08 would drain construction areas (roads, etc.) where drainage would contact waste rock. Discharge from the sediment retention structures for the NWRD and the SWRD would be at outfalls SWO-06 and 09, respectively. Outfall SWO-07 would drain the office, topsoil stockpile and undisturbed area and would be downstream of SWO-06. Drainage and catchment areas for the water resources study area (WRSA) are shown in Figure 3-6. Additional detail regarding the design of diversions and sediment retention structures can be found in Section 2.1.6.15.

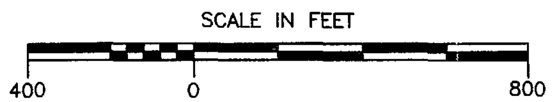
As discussed in the MPO and Baseline Geochemical Report prepared for ADEQ, geochemical testing of waste rock samples was conducted to assess the potential for acid mine drainage. The potential for generation of acid mine drainage will be analyzed in Chapter 4 of this EIS.

2.1.3 ORE CRUSHING AND STOCKPILES

2.1.3.1 Crushing

Ore would be hauled from the pit in 60-ton trucks, dumped into a hopper and fed into a primary 36-inch-by-48-inch jaw crusher. The product of the primary crusher would have 80 percent crushed to a six-inch size or less, with a maximum to a nine-inch size. The crushed product would be conveyed to the secondary crushing plant consisting of a vibrating screen, a 5½-foot standard cone crusher, discharge conveyors and electrical panels. The secondary crusher would produce a product with 80 percent less than 1½ inches.





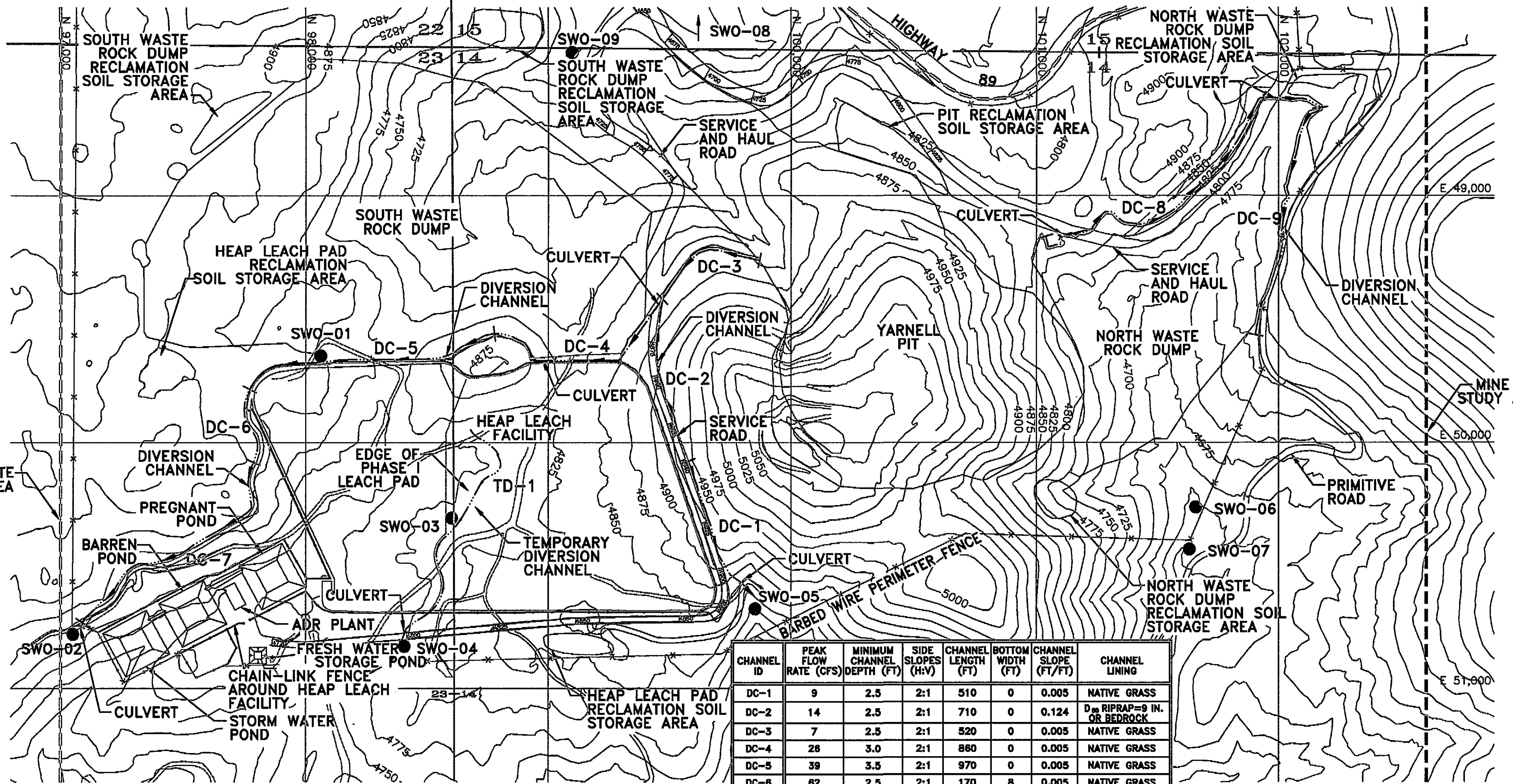
SEE FIGURE 2-2 FOR CROSS SECTION LOCATIONS

NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

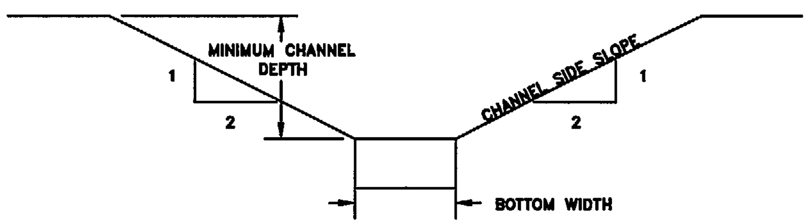
PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 2-3

HEAP LEACH AND WASTE ROCK DUMP CROSS SECTIONS



CHANNEL ID	PEAK FLOW RATE (CFS)	MINIMUM CHANNEL DEPTH (FT)	SIDE SLOPES (H:V)	CHANNEL LENGTH (FT)	BOTTOM WIDTH (FT)	CHANNEL SLOPE (FT/FT)	CHANNEL LINING
DC-1	9	2.5	2:1	510	0	0.005	NATIVE GRASS
DC-2	14	2.5	2:1	710	0	0.124	D_{50} RIPRAP=9 IN. OR BEDROCK
DC-3	7	2.5	2:1	520	0	0.005	NATIVE GRASS
DC-4	26	3.0	2:1	860	0	0.005	NATIVE GRASS
DC-5	39	3.5	2:1	970	0	0.005	NATIVE GRASS
DC-6	62	2.5	2:1	170	8	0.005	NATIVE GRASS
DC-7	85	2.5	2:1	1090	12	0.005	NATIVE GRASS
DC-8	50	4.0	2:1	1530	0	0.005	NATIVE GRASS
DC-9	87	3.0	2:1	1000	10	0.005	NATIVE GRASS
TD-1	40	3.5	2:1	1250	0	0.005	NATIVE GRASS



TYPICAL DIVERSION CHANNEL CROSS SECTION
(NOT TO SCALE)

LEGEND

DIVERSION CHANNEL

● SWO-01 STORM WATER OUTFALL

NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

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FIGURE 2-4

DIVERSION CHANNELS

2.1.3.2 Stockpiles

Run-of-mine (ROM) and fine ore stockpiles would be at the crusher site. Ore would be stockpiled, as necessary, when the crusher is down and/or ore cannot be hauled to the leach pad. The ROM ore stockpile would be constructed to allow ore trucks to dump directly into the bin feeding the primary crusher.

2.1.3.3 Crushing Schedule and Rate

Ore would be crushed at a rate of approximately 300 tons per hour, 24 hours per day, five days per week. Dust would be controlled as necessary with high pressure water spray at a rate of four to 10 gallons per minute (gpm) of water. Generally, crushing would occur Monday through Friday each week. However, the crusher may be required to operate additional days for short periods to adjust for down time. The crusher would not operate more than 6,240 hours per year.

2.1.4 LEACHING

This section describes the proposed heap leaching portion of the ore processing plan for the Yarnell Project. The proposed layout and other details of the heap leach facility are illustrated in Figure 2-5. The project flowchart shown previously (Figure 2-1) includes proposed ore processing activities.

The crushed ore would be placed on the heap leach pad in 20-foot lifts by controlled dumping and dozing to minimize compaction of the top surface of each lift. The ore would be leached by percolation of dilute sodium cyanide solution through the crushed ore to liberate precious metals. The cyanide-enriched solution would be applied to the ore 24 hours per day at a constant rate of about 0.005 gpm per square foot. Leaching of a particular area would occur for about 100 days. The resulting "pregnant" or gold-bearing solution would be collected and processed in the ADR plant to recover the precious metals from the solution. The leach solution, pH and sodium cyanide concentration, are adjusted prior to re-application on the heap.

2.1.4.1 Design Criteria

The proposed heap leach system has been designed as a closed system, such that the leach solutions are contained within the heap and collection ponds with no discharge or leakage. Outside additions of water are limited to precipitation directly onto the leach pad and collection ponds and makeup water. Losses of water are limited to evaporation of solution. The potential for any cyanide gas emission would be controlled by maintaining a pH at or above 10.5 during operation and allowing the pH to decrease to that of the makeup water as free or weak-acid dissociable (WAD) cyanide concentrations decrease.

The proposed heap and underlying leach pad have been sized for seven million tons of ore. Using a swell factor of 30 percent for crushed and stacked ore, the average as-mined ore density used for heap design was 1.50 tons per cubic yard (17.9 cubic feet per ton or 112 pounds per cubic foot). At this density, the required heap capacity is approximately 4.6 million cubic yards. The leached, drained moisture content of the ore is five percent higher than the as-mined moisture content, so the drained unit weight would be 117.6 pounds per cubic foot. As proposed, the difference in unit weight is insignificant to the slope stability and in the settlement design analyses.

The leach pad has been designed to be consistent with ADEQ-BADCT guidelines for precious-metal heap leach facilities (ADEQ 1996) and to meet or exceed the prescriptive design requirements for solution containment in these guidelines. The leach facility has also been designed with containment and leak detection features consistent with BLM guidelines for cyanide management (BLM 1992). The external slopes of the heap have been designed with acceptable factors of safety under both static and seismic conditions. The minimum acceptable factor of safety is based on the ADEQ-BADCT guidelines. Supporting calculations and discussions are provided in YMC's Facilities Design Report submitted to the ADEQ.

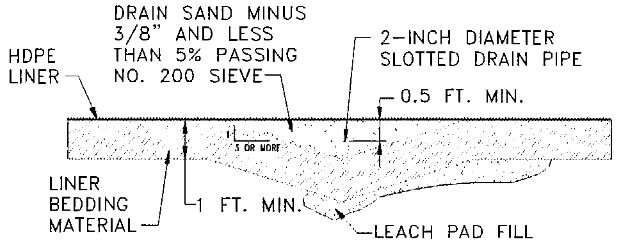
2.1.4.2 Leach Pad

The 36-acre leach pad has been designed to drain by gravity toward the pad's southeast corner and into the solution ponds (Figure 2-5). The leach pad would be constructed as a combination of three methods: (1) a fill area (forming the bottom and south end of the leach pad) consisting of compacted fill at a finished grade of four percent, (2) fill areas (along the west side of the leach pad) consisting of compacted fill at a finished slope of 33 percent (3 horizontal:1 vertical) and (3) regraded existing site slopes (along the east, west and north sides of the site) consisting of reworked and compacted existing site subsoils with existing slopes ranging from four percent to 33 percent. The compacted fill material would consist primarily of selected waste rock.

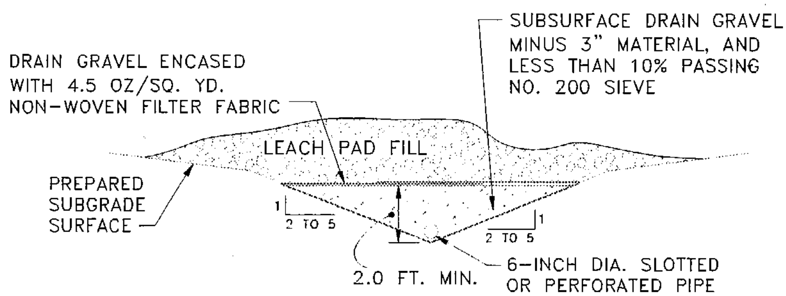
The proposed leach pad is designed for phased construction, with three phases currently planned. The initial leach pad phase would form the south end of the leach pad (nearest the ponds) and have an area of approximately 15 acres (650,000 square feet). The second phase would form the central portion of the leach pad and is planned with an area of approximately 12 acres (520,000 square feet). The third phase would form the north end of the leach pad and is planned with an area of approximately nine acres (390,000 square feet), to reach the total leach pad area of 36 acres (1.56 million square feet).

The constructed leach pad slopes would range from two to 33 percent to facilitate subgrade construction and installation of the liner system. Leach pad elements are shown in Figure 2-6 and include (from bottom to top):

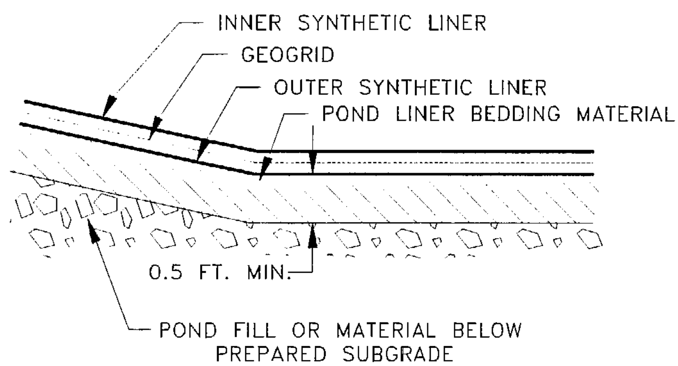
- **Subsurface drain system.** A subsurface drain system would be installed on a competent or manually compacted subgrade following natural drainage patterns under the area to be covered by the heap leach pad and under the pond and ADR plant site. This system would act as a subsurface drain should any groundwater find its way beneath this construction. Slotted or perforated pipe would be installed in triangular depressions, encased in gravel and wrapped with filter fabric. This system would reach the ground surface at the south end of the project site, where the drain would discharge to a collection sump downgradient of the solution ponds.
- **Leach pad fill.** This would consist of placing select waste rock and weathered site soils in compacted lifts. These materials would be well-graded and, when compacted, form a dense fill.
- **Liner bedding layer and secondary liner.** This would consist of selected residual soils, clay-amended, moisture-conditioned and compacted in one or more lifts to form a secondary liner with a minimum thickness of 12 inches.



LEAK DETECTION SYSTEM DETAIL



SUBSURFACE DRAIN DETAIL



NOT TO SCALE

TYPICAL DETAIL
BARREN AND PREGNANT
POND LINER SYSTEM

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 2-6

TYPICAL LEACH PAD AND BARREN POND LINER SYSTEM DETAILS

NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

- **Leak detection system.** The leak detection system would consist of slotted or perforated pipe (or other drainage materials) in triangular depressions filled with sand between the High Density Polyethylene (HDPE) liner and the liner bedding layer. This piping would act as a leak detection system and would daylight to monitoring sumps along the south end of the heap leach pad. The degree of impermeability of the underlying material at the pipe inverts would encourage the more permeable drain gravels and sands to become saturated at that point and encourage flow in the piping to occur. During standard operations, the leak detection drains would be inspected daily to determine the presence and amount of moisture in the sumps. The APP identifies specific leak detection monitoring points, parameters, methods and frequencies.
- **Primary liner.** This would consist of a 60-mil nominal thickness HDPE, with panels seamed and tested according to current standards of seaming and construction quality assurance (QA) testing.
- **Collection pipes.** A series of perforated or slotted solution collection pipes would be placed on top of the primary liner for rapid conveyance of solution to the pregnant solution pond.
- **Liner cover.** This would consist of crushed ore (¾-inch minus) placed on top of the primary liner and collection pipes in one 18-inch thick lift.

Any potential solution leaks would show up first through the leak detection system described above. Groundwater well monitoring would also identify leaks but at a later time. Specific solution leak contingency plans are outlined in the MPO and in the APP.

2.1.4.3 Heap Construction and Operation

The crushed ore would be hauled to the leach pad and lifts would be constructed by dumping onto the previous lift, then pushing the ore upward with a dozer to form the new lift. Each lift would have a nominal height of 20 feet. This method of heap lift construction was selected to minimize compaction of the top surface of each lift.

Dilute sodium cyanide solution would be distributed over the heap by a drip emitter irrigation system on a 24-hour-per-day schedule. This system was selected to enhance application efficiency and minimize evaporative loss of solution. The barren solution application rate would be approximately 0.005 gpm/ft^2. Leaching of a particular area of heap lift would be conducted for approximately 100 days. At the design application rate of 1,200 gpm, each area of solution application would be approximately 5.5 acres or 240,000 square feet. A settling basin with a concrete sump would be constructed in the southeast corner of the leach pad where sediment carried in the leach solutions would be conveyed via collection pipes. The basin would be lined as part of the leach pad liner system and covered with netting. The settling basin would be designed specifically for collection and removal of sediment.

On the outside slopes of the heap, the lifts of ore would be set back on benches approximately 10 feet wide to form overall exterior slopes of 50 percent. The ultimate heap height would range between 100 and 200 feet.

Slope stability of the heap leach was evaluated by YMC at its maximum height and most critical slope configuration. Analyses were conducted under both static and seismic conditions for operational and reclaimed configurations of the heap, using the most likely modes of failure. The material properties used in the stability analyses were determined from laboratory testing of on-site materials and accepted values from geotechnical literature. Analyses under static conditions resulted in factors of safety (1.38 to 1.41) above accepted criteria.

The seismic stability of the heap leach facility was analyzed using pseudostatic methods. A pseudostatic coefficient of 0.08 g was used. This coefficient represented seismic conditions for a 250-year recurrence interval earthquake (or a 90 percent probability that an earthquake of larger magnitude would not occur with 250 years). The resulting minimum pseudostatic factor of safety (1.15) was above accepted criteria.

2.1.4.4 Solution Containment

Three ponds are planned to collect and store process solutions from heap leaching and freshwater/storm water. The total capacity, less freeboard, of the three ponds is approximately 9.3 million gallons (3.1 million gallons for each pond). Expected solution volumes total 9.1 million gallons, as follows:

- ♦ Containment of precipitation on the leach pad from the 100-year, 24-hour storm (4.8 inches), plus a 10 percent safety factor (a total of 5.2 inches), totaling 5.4 million gallons (5.2 inches over a 38-acre area). This includes the 36-acre leach pad proper, two acres for the lined channels between the solution ponds, and the lined area in the ADR plant vicinity.
- ♦ Provision for operating volume, totaling two million gallons in the pregnant and barren solution ponds (one million gallons in each pond).
- ♦ Provision for heap draindown (24 hours at the anticipated 1,200-gpm application rate), totaling 1.7 million gallons.

An additional 200,000-gallon freshwater storage pond is shown in Figure 2-5. This pond is not connected to the other ponds and is thus not included in the capacity calculations described above.

The ponds would have two feet of space above the 9.3-million-gallon capacity (freeboard). This is equivalent to 1.7 million gallons for additional water storage. Thus, the total pond system capacity is 11.0 million gallons. Each pond would be 200 feet square and 20 feet deep at the center. The pond interior would be sloped at approximately 40 percent, resulting in 100-foot-square bottoms. The pond bottoms would be sloped to one corner to allow the complete removal of water (if needed) and the low corner would also contain the leak detection sump beneath the inner liner.

The pregnant and barren solution ponds would be constructed with the first phase of the leach pad, with a total capacity of more than seven million gallons. The third pond, operated as a freshwater and storm water storage pond, would be constructed either initially or concurrently with the second phase of leach pad construction. The pond layouts and details are shown in Figure 2-7. Typical barren and pregnant pond cross sections are presented in Figure 2-8.

The pregnant and barren solution ponds would be connected by a lined spillway to convey excess water from the pregnant pond to the barren pond should it be filled. The overflow pond would be constructed downstream of the barren pond, with a lined spillway between the barren pond and storm water pond.

The pregnant and barren solution ponds would have double synthetic liners with a leak detection system between the liners (as outlined in ADEQ-BADCT guidelines). The overflow pond would be constructed with a single 60-mil-thick HDPE liner. Typical leach pad and barren and pregnant pond liner system details are shown in Figure 2-6.

As documented in Appendix C of the Facilities Design Report submitted to ADEQ by YMC, monthly water balance calculations for the heap leach facility show that there would be a net replacement water requirement for heap leaching and rinsing. During active ore placement and leaching, makeup water requirements range from approximately 30 gpm in winter to approximately 140 gpm in summer (under average climatic conditions). Following active ore placement, makeup water requirements decrease to 80 gpm in summer months and zero in winter months.

2.1.4.5 Solution Application and Collection

Solution application to the ore would be by a drip emitter system pumped and piped from the barren solution pond. No open areas of ponded or flowing water would be exposed and open to access by wildlife. The leach pad and pond area would be completely fenced, and the barren and pregnant solution ponds would be covered with netting or other approved protection to prevent access by birds and other animals.

2.1.5 OTHER PROCESSING CONSIDERATIONS

In addition to crushing and heap leaching described previously, the process circuit includes carbon adsorption and stripping. Cathodes would be smelted at the mine to produce doré bars for shipment. The processing circuit process flow was shown previously in Figure 2-1. The gold recovery steps below would take place at the ADR plant, south of the heap leach (see Figure 2-2).

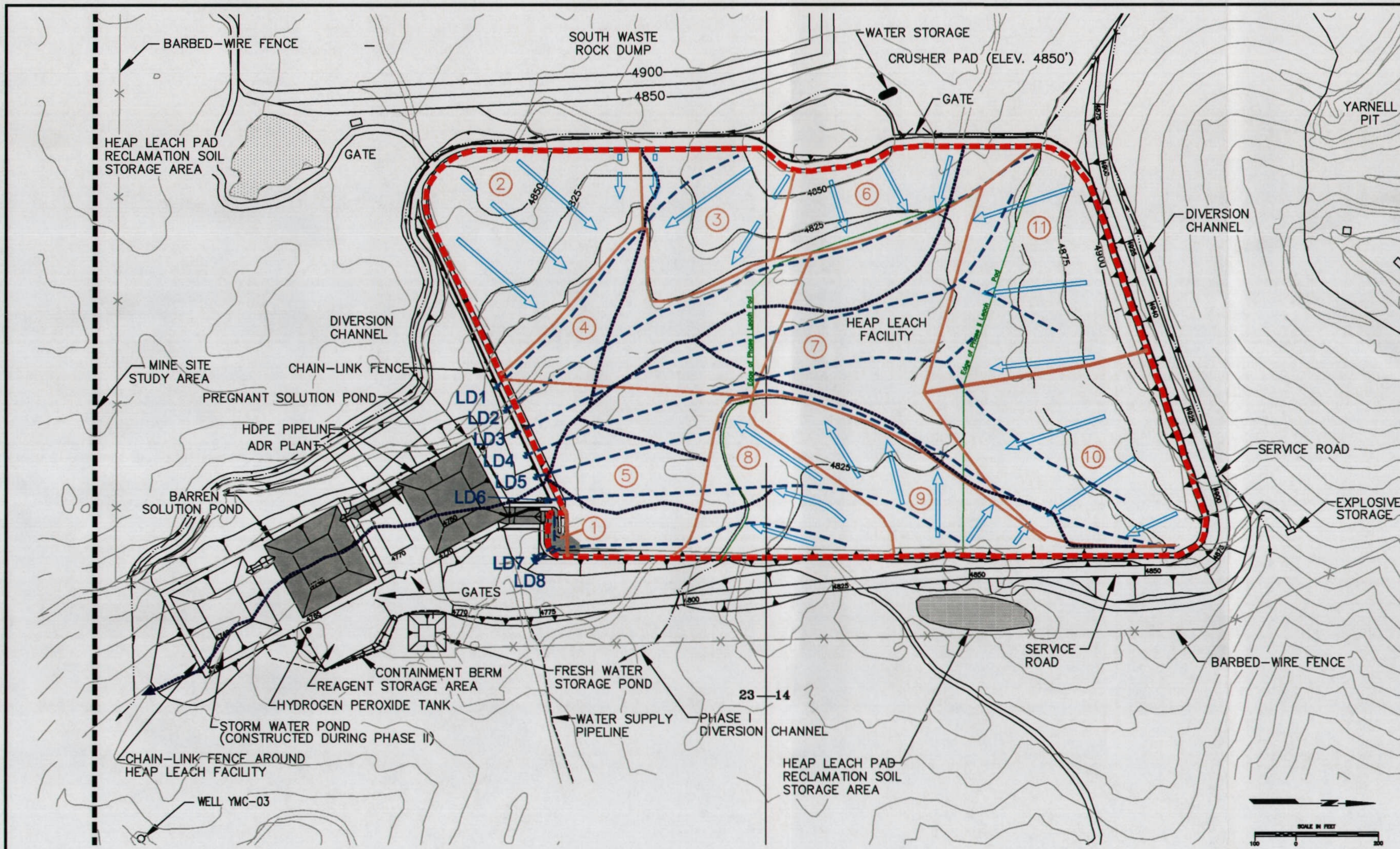
2.1.5.1 Gold Recovery

Adsorption. The gold would be recovered from the gold-bearing solution by adsorbing the dissolved gold onto activated carbon contained in one row of six carbon columns. Each column would hold two tons of carbon.

Acid Washing. The gold-bearing carbon would be moved from the carbon adsorption columns to an acid wash tank. Dilute hydrochloric acid would be circulated through carbon in the acid wash tank until the return solution decreases to a pH of one.

When the washing cycle is complete, a solution of caustic soda would be added to the acid wash pump box and pumped through the acid wash tank to neutralize the free acid. Once neutralization has occurred, as indicated by a final pH of eight, the washed carbon would be transferred to the stripping circuit.

Carbon Stripping. Twice a week, one carbon column would be stripped of its gold content in a desorption column. Strip solution-containing caustic soda and cyanide would be pumped through the strip



SUBSURFACE DRAIN (BENEATH LEACH PAD FILL)

LEAK DETECTION SYSTEM (BENEATH SYNTHETIC LINER IN LEACH PAD LINER SYSTEM)

LD5 POINT AT WHICH LEAK DETECTION SYSTEM DRAINS REACH SURFACE

DIRECTION OF FLOW ABOVE SYNTHETIC LINER

LEAK DETECTION MONITORING AREA

EDGE OF LEACH PAD LINER SYSTEM

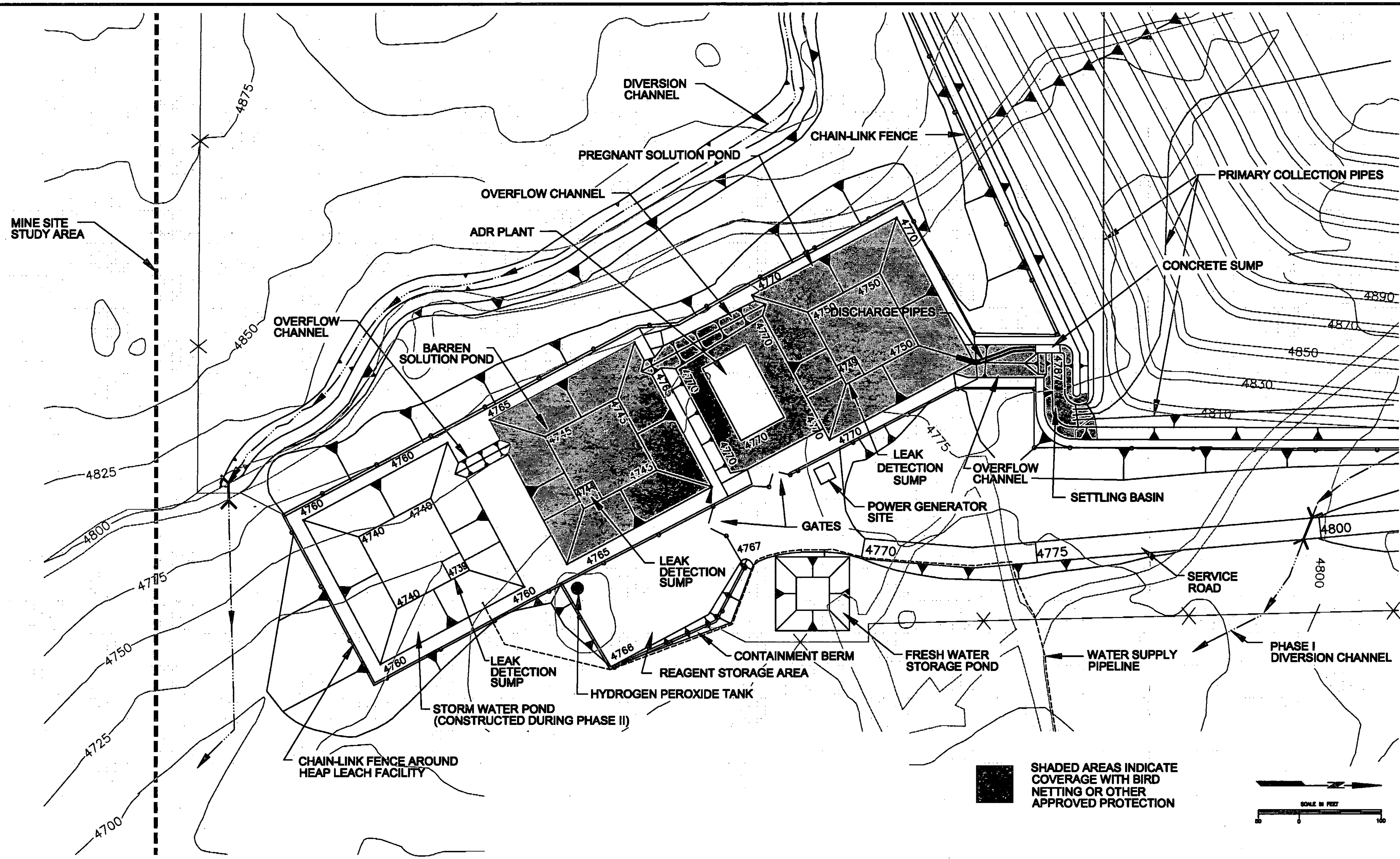
SHADED AREAS INDICATE COVERAGE WITH BIRD NETTING OR OTHER APPROVED PROTECTION

NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 2-5

HEAP LEACH AND POND SYSTEM FACILITY LAYOUT



NOTE: Based on Figure from Facilities Design Report, SMI – 1996.

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FIGURE 2-7

SOLUTION COLLECTION POND LAYOUT

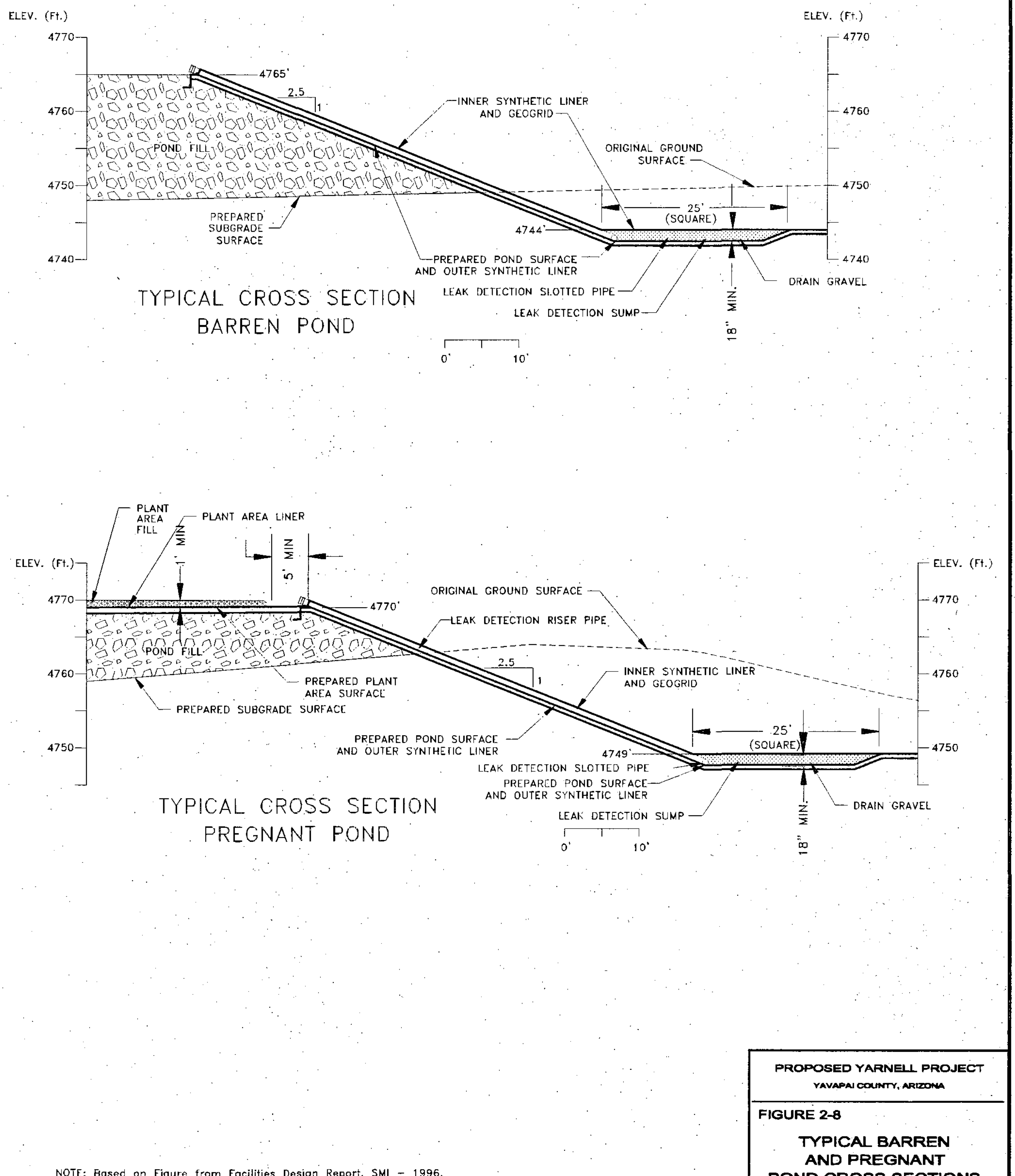

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FIGURE 2-8
TYPICAL BARREN AND PREGNANT POND CROSS SECTIONS

vessel at a temperature of 265°F and a pressure of 30 psi. The gold-bearing solution would be cooled to 150°F and stored in a tank prior to being pumped to the electrowinning cells.

Electrowinning. The cooled solution would be pumped through the electrowinning cell and the precious metal would be plated onto stainless steel mesh cathodes. The loaded cathodes would be removed from the electrowinning cell and washed with water at 100 psi pressure. The precious metal slurry would be pumped through a filter press to recover the metal particulates, which would be dried in an oven prior to refining. Periodically, the sludge that has accumulated on the bottom of the electrowinning cell would be removed and refined with the cathode metal.

Refining and Doré Bar Production. The dried precious metal sludge and cathodes would be mixed with the appropriate fluxes and melted in a propane-fired furnace. The capacity of the furnace would be 1.2 million BTU per hour. The precious metal would be heated to approximately 1,800° Celsius. The molten bullion would be cast into doré bars for shipment to a refinery and the slag would be poured into a mold, crushed and stored in drums for periodic shipment to a smelter for precious metal recovery. YMC would have to follow the Resource Conservation and Recovery Act (RCRA) for hazardous waste storage requirements.

2.1.5.2 Reagent Handling

Lime. Lime would be added to the ore stream by a belt feeder following secondary crushing so that thorough mixing of the lime and ore can occur. About five pounds of lime per ton of ore would be used to reach a protective alkalinity range at or above pH 10.5. Lime would be delivered approximately twice a week by truck to a 60-ton storage silo at the crusher site.

Sodium Cyanide. Solid sodium cyanide would be delivered by truck to the site in briquette form. Most likely, the material would be shipped from a Nevada distribution point and transported to the site by a licensed hauler via State Highway 89 from its junction with U.S. Highway 93. The material would be available in three possible packaging systems: (1) stainless steel bins, (2) steel-reinforced, polyethylene-lined, plywood boxes or (3) bulk containers. As needed, the briquettes would be dissolved in a mixing tank and the resulting solution would be pumped into a solution storage tank at the processing plant. The resulting liquid cyanide product would be used to maintain the cyanide concentration of the barren solution at one pound per ton. Sodium cyanide would be delivered to the mine as needed, approximately two or three times per month. The empty containers would be recycled by the hauler when cyanide is delivered to the site.

Caustic Soda. Caustic soda would be added to the barren solution when required to maintain protective alkalinity in the system. Because the bulk of the alkalinity would be provided by lime, caustic soda consumption would be low. One truckload (about 20 tons) of caustic soda would be delivered approximately once each month. Dry caustic soda would be stored in the process storage area. Liquid caustic soda would be stored in a tank at the ADR plant.

Anti-scaling Agent. Antiscalant would be added to the pregnant solution ahead of the carbon columns and also to the barren feed pumps. Insulated bulk tanks and metering pumps for antiscalant would be provided by the supplier. Tanker trucks would deliver antiscalant to the mine approximately once a month.

The specific antiscalant agent which would be used has not been selected, and the actual chemical used would depend on the chemistry of the makeup water and the ore (particularly calcium, carbonate and sulfate concentrations). Antiscalants are generally water softening agents added to the makeup water and are not a hazardous material.

2.1.6 ANCILLARY FACILITIES AND PROCEDURES

2.1.6.1 Access Road

Access to the site from Wickenburg or Prescott would be via State Highway 89 to Yarnell, then on Mina Road to the mine entrance and office. Public access to Mina Road would not be restricted by proposed operations except when closed for blasting.

2.1.6.2 Electrical Power Supply

The majority of electric power required at the mine would be supplied by on-site generators. Power for the crushing circuit would be provided by an on-site diesel-fueled generator with 820-kW capacity. A second generator with 365-kW capacity would be at the ADR Plant. (An additional 365-kW generator at the ADR plant would serve as a backup generator.) Each generator would be operated within a contained area (roughly 12 feet by 60 feet). This contained area would be underlain by a concrete pad or a synthetic liner. Arizona Public Service would continue to supply low-voltage electricity to the mine site, powering the mine office and maintenance shop. Step-down transformers would be used as necessary.

Water supply pumps would be powered by line power supplied by Arizona Public Service and by dedicated generators at the well sites. Well TW-01 would be powered by a diesel-fueled generator with 25-kW capacity, and Well 2BCD would be powered by a diesel-fueled generator with 113-kW capacity. The remaining wells and pump stations would be powered by overhead line power.

The maximum annual electrical power requirement for the project would be 8,915,000 kWh as shown in Table 2-4.

2.1.6.3 Outdoor Lighting

YMC has proposed that outdoor lighting be used at project facilities to extend operating hours beyond daylight, as well as for security and safety. Portable light plants (metal halide) would be required to light the active ore and waste removal mining area and the active waste rock dump areas. Lighting would also be necessary at the crusher, ADR plant and shop. It is anticipated that five 6-kW diesel-powered light plants would be employed during operations. All lights would be hooded and directed away from the highway and residences to avoid unnecessary glare.

2.1.6.4 Water Use and Storage

The average water supply required for dust suppression, ore processing and potable uses is approximately 100 gpm or 144,000 gallons per day. Water would be required for approximately five to six years during operations and two to three years during mine closure.

The estimated average ore processing requirement would be approximately 48 gpm (approximately 20

TABLE 2-4
Electrical Power Equipment

Facility	Power draw (HP)	Power draw (kW)	Operated hours/day	Operated days/year	Power required (kWh/year)
Crusher	875	652	24	260	4,071,522
Leach/ADR Plant	400	298	24	365	2,612,933
Maintenance	21	16	24	260	97,717
Assay lab	68	51	8	260	105,472
Water supply pumps	300	224	24	365	1,959,700
Administration office	29	22	12	260	67,471
Total					**8,914,815**

gallons per ton of ore or 480,000 gallons per week at seven days per week). The estimated water requirement for dust control in the crushing circuit would be approximately 4 to 10 gpm (72,000 gallons per week). The estimated water requirement for dust control on roads would be approximately 27 gpm (200,000 gallons per week). Potable water would be supplied to the ADR plant, the crusher site, office, maintenance shop and in portable coolers as necessary.

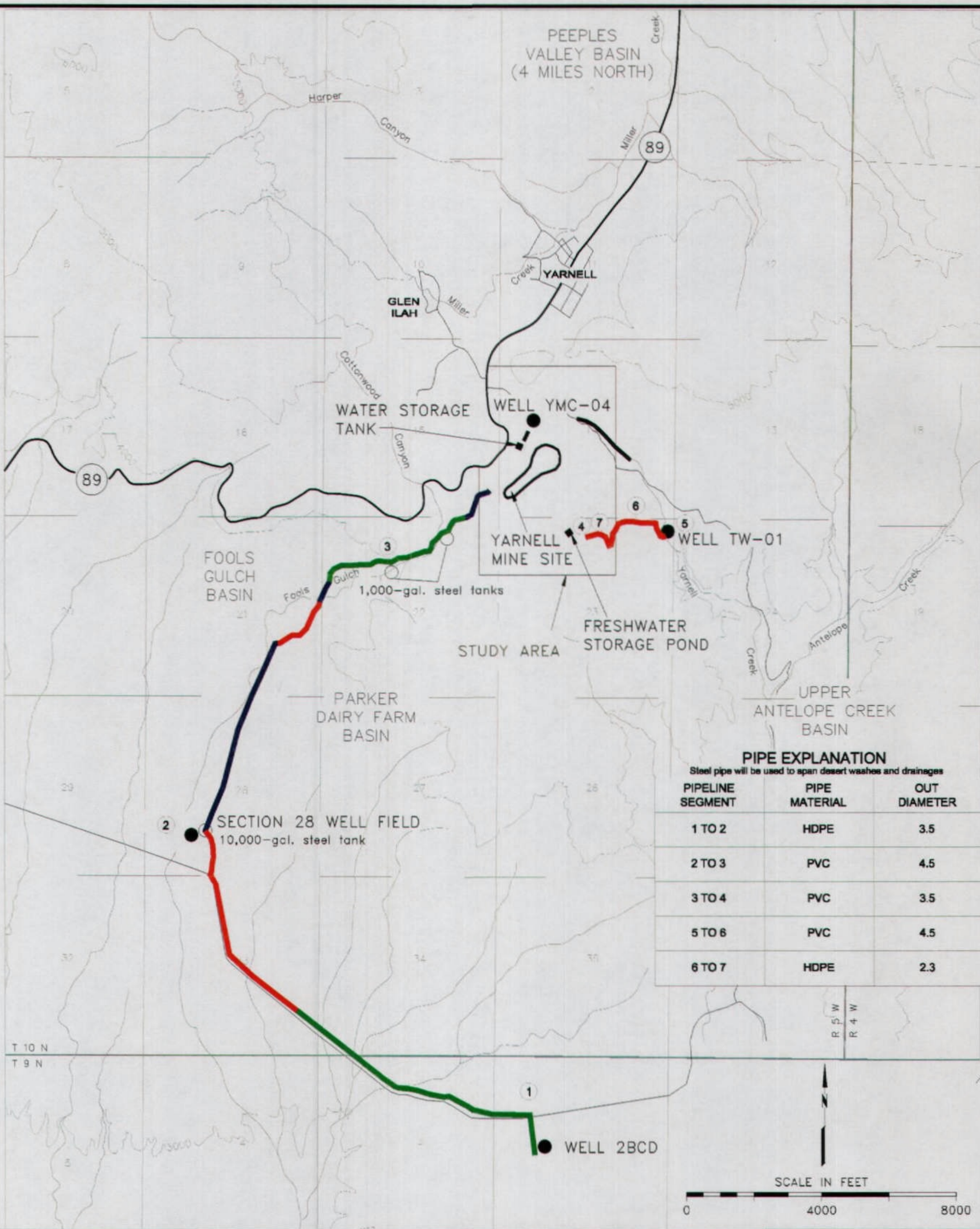
Water Supply Sources. Based on hydrogeologic testing completed in 1996, YMC has proposed that groundwater be pumped from existing wells at four locations, as shown in Figure 2-9 and described below in Table 2-5.

Well YMC-04 and the Section 28 well field are private wells on land owned by YMC. Well TW-01 was developed by YMC on public land through a BLM-authorized right-of-way. Well 2BCD is on State Trust land and is registered to the Arizona State Land Department. YMC has filed right-of-way and use permit applications with the State Land Department for use of this well.

Any groundwater encountered during mining would be diverted to an in-pit sump and used for dust suppression. This would likely be an insignificant and unreliable water supply source.

Water Transport and Storage. YMC proposes to transport water from these four locations to mine-site water storage facilities in above-ground HDPE, PVC and steel pipe. The water supply pipelines would cross federal, state and private land. Rights-of-way authorizations by the BLM and the Arizona State Land Department would be necessary. The proposed pipeline construction and access corridors would be approximately 25 feet wide. The pipeline would be 3½ or 4½ inches in diameter and placed directly on the ground and follow existing roads and disturbance where possible to minimize new surface disturbance. The proposed pipeline corridors are shown in Figure 2-9.

Water from Well YMC-04 would be pumped to a 10,000-gallon freestanding steel storage tank at the maintenance facility. As necessary, a 5,000-gallon water truck would transport water from this tank to another 10,000-gallon storage tank at the crusher.



PIPE EXPLANATION

Steel pipe will be used to span desert washes and drainages

PIPELINE SEGMENT	PIPE MATERIAL	OUT DIAMETER
1 TO 2	HDPE	3.5
2 TO 3	PVC	4.5
3 TO 4	PVC	3.5
5 TO 6	PVC	4.5
6 TO 7	HDPE	2.3

EXPLANATION

- — 3000 — EXISTING CONTOUR – 1000-FT INTERVAL
- ○ PUMP STATION
- WATER LINE CORRIDOR – PRIVATE LAND
- WATER LINE CORRIDOR – BLM LAND
- WATER LINE CORRIDOR – STATE LAND
- DELINEATED WETLANDS

NOTE: Based on Figure from Mining Plan of Operations 1995, updated 1996.

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FIGURE 2-9

WATER SUPPLY AND PIPELINE CORRIDORS

Table 2-5
Water Supply Sources

Arizona Dept. of Water Resources Well Registration Number	Legal description	Long-term sustainable yield (gpm)	Land ownership
55-806970L (YMC-04)	SE 1/4 of SW 1/4 of NW 1/4 of Section 14, T10N, R5W	20	Private
55-550684 (TW-01)	NE 1/4 of NE 1/4 of NE 1/4 of Section 23, T10N, R5W	10-20	BLM
55-804048 (Well 2BCD)	SE 1/4 of SW 1/4 of NW 1/4 of Section 2, T9N, R5W	50	Arizona State Trust land
55-520462, 55-524691, 55-525982 (Section 28 well field)	SW 1/4 of NE 1/4 of SW 1/4 of Section 28, T10N, R5W	60*	Private

*Signifies the aggregate yield from three wells
Sources: Sustainable Yield - pump testing and historic information
Land ownership - Yavapai County Assessor

Water from the Section 28 well field would be pumped directly into a 10,000-gallon storage tank at the well field. Water would be transported from this pump station to the freshwater pond near the ADR Plant. Two intermediate pumping stations, each consisting of a 1,000-gallon water storage tank and two booster pumps, would be constructed in Section 22 (within the pipeline right-of-way) to boost the water up Yarnell Hill to the mine.

Water from Well TW-01 would be pumped directly to the freshwater pond near the ADR Plant. Water from Well 2BCD would be pumped to the 10,000-gallon water storage tank at the Section 28 well field.

2.1.6.5 ANFO/Explosive Storage

Ammonium nitrate used in blasting would be delivered as bulk prill. The prill would be stored in an approved 30-ton silo adjacent to the maintenance facility. Explosives would be delivered by licensed haulers and stored on site in approved storage facilities (bulletproof explosives magazines). Magazines and detonating devices would be kept an appropriate distance from the ammonium nitrate storage silo. All employees responsible for explosives would be trained and certified by government agencies as required.

2.1.6.6 Fuel Storage

Diesel and gasoline would be stored in above ground, closed steel tanks adjacent to the maintenance facility, at least one mile from the explosives magazines. The tanks would be within a bermed containment area, lined with an impervious synthetic liner covered with rock to minimize any impacts from spills. The containment area would be designed to hold 100 percent of both tank capacities, plus a 25-year, 24-hour rainfall event. The diesel and gasoline storage tanks would have 10,000- and 5,000-gallon capacities, respectively. Fuel would be delivered to the mining equipment via a service vehicle. Warning signs would be posted at fuel storage areas and containment berms.

Propane would heat the mine office during winter months and fire the carbon reactivation kiln and the smelting furnace. The propane vendor would supply and install tanks at the mine office and processing plant in accordance with current safety regulations.

Diesel-powered generators would provide electricity to some water supply pumps. Fuel for these generators would be stored at the water well sites.

2.1.6.7 Reclamation Soil Stockpiles

In areas of the site to be covered or disturbed, available soil would be stripped (where it is present) and salvaged for use in reclamation. Soils on steep slopes and boulder areas of the site would be selectively stripped due to inaccessibility. An area near a topsoil stockpile would be made a plant nursery for species protected under the Arizona Native Plant Act. The Act includes a provision to let a commercial nursery take the plants for resale. Primary locations of reclamation soil stockpiles were shown in Figure 2-2. Smaller locations for stockpiles may also be necessary at unspecified locations.

2.1.6.8 Sanitary and Solid Waste Disposal

Refuse produced on site would be handled and disposed of according to Yavapai County and state requirements. Trash would be temporarily stored in a receptacle at the mine site and hauled off site to a local licensed municipal waste disposal facility. Items which may be classified as hazardous would be appropriately packaged and shipped by a licensed hauler to a Class I landfill for disposal.

The project would use both permanent and portable sewage facilities. The permanent facilities would consist of a system of engineered collection piping, a septic tank and accompanying leach field designed according to Yavapai County Health Department standards. The portable facilities would be chemical toilets which would be moved periodically as operations dictate. Waste from the chemical toilets would be hauled off-site by the licensed vendor supplying the toilets.

2.1.6.9 Potable Water

Wash water and drinking water would be piped to the mine office from Well YMC-04. Small storage tanks would be placed at the shop and ADR plant and filled from the freshwater storage pond as necessary. YMC would comply with all federal and state regulations for drilling, completion and pumping of water supply wells. Bottled water may also be purchased for drinking from a local vendor. Any groundwater used would be treated as necessary to meet EPA primary and secondary drinking water standards.

2.1.6.10 Maintenance and Warehouse Facility

The maintenance shop (approximately 6,000 square feet) would be erected just west of the pit area. Heavy mobile equipment repair, maintenance and service would be performed in the shop. The shop area would also be set aside for light truck maintenance, welding and tool storage. The shop floor is designed to eliminate any contamination of the surrounding area by machine fluids. A floor sump would be constructed to contain any spills that may occur.

2.1.6.11 Mine Office

Administrative facilities (approximately 3,600 square feet) would be provided on site at the mine office for the operating management and staff. The mine manager, department heads and engineering support group would be assigned offices in these facilities (see Figure 2-2). Accounting, payroll and purchasing would also operate within the mine office.

2.1.6.12 Assay Laboratory

An assay laboratory in the ADR building would include a sample preparation area, analytical area and offices for lab personnel. The sample preparation area includes equipment for drying, crushing, splitting and pulverizing samples. The analytical area includes provisions for weighing, wet chemical analyses and atomic absorption assays. Most of the samples assayed would be mine grade control samples.

Storage for pulps would be provided adjacent to the lab and added to as needed. These storage units would also provide space for samples brought from the pit.

2.1.6.13 Fencing and Security

The mine and process area would be fenced by barbed wire with several locked gates. The gate at the mine entrance off Mina Road would be manned by office staff. The mine site would be manned 24 hours per day, seven days per week. A six-foot tall, chain-link fence topped with three strands of barbed wire would be installed around the process area, leach pad and all solution ponds to prevent entry by unauthorized personnel. Movement of grazing animals would also be restricted by the chain-link fence, but the fencing would not exclude entry into the project area by all wildlife.

2.1.6.14 Fire Protection, Emergency Response and Safety

Adequate fire protection is necessary to protect the resources, facilities and personnel of the mining company and the community and to maintain compliance with MSHA regulations, the Arizona mining code and applicable state and county building codes. The location of the Yarnell Project is such that local fire/rescue facilities in Yarnell can assist with medical and/or fire emergencies, if needed. As specified by MSHA, YMC would conduct first aid training for all employees. On-site water tanks would be available for fire protection.

An Emergency Notification Plan, Contingency Plan and Spill Prevention Control and Counter Measures Plan (SPCC) would be prepared to cover actions to be taken in the event of an on-site spill, fire, release of toxic gas or other emergency. These actions would include notification procedures, as well as loading and unloading procedures, description of containment structures, surveillance and inventory control procedures for these critical materials. The plans would also include lists of safety and emergency response equipment on site, as well as a personnel safety training program. As part of the planning requirements, trained staff would be assigned to each shift, including weekends.

To provide for the safety and well-being of all individuals involved with the project, the general public and local wildlife, the following precautions would be taken.

- Warning signs would be placed on the chain-link fence at 200-foot intervals and entrance gates would be kept closed. Additional gates would be placed to block vehicular access to the entire mine site. The open pit and waste dump areas would be surrounded by a four-strand barbed wire fence.

- All chemicals would be stored in accordance with applicable regulations within the fenced area. Sodium cyanide and acid would be stored separately from each other and from other incompatible materials.
- Open ponds and ditches containing sodium cyanide solution would be covered with netting or other approved protection (see Figure 2-6).
- Sufficient calcium hypochlorite and/or hydrogen peroxide would be maintained on site to neutralize possible spills.
- Empty sodium cyanide containers (if applicable) would be triple-rinsed, rendered unusable and removed to an approved disposal site or recycled back to the manufacturer.
- All employees would be trained and certified where required in the safe use of chemicals.
- Hard hats, safety glasses and steel-toed boots would be worn by all personnel on site. Face shields or goggles, rubber aprons, gloves and respirators would be worn when handling chemicals. This safety equipment plus earplugs would be used at all appropriate times to meet MSHA requirements.
- A cyanide antidote kit, oxygen bottle, first aid kit, freshwater shower and eye wash station would be maintained in the plant area. An additional cyanide antidote kit, oxygen bottle, first aid kit and trauma kit would be kept in the mine office. All employees would be instructed in their use.
- At least two trained people would be present when a shipment of sodium cyanide is delivered to the mine site and transferred from a briquette form to a liquid.
- All applicable county, state and federal rules and regulations would be followed.

2.1.6.15 Drainage, Diversion and Sediment Control

The generation of sediment with surface water runoff would be minimized by mine site features and diversion channels designed for overall surface water control. The heap leach pad, solution storage pond and ADR plant areas are designed as areas of zero surface water discharge.

The Storm Water Pollution Prevention Plan, prepared by YMC for approval by the EPA, would address the management of runoff that could carry sediment from the waste rock dumps, roads and parking areas. Elements of this plan are described in Section 2.1.2 and shown in Figure 2-4. Discharge from the storm water outfalls would occur during storms. The peak flow and runoff volume that would be expected from three different sized storm events are shown in Figure 2-10. From a 100-year, 24-hour precipitation event, the maximum peak flow (164 cfs) would be from the undisturbed area and soil stockpile adjacent to the SWRD (SWO-02) while the maximum runoff would be 10.9 acre-feet from the office and undisturbed area above the NWRD (SWO-07).

Mine Pit. The mine pit would generally be a containment basin for runoff from the mine pit slopes. During operations, runoff and any seepage would be collected and used for dust suppression. After mining, the pit would be partially backfilled with waste rock and a drainage channel would be established at an average grade of 0.5 to two percent. At that time, a

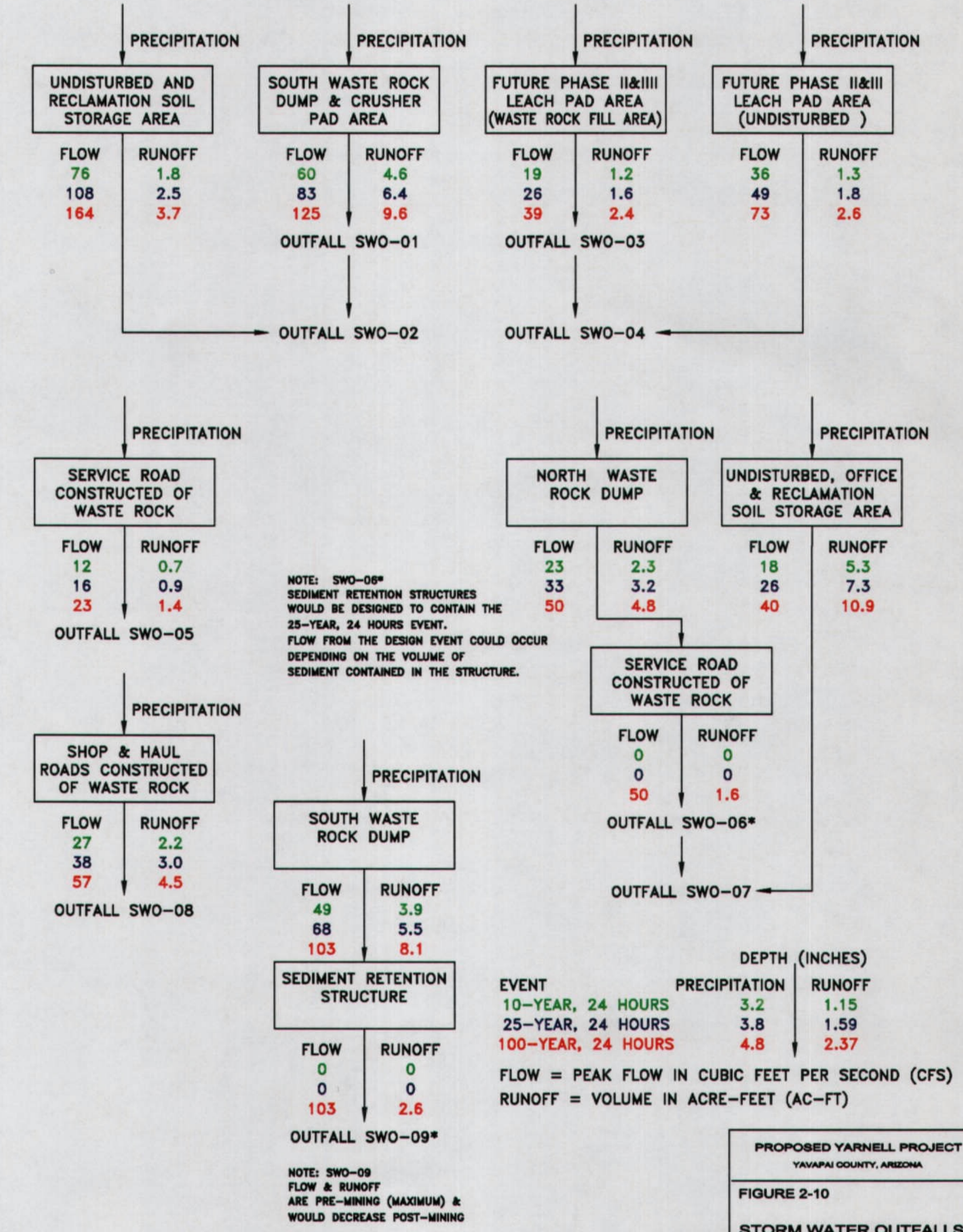

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FIGURE 2-10

STORM WATER OUTFALLS PEAK FLOW AND RUNOFF sediment retention structure would be constructed, if necessary, to detain runoff from the pit. The need for any NPDES permit would be determined at that time.

Waste Rock Dump. Diversion and drainage around the waste rock dumps (WRDs) have been designed to convey the 100-year, 24-hour storm (4.8 inches). The sediment retention structures below the WRDs have been designed for the 25-year, 24-hour precipitation event (3.8 inches). Upon reclamation, the WRDs would be regraded, covered with soil or a suitable growth medium and revegetated. The sediment retention structures would be partially filled to establish drainage and be stabilized to minimize erosion. Waste rock would be placed to within five feet of the embankment crest. Storage of runoff would occur in pore space and the area above the waste rock. The drainage diversions are permanent structures and would be retained.

Discharge from the sediment retention structures for the NWRD and SWRD would be permitted as outfalls SWO-06 and 09, respectively. As proposed by YMC, these structures were sized to contain the 25-year, 24-hour storm. This capacity is equivalent to containment of runoff from the 10-year, 24-hour storm plus two to three years of accumulated sediment under average conditions. The structures would be flow-through structures with the embankments constructed from compacted, coarse waste rock. A coarse rock zone over a selected reach of the embankment crest and downstream slope would serve as the emergency spillway and would be designed to safely pass the peak flow from the 100-year, 24-hour storm (50 cubic feet per second (cfs) and 103 cfs for the NWRD and SWRD sediment retention structures, respectively).

The total capacity of the sediment retention structures for the NWRD and SWRD would be about 3.25 acre-feet and 5.47 acre-feet, respectively (including one foot of freeboard). The structures would be total containment structures and no discharge is anticipated. However, any discharge from the sediment retention structures would be monitored and would be subject to effluent limitation guidelines. It is anticipated that water entering the structure would seep into the embankment and infiltrate into the materials below the embankment before seeping through the embankment. No dewatering of the structures is planned. However, any stored water may be used for dust suppression.

Sediment from the retention structures would be inspected annually and removed, if necessary. Annual sediment entering the pond was estimated by YMC as being equivalent to the volume from a two-year, 24-hour storm. This volume is roughly 10 percent of the capacity of the sediment retention structure. For the 25-year, 24-hour storm, sediment volume would be 31 percent of the capacity of the NWRD and 46 percent of the capacity of the SWRD sediment retention structure. This indicates that with larger storms, sediment removal may be required more frequently. Sediment would be disposed of by burial in the waste rock dump. The waste rock would be sampled and tested for acid generation potential and leaching of metals. Sediment (derived from the waste rock) would not be sampled.

Heap Leach Facility. It is proposed that precipitation runoff and drainage from the heap be collected in the solution ponds. A diversion channel designed to convey the 100-year, 24-hour storm would be constructed on the upstream side of the leach pad for all three phases of heap construction to prevent upstream runoff from entering the leach pad.

Roads and Other Disturbed Areas. Runoff from haul roads, other access roads, waste rock fills and other areas on the site (runoff in contact with waste rock) would be collected and discharged from outfalls SWO-01, 03, 05 and 08 under an individual permit issued by the EPA. Storm water discharges from outfalls SWO-02, 04 and 07 would not contact waste rock and would be authorized by the EPA under the general Multi-Sector Permit. These discharges would be from diversion channels routing runoff around structures. Straw bales, silt fences and other best management practices would be used along the diversion channels, ditches and swales, draining roads and areas filled with waste rock, if required, to control sediment. These areas would be compacted and would not be expected to generate substantial quantities of sediment.

2.1.7 CLOSURE AND RECLAMATION

Closure and reclamation would be conducted in accordance with the MPO, as summarized below. The BLM, ADEQ and State Mine Inspector's Office would require YMC to post adequate bonds to meet federal and state requirements.

2.1.7.1 Closure and Reclamation of Facilities Associated with Cyanide Use

Closure procedures to be implemented following the cessation of mining and ore processing would provide for removal of potential pollutants or contaminants. Protection of surface water, groundwater and air would be provided by decommissioning all facilities and returning the land to multiple uses that existed prior to mining.

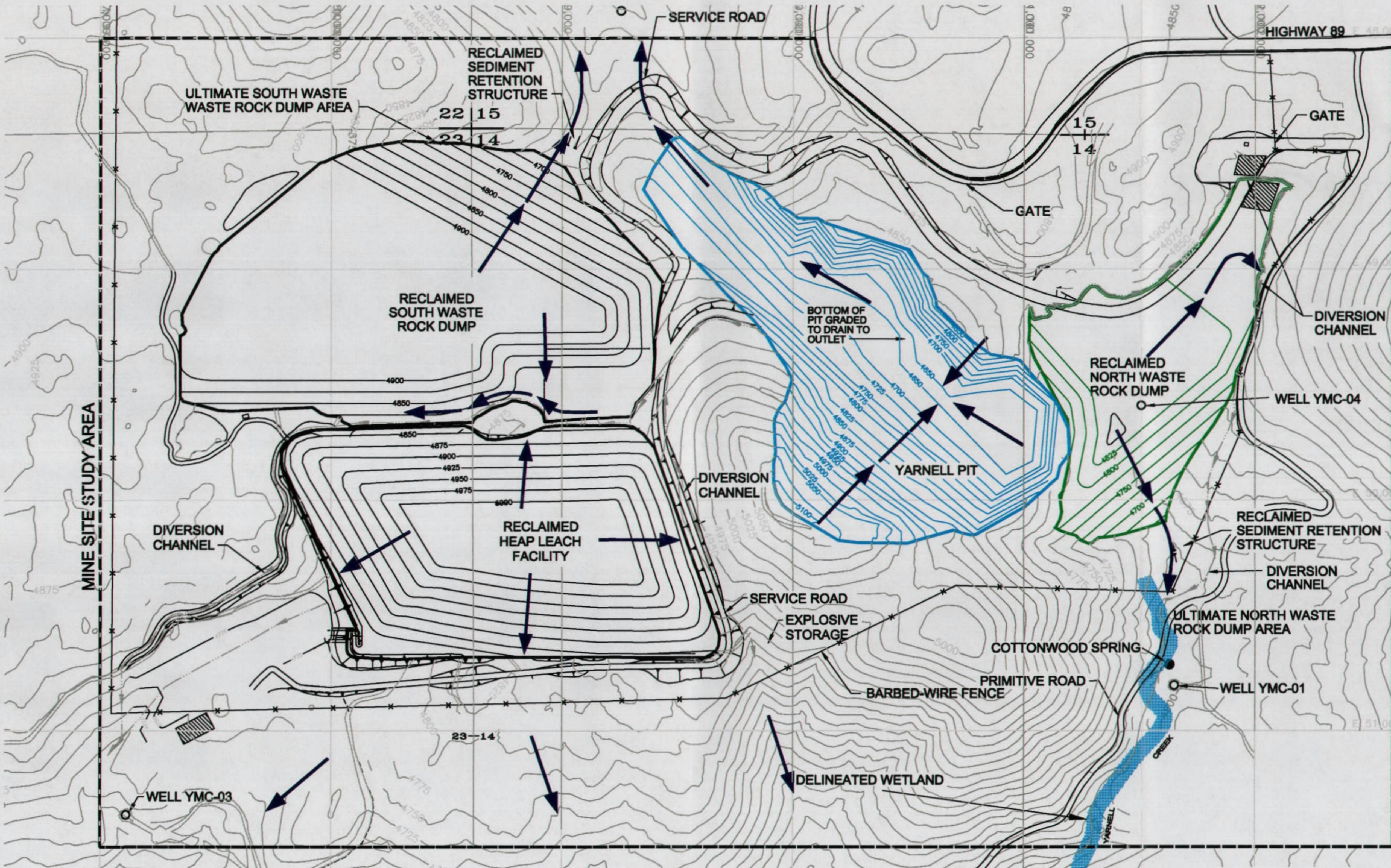
Decommissioning of the heap leach facility, solution/process ponds and associated ancillary facilities and structures would be performed to meet requirements established by ADEQ in the APP and the guidelines within the BLM Cyanide Management Plan and Surface Management Regulations (43 CFR 3809). Closure activities on private land would conform to the Arizona Mine Inspector's Final Mined Land Reclamation Rules.

Closure would include detoxification/neutralization of the spent ore on the leach pad and solutions contained in the process ponds, demolition and salvage of the associated ancillary facilities and structures, reclamation and revegetation of these areas and monitoring. Figure 2-11 shows the facilities layout after reclamation.

Heap Leach Facility. The heap leach facility closure is divided into two separate tasks. The first task would be to detoxify and neutralize the heap material. The second task would include regrading, establishment of a suitable growth medium and revegetation.

As gold recoveries begin to decrease, freshwater would be added to the leaching circuit to begin the heap-rinsing process. This passive rinsing would be performed untkl gold values in the rinsate from the heap reach a level at which it becomes uneconomical to recover. Rinsing with water increases the natural degradation process of cyanide, yet allows recovery of residual gold.

Following this initial passive rinsing stage, active rinsing with hydrogen peroxide or an equivalent oxidizing agent would occur until the required water



MINE SITE STUDY AREA

SURFACE FLOW DIRECTION

SCALE IN FEET 200 0 400

NOTE: Based on Figure from Mining Plan of Operations 1995, updated 1996.

LEGEND

- SEPTIC SYSTEM LEACH FIELD
- SEDIMENT RETENTION STRUCTURE
- DIVERSION CHANNEL
- BARBED WIRE PERIMETER FENCE

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FIGURE 2-11

FACILITIES AFTER RECLAMATION

quality standards established by ADEQ are met. These standards include reducing the WAD cyanide level to 0.2 mg/l, stabilizing the pH between 6.0 and 8.5 and the rinsate meeting the water quality standards as set forth in the APP. If feasible, selected species of bacteria may be added to the rinse water to speed up the detoxification process.

All rinsate would be collected following completion of detoxification and neutralization procedures for appropriate removal by evaporation using sprayers or other means. Upon completion of all detoxification/ neutralization, the collection system would be removed and the area reclaimed as described in the following section.

Once the heap leach material has been detoxified and neutralized, the heap leach facility would be regraded to promote runoff and avoid ponding. This regrading would enhance the blending of the heap leach area with the surrounding topography by providing a smooth transition. Slopes would be regraded to 50 percent.

The establishment of suitable growth media would consist of placement of reclamation soil (topsoil) or the incorporation of soil amendments prior to seeding. Revegetation would be performed to meet post-mining land uses such as wildlife habitat, open space or grazing.

Solution Storage Ponds. Closure of the solution storage ponds would include the evaporation of any remaining water followed by regrading the ponds and revegetating the disturbed area. Spray evaporation may be incorporated to enhance the evaporation process. Land application by spraying treated water may be considered if the water meets ADEQ water quality standards. Accumulated precipitates within the ponds would be sampled and analyzed for proper disposal. Analysis would include pH, cyanide and leachable metals following ADEQ requirements. Any hazardous materials would be disposed of off-site at an appropriate disposal facility in accordance with state and federal regulations. Non-hazardous materials would be placed in an appropriate disposal area on site or buried.

The pond liner would be folded over and covered in place to a minimum depth of five feet below the final reclamation surface. The pond area would then be backfilled and the surface regraded to establish a reclamation configuration compatible with the surrounding terrain.

The establishment of a suitable growth medium would be performed by the placement of topsoil or the incorporation of soil amendments prior to seeding. Revegetation would be performed to meet post-mining land uses. Seeding would occur in the fall to allow plant growth in the spring when temperature and moisture conditions are optimum.

Ancillary Facilities and Buildings. Reclamation would include proper disposal of buildings, equipment, piping, scrap, utility lines, reagents and other hazardous or toxic materials, demolition of buildings and structures for salvage, regrading of the areas and revegetation.

The process plant and associated pipelines involved with the cyanide process would be neutralized, decontaminated and removed during the detoxification/neutralization process of the heap leach facility. Excess reagents would be resealed in containers and returned to suppliers or used at other mine sites. Ancillary buildings and structures would be dismantled for salvage. Non-salvageable items such as concrete and scrap material and equipment would be buried on site or disposed of off site in compliance with state and federal regulations.

Regrading of these areas would be performed following demolition and salvage. Foundations would be left in place and covered with a minimum of 24 inches of fill. Other areas would be ripped to relieve compaction, and the areas graded to create a suitable growth medium prior to revegetation. Topsoil may not be required, as the substrate material in these areas may be more conducive to plant growth than the heap leach and waste rock dump areas. Topsoil may be added, if necessary.

As for the other mine-related facilities, seeding would occur in the fall following regrading activities to allow plant growth in the spring when temperature and moisture conditions are optimum. Mulch would be applied immediately following seeding, if necessary. Efforts would be made to minimize the potential to introduce exotic seeds into the mulch mix.

2.1.7.2 Reclamation of Other Facilities

Reclamation of other facilities would occur following closure activities. These areas include the waste rock dumps, the open pit, access and haul roads, powerlines, fences, water pipelines, sediment and diversion structures and other site disturbances.

Waste Rock Dumps. YMC proposed to shape the waste rock dumps to a 50 percent slope by regrading approximately 270,000 cubic yards of material to achieve the final waste rock dump reclamation configurations. Available reclamation soil or topsoil may be placed proportionally over regraded areas or soil amendments incorporated to establish a suitable growth medium.

The waste rock dumps would have two types of surface conditions before reclamation. The first would be loose, undulating surface resulting from the waste rock being dumped at its angle of repose without dozing or grading. The second would be a hard-packed top surface from haul truck traffic. The loose areas would be regraded by dozing materials downward from the top of the dump face to provide a uniform surface for placement of reclamation soil. The hard-packed areas on top of the dumps and on the access roads would be ripped, scarified and graded to minimize erosion and facilitate revegetation. After dump reclamation, the slopes would be stable, as documented in the Facilities Design Report submitted by YMC to ADEQ.

Reclamation of the NWRD would begin after the site is filled with waste rock. Reclamation of the SWRD would take place just prior to the end of mining. Reclamation of the dumps concurrent with operation is not possible due to the proposed method of dump advancement (by end-dumping from the top surface of the waste rock dump).

Open Pit. Pit slopes and benches have been designed to provide a stable configuration. Therefore, reclamation of the pit area would be limited to features that would restrict public access. This would include constructing a barbed-wire fence around the pit perimeter, with berms across all haul and access roads into the pit. Berms would be a minimum of five feet tall with signs posted at potential access points identifying the potential hazard. In addition, the mine pit would be partially backfilled with waste rock to allow precipitation runoff collected in the pit to flow through its southwest end. At its northern end, the pit would be backfilled with approximately 40 feet of waste rock to an elevation of 4,660 feet. The backfill would slope southwest for approximately 500 feet until it reached an elevation of 4,640 feet. From this point, the pit bottom would be relatively flat until its southwest end is reached (as shown in the MPO, Figure 7.5). Backfilling would be started after completion of mining and a drainage channel established (see Figure 2-11) at an average grade of 0.5 to two percent along the pit bottom to provide flow without excessive erosion. A sediment control structure would be constructed at the southwest end of the pit if needed.

Flat benches that are accessible would be ripped and/or scarified to produce rough surfaces for anchoring any soil materials. Surface material would be left in a loose, rocky condition to aid in moisture collection, decrease wind erosion losses and encourage establishment of seedlings in small surface crevices. Some small depressions would be left on the surfaces to aid in moisture retention. These areas would be used to seed native species and transplant selected native shrubs. In addition, over time, some natural encroachment of native species adapted to rock outcrop habitats would occur in isolated groupings.

Access/Haul Roads. Except for roads which the BLM wants to remain on the property, access and haul roads would be reclaimed following mine closure. Reclamation would include regrading and revegetating the disturbed areas to blend with the surrounding topography. Culverts installed for the mining operations would be plugged and buried in place or removed and salvaged, with the natural drainage restored. Approximately 10,000 cubic yards of material would be moved during the regrading process to achieve the final reclamation configuration. Ripping would be conducted to relieve compacted areas and provide a more suitable growth medium. Available topsoil may be placed in areas requiring additional soil growth medium.

Other Facilities. All other miscellaneous disturbances such as fences, water lines, sediment and diversion structures would be reclaimed. Reclamation would entail removing water lines, minor regrading and revegetation of disturbances. Sediment structures would be filled in to promote natural runoff and the areas stabilized with waste rock to enhance erosional stability. The shop, office, equipment lay down area and other miscellaneous disturbance areas would be reclaimed by dismantling and removing buildings, foundation removal (if high above reclamation grades) or burial, ripping of compacted surfaces, regrading and revegetation.

Overhead lines and poles used to distribute electrical power for the project would be removed upon reclamation, and the powerline corridor would be revegetated with native species. The power-generating equipment on site would be salvaged and removed, with the generator pad regraded, covered with soil and revegetated.

Water supply and monitoring wells on YMC's private land include YMC-02, YMC-04, YMC-05 and YMC-06. These wells would be sealed after the post-closure monitoring period, unless they were to be used as future water supply sources. YMC-06 would be mined through in the first year of operations.

YMC's plans for wells on public land call for all wells that are not assigned to the BLM for multiple-use purposes to be sealed by a drilling contractor certified by the state according to abandonment procedures set forth by the ADWR. Wells on public land include:

- ♦ Monitoring wells YMC-01 and YMC-03: The BLM would make a determination of use of these wells after the post-closure monitoring period.
- ♦ Observation wells TW-02 and TW-03: The BLM right-of-way (No. AZA-29209) expired in October 1997. These wells are not proposed for groundwater monitoring use. They will be abandoned in accordance with ADWR procedures and BLM stipulations for reclamation.
- ♦ Water supply Well TW-01: The BLM would make a use determination at the end of operations.

The water supply line storage tanks, pumping stations and pipelines would be removed when water is no longer needed on the site.

2.1.7.3 Reclamation Planning and Scheduling Considerations

YMC proposes to perform reclamation to re-establish a productive environment to allow for grazing, wildlife habitat and other land uses. As such, the reclamation plan has been developed to achieve the following objectives.

- ♦ Ensure public safety, reduce or eliminate adverse environmental impacts and reduce unsightly visual effects.
- ♦ Re-establish a stable environment that would support a diverse self-sustaining vegetation community consistent with post-mining land uses.
- ♦ Minimize off-site impacts by controlling infiltration, erosion, sedimentation and related degradation of existing drainages.

Erosional Stability. Diversion channels would be constructed prior to commencement of operations and would remain following reclamation. These channels are intended to intercept upgradient runoff and, following reclamation, collect runoff from the reclaimed surfaces and divert the combined flow to natural drainages. It is proposed that the regrading would be conducted to minimize erosion by reducing the surface slopes similar to the adjacent undisturbed areas.

Site runoff from the disturbed areas would be diverted to sediment retention structures downstream from the north and south WRDs. Runoff would be retained in these sediment retention structures prior to controlled discharge. Runoff from undisturbed areas on site would be diverted off site along the NWRD and along the west side of the solution storage ponds. Upon regrading, sediment retention structures would be backfilled. Proper grading would then allow for natural drainage patterns.

Revegetation. Once regrading of the various facilities is completed, certain areas may be ripped to provide a suitable growth medium prior to placement of topsoil, addition of soil amendments and seeding. Topsoil stripped prior to commencement of operations may be re-applied to disturbed areas to assist in the development of a self-sustaining vegetation community. Alternatively, amendments may be incorporated into the regraded surface materials to create a suitable growth medium. A baseline study of vegetation at the proposed mine site was conducted in 1993. Based on the results of this study, vegetation species were selected for use in revegetation of the disturbed areas (see Table 2-6).

Stripping and Salvage of Soils for Reclamation. The baseline soil survey of the proposed mine site (Walsh 1994) identified four horizons that contain between four and 30 inches of topsoil suitable for reclamation. All of the projected disturbed areas would be stripped of topsoil. However, areas on steep slopes and bouldery areas of the site would have selective soil stripping due to the inaccessibility of equipment.

The topsoil would be stockpiled at the locations shown in Figure 2-2 or at additional smaller locations on site. The stockpile locations were selected to be close to the facilities to be reclaimed but in protected areas out of major drainages. The stockpiles would be constructed with 30 percent slopes (or less steep) and seeded with a native grass mixture to minimize erosional loss of topsoil.

TABLE 2-6
Reclamation Seed Mix for Proposed Yarnell Project

Scientific name	Common name	Variety	Application rate pounds PLS/acre
Shrubs (seed 4-5)			
Acacia greggii	Catclaw acacia		1
Baccharis sarothoides	Desert broom		1/4
Cercocarpus montanus	Mountain mahogany		1
Eriogonum fasciculatum	Bush buckwheat		1/4
Gutierrezia sarothrae	Snakeweed		1/2
Rhus trilobata	Squawbush		1/2
Yuccas/Nolinas (seed both)			
Nolina microcarpa	Beargrass		1/2
Yucca baccata	Banana yucca		1/2
Perennial grasses (seed 6-8)			
Aristida purpurea	Purple threeawn		4
Bouteloua curtipendula	Sideoats grama	Niner	4
Bouteloua gracilis	Blue grama	Hachita	4
Eragrostis intermedia	Lovegrass		1/2
Festuca arizonica	Arizona fescue	Redondo	4
Koeleria cristata	June grass		1/2
Muhlenbergia wrightii	Shrike muhly	El Vado	3
Setaria macrostachya	Bristlegrass		3
Sitanion hystrix	Squirreltail		3
Sporobolus cryptandrus	Sand dropseed		1/2
Trichachane californica	Cottontop		4
Forbs (seed 3-4)			
Artemisia ludoviciana	Wormwood		1/16
Baileya multiradiata	Desert marigold		1/8
Cassia covesii	Desert senna		1/2
Eschscholtzia mexicana	Mexican gold poppy		1/2
Castilleja integra	Paintbrush		1/16
Sphaeralcea grassulariaefolia	Globemallow		1/2

Testing would be performed during the life of the mine to evaluate the suitability of rinsed heap materials and waste rock for direct revegetation. In addition, varying thicknesses of topsoil would be evaluated to determine the most efficient soil depths for revegetation.

YMC would comply with the Arizona Native Plant Act by salvaging and transplanting protected species of prickly pear cactus, yucca and beargrass on site. An area near the topsoil stockpile would be dedicated as a plant nursery and maintained as such. During reclamation, these plants would be re-planted. Alternatively, the Native Plant Act includes a provision to allow a commercial nursery to take the plants for resale. There is no permit required to move the plants out of areas to be disturbed and transfer them to another area on the project site, i.e., a nursery or undisturbed area.

Reclamation Schedule. Approximately seven years would be required (two years for decommissioning and reclamation and five years of observation and monitoring) to complete reclamation activities including monitoring of the site to ensure that revegetation and water quality goals are achieved. The relatively compact nature of the project and the six-year life span of the mine indicate that there would be a limited opportunity for interim or staged reclamation. The manner of heap construction and leaching and the end-dump construction of the waste rock dumps preclude the ability for interim reclamation. Because the NWRD would be filled to capacity before the end of mining, an initial phase of reclamation would begin at that time.

2.1.8 MONITORING

2.1.8.1 Revegetation

YMC proposes to conduct vegetation sampling of revegetated areas during the first three growing seasons following seeding. Plant cover would be sampled by the point intercept method or equivalent at random locations and at an intensity level that would provide a statistical representation. Cover data would be collected at the species level to determine whether desirable species have been established. Undisturbed reference areas may be selected for sampling to provide a representation of the undisturbed plant community. Reference areas would be sampled for cover using the same measurement techniques. YMC proposes that revegetation would be considered successful if, after three growing seasons, the revegetated site has an erosionally stable environment that would support a native vegetation community consistent with the post-mining land use. The BLM would make this determination based on field observations of the progress of growth of native species.

If this standard is not met in three years, YMC would consult with the Arizona Mine Inspector's Office and BLM to determine the best course of action to meet the revegetation goal. Bonds posted by YMC would not be released unless revegetation was successful. If unsuccessful, the bonds would be used by the BLM and Arizona Mine Inspector's Office to hire a contractor to perform the necessary work.

Following closure and reclamation, observations would be made concerning invasion by noxious weeds and the occurrence of rill and gully erosion. This monitoring period would be for up to five years. Noxious weeds would likely be overgrown by native species. If not, artificial means of control, such as herbicide, would be used. Sites exhibiting severe gully erosion would be stabilized and reseeded at the earliest opportunity to prevent site deterioration. Areas of unsatisfactory plant establishment would be sampled, amendments added if required and reseeding would take place in the first available planting season. Reclamation seed mix should be "Certified Weed Free." Revegetation monitoring would be performed annually for five years to determine if revegetation was successful and whether any erosion had occurred on reclaimed surfaces.

2.1.8.2 Water Quality

During operations, groundwater and surface water monitoring would be accomplished according to requirements established in the APP, including quarterly monitoring of the compliance well (YMC-03) and Cottonwood and Fools Gulch Springs (see Figure 2-2). Well YMC-03 was drilled in 1995 for groundwater characterization. It is southeast of the planned solution storage pond area and would be the point of groundwater monitoring compliance downgradient of the heap leach pad and solution storage pond area.

Water quality in existing wells YMC-01, YMC-02 and YMC-04 would be checked on an informational basis, but not used for groundwater monitoring. The subsurface drain outlet from the heap would be covered with permeable materials at reclamation to allow groundwater to seep from the drain but prevent disturbance of the drain outlet. The drain outlet would not be used as a monitoring point.

Water monitoring efforts, as required by terms of the APP, are summarized in Table 2-7. YMC would conduct the monitoring program and report the results to ADEQ. All samples would be sent to a state-certified laboratory for testing.

TABLE 2-7
Proposed Water Quality Monitoring Program Summary

Monitoring Point	Monitoring Frequency
YMC-03	Quarterly
Underdrain Sump	Quarterly or when water is present
Cottonwood Spring	Quarterly or when water is present
Fools Gulch Spring	Quarterly or when water is present

Post-mining groundwater monitoring would be conducted in compliance with ADEQ requirements in the APP.

2.1.8.3 Other Monitoring

During operations, air emissions would be monitored in accordance with air permit requirements. The structural stability, function and safety of all project structures and facilities would be monitored in accordance with APP permit requirements and standard engineering practices. The BLM would conduct at least four inspections per year to monitor compliance with the MPO. The BLM also would monitor compliance with the measures defined in the record of decision, the final MPO and the approved reclamation and closure plan.

2.2 ALTERNATIVES TO THE PROPOSED ACTION

CEQ regulations (Section 1502.14) require the EIS to examine reasonable alternatives to the proposed action. Alternatives to the proposed action were developed by the BLM after a detailed review of the MPO and a consideration of scoping comments provided by the public and other government agencies. Each alternative was evaluated against four criteria.

- Does the alternative meet the need of the project as stated in Chapter 1?
- Is the alternative technically feasible?
- Is the alternative economically feasible?
- Is the alternative environmentally advantageous?

Action alternatives that satisfied the above criteria and the no action alternative are described in detail in sections 2.2.1 through 2.2.3 of this chapter. Alternatives that did not satisfy the above criteria are briefly discussed in Section 2.2.5 of this chapter. These alternatives were eliminated from further study and are not analyzed in subsequent chapters.

Alternatives to the proposed action which are considered in detail in this EIS include:

- no action,
- elimination of the South Waste Rock Dump (SWRD) and consolidation of waste rock into the North Waste Rock Dump (NWRD) and
- elimination of the NWRD and consolidation of waste rock into the SWRD.

A summary comparing each of the project alternatives is presented below.

2.2.1 ALTERNATIVE 1 -- NO ACTION

The no action alternative serves as the baseline for evaluation of the potential effects of all other project alternatives. Under this alternative, the proposed action or other action alternatives presented within this EIS would not occur.

If no mining occurs, development and use of BLM-managed lands within the proposed project boundaries would be limited to existing uses, i.e., mineral exploration activities, livestock grazing, open space and other uses. Upon completion of mineral exploration, the associated disturbance areas would be reclaimed consistent with BLM guidelines. With no mine, existing resource values would remain in their current condition subject, however, to the actions and impacts of natural forces and ongoing mineral exploration and other previously approved activities. In addition, mining could legally be conducted on up to five acres of federal land under a notice(s) as acknowledged by the BLM. The BLM could not prevent the action, although it could work with the operator to mitigate adverse impacts and require reclamation bonding. While any potential adverse impacts related to the proposed action and alternatives could be precluded with the no action alternative, any economic benefits related to project development would also be lost.

However, the no action alternative does not necessarily preclude mining activities on project area lands which are not administered by the BLM. Mining could occur on private lands, with indirect impacts likely to occur on surrounding public land. Mining has been conducted in the past and could be conducted in the future without any approval by the BLM. With mining on private lands, existing resource values might not remain in their current condition.

2.2.2 ALTERNATIVE 2 -- ELIMINATION OF THE SOUTH WASTE ROCK DUMP AND CONSOLIDATION OF WASTE ROCK INTO THE NORTH WASTE ROCK DUMP

The project as proposed by YMC includes the disposal of roughly four million tons of waste rock at the NWRD and seven million tons of waste rock at the SWRD. Roughly one million tons of waste rock would be used as construction materials during initial mine development. The proposed north and south dump sites cover surface areas estimated at approximately 22 and 48 acres, respectively. Alternative 2 would eliminate the SWRD and confine waste rock disposal to the NWRD site. Other elements of the proposed project would remain the same under Alternative 2.

The proposed NWRD is in a valley at the upper end of the Yarnell Creek basin. Expansion of the NWRD would encounter the following conditions.

- Cottonwood Spring, Yarnell Creek and a delineated vegetated wetlands area are east of the dump site. The wetland occurs as a small linear strip along Yarnell Creek and extends through the northeast corner of the property for approximately 1,700 linear feet. The expansion would displace or eliminate the wetlands and sections of the creek and would bury Cottonwood Spring.
- A portion of Mina Road in the northeast corner of the property bisects the area of expansion.
- The proposed mine pit directly south of the dump site area precludes expansion to the south.

The benefits derived from elimination of the SWRD and expansion of the NWRD primarily consist of a reduction of the overall visual impact caused by project development and a decrease in the amount of surface area used for waste rock disposal. The total surface area used for waste rock disposal would be reduced to approximately 50 acres from the estimated 70 acres specified in the proposed action. However, expansion of the NWRD would require:

- diversion of approximately 1,200 feet of the Yarnell Creek channel,
- mitigation of impacts to Cottonwood Spring and wetlands, including site investigation and study, permitting and agency consultation and construction and remediation efforts,
- construction of approximately 4,000 feet of road to replace the existing road and to facilitate dump development and operation activities,
- construction, modification and maintenance of ancillary support structures such as sediment control and diversion structures and storm water detention ponds, and
- increased operating costs due to longer haul distance and reconstruction of Yarnell Creek and wetlands.

Figure 2-12 shows the expanded NWRD area and additional infrastructure associated with Alternative 2.

2.2.3 ALTERNATIVE 3 -- ELIMINATION OF THE NORTH WASTE ROCK DUMP AND CONSOLIDATION OF WASTE ROCK INTO THE SOUTH WASTE ROCK DUMP

The project proposed by YMC includes the disposal of roughly four million tons of waste rock at the NWRD and seven million tons of waste rock at the SWRD. The proposed north and south dump sites cover surface areas estimated at approximately 22 and 48 acres, respectively. Alternative 3 would eliminate the NWRD and confine waste rock disposal to the SWRD. Other elements of the proposed project would remain the same under Alternative 3.

The proposed SWRD site is at the head of the Fools Gulch valley southwest of the mine pit area. Disposal of all of the waste rock at the SWRD site would result in the following.

- The modified SWRD dump capacity would be raised by approximately 100 feet from an estimated elevation of 4,900 feet above MSL to an ultimate elevation of 5,000 feet above MSL. This would result in slightly greater visual effects from State Highway 89.
- Existing mining disturbances would remain. Under the proposed action, the NWRD would cover existing mill tailings and surface disturbance from previous mining activities, thereby enhancing the neutralizing capacity of the underlying tailing fluids and reducing the precipitation-induced moisture that comes into contact with the exposed tailings. The NWRD would also provide a flat area for parking and other facilities. These actions would not occur under Alternative 3.
- Increased operating costs due to longer haulage distance and increased dump height.

The primary benefits derived from elimination of the NWRD and expansion of the SWRD consist of a decrease in the amount of surface area used for waste rock disposal. Specifically, the total surface area used for waste rock disposal would be reduced from a combined 70 acres necessary for both sites (as specified in the proposed action) to approximately 48 acres. Design specifications for the SWRD support infrastructure are not expected to change significantly from specifications presented in the proposed action. Figure 2-13 shows the expanded SWRD site and associated infrastructure.

2.2.4 COMPARISON OF PROPOSED ACTION AND PROJECT ALTERNATIVES

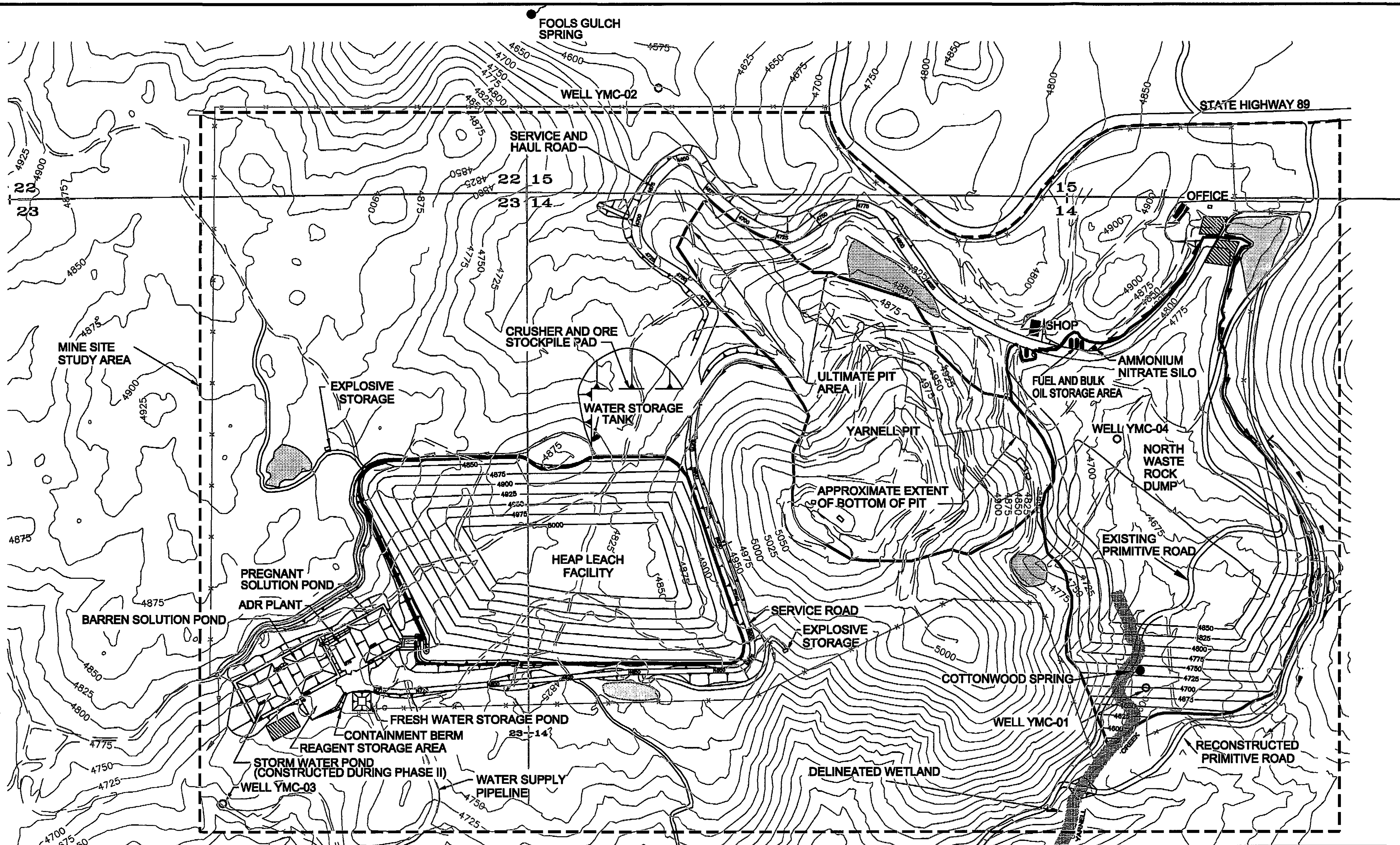
Table 2-8 provides a comparison of the proposed action and each of the project alternatives identified above, based on:

- area of disturbance (acreage used for waste rock disposal),
- significant modifications to the proposed action including wetlands mitigation and road relocation and
- cost percentage relative to the proposed action.

A detailed discussion of potential impacts within each resource category for the proposed action and the project alternatives is presented in Chapter 4.

2.2.5 ALTERNATIVES ELIMINATED FROM FURTHER STUDY

The scoping process identified a number of alternatives determined to be infeasible or otherwise unreasonable. All alternatives were evaluated based on technical and economic feasibility, the magnitude and scope of potential environmental impacts, and the ability to be permitted under current law. Alternatives that did not meet one or more of the above criteria were eliminated from detailed analysis.



MINE STIE STUDY AREA

SCALE IN FEET
200 0 400

NOTE:
TOPOGRAPHY AND ORIGINAL FACILITIES LAYOUT TAKEN FROM MINING PLAN OF OPERATIONS

LEGEND
RECLAMATION SOIL STORAGE AREA
SEPTIC SYSTEM LEACH FIELD
SEDIMENT RETENTION STRUCTURE
DIVERSION CHANNEL
BARBED WIRE PERIMETER FENCE

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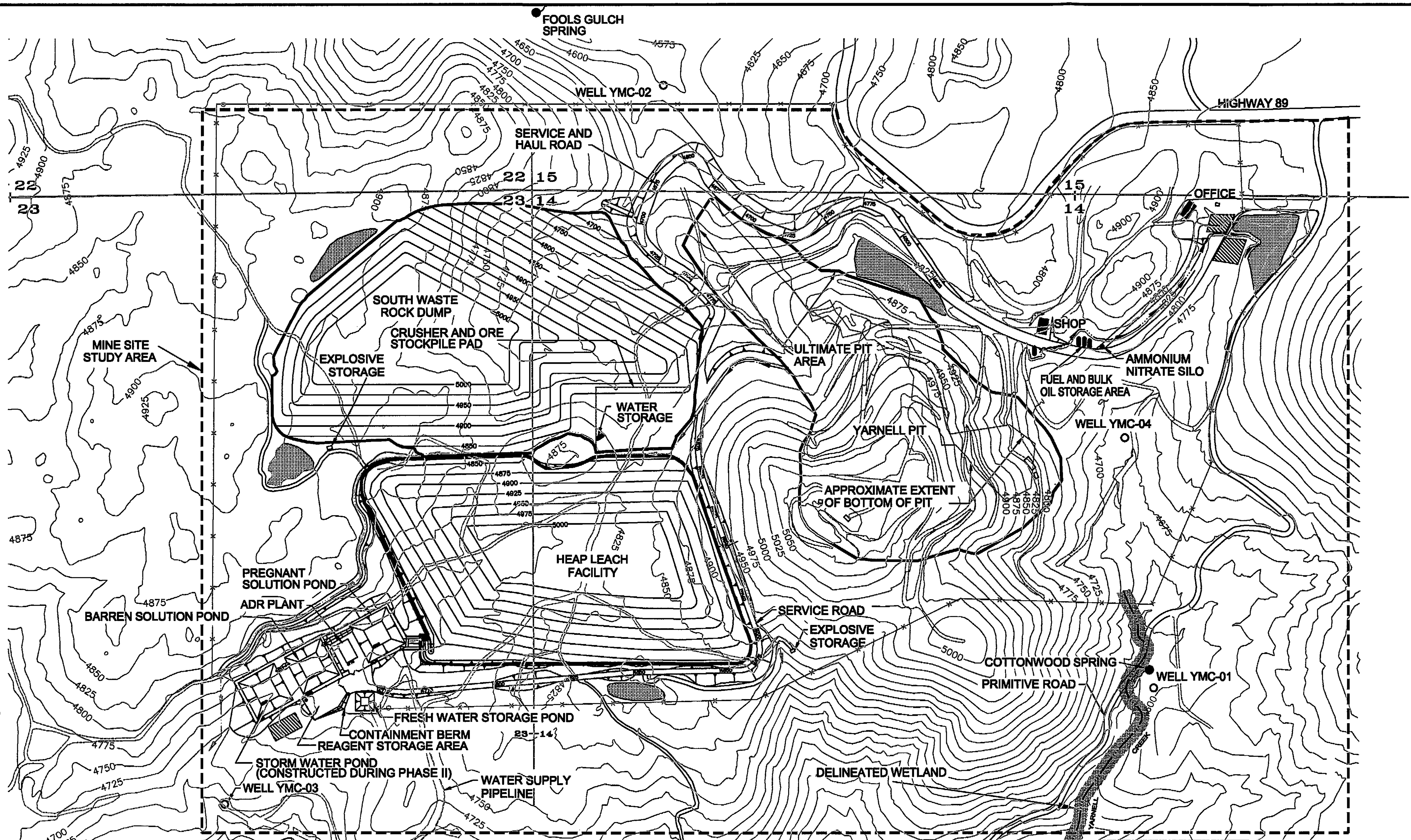
FIGURE 2-12
ALTERNATIVE 2
ELIMINATION OF THE SOUTH DUMP CONSOLIDATION OF WASTE ROCK INTO NORTH DUMP SITE



MINE SITE STUDY AREA

SCALE IN FEET
200 0 400

NOTE:
TOPOGRAPHY AND ORIGINAL FACILITIES LAYOUT TAKEN FROM MINING PLAN OF OPERATIONS 1995, UPDATED 1996.

LEGEND
- RECLAMATION SOIL STORAGE AREA
- SEPTIC SYSTEM LEACH FIELD
- SEDIMENT RETENTION STRUCTURE
- DIVERSION CHANNEL
- BARBED WIRE PERIMETER FENCE

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FIGURE 2-13
ALTERNATIVE 3
ELIMINATION OF THE NORTH DUMP
CONSOLIDATION OF WASTE ROCK INTO SOUTH DUMP SITE

The alternatives eliminated from further consideration fall into three categories.

- Changes in mining methods
- Changes in waste rock and processed ore disposal
- Changes in ore processing techniques

A discussion of the dismissed alternatives follows and a summary of the reasons for elimination is presented in Table 2-9.

2.2.5.1 Changes in Mining Methods

YMC has proposed the use of conventional surface open pit mining methods. Use of underground mining methods at the site could reduce environmental impacts and present an environmentally advantageous option. Potential environmental benefits include a lower overall tonnage of waste rock produced and elimination or reduction in size of the proposed open pit.

However, underground or a combination of underground and surface mining techniques would not be technically or economically feasible. Underground mining is typically suited to deep mineral deposits of high-grade veins or seams. Ore can be mined from underground workings (adits) driven along these deposits, leaving most of the host rock in place to support the overburden. However, the grade and distribution of gold within the remaining Yarnell deposit (residual from historic mining) is variable and disseminated (i.e., the gold occurs as small dispersed particles).

Historically, about 150,000 tons of ore at an average grade of 0.29 troy ounces per ton (opt) were mined from the Yarnell deposit. In the early 1940s, low-grade wall rock diluted the mining grade to 0.19 opt and mining ceased in 1942. YMC would recover an average grade of 0.035 opt by surface mining the disseminated deposit. There are no known remaining high-grade areas.

TABLE 2-8
Comparison of Proposed Action and Project Alternatives

Environmental criteria	Proposed action	Alternative 1	Alternative 2	Alternative 3
Acres of disturbance of waste rock dumps	70	Limited to existing uses	50	48
Significant modifications to the proposed action	Not applicable	Yes	Yes	Yes
Road relocation	No	No	Yes	No
Wetlands mitigation necessary	No	No	Yes[1]	No
Cottonwood Spring buried	No	No	Yes[2]	No
Dump height	As proposed	No dump	+ 100 feet[3]	+ 100 feet
Cost percentage[4] (relative to the proposed action)	0.0	Not applicable	+16.41%	+ 9.1%

[1] See Section 4.3.4 for discussion of impacts to wetlands.
[2] Cottonwood Spring would likely surface at the toe of the waste rock dump.
[3] Top of dump would remain at same elevation as proposed action, but dump would bottom about 100 feet lower thereby resulting in an overall increased bottom-to-top dump height of 100 feet.
[4] Project alternatives are based on the cost of the proposed action plus the additional expense (shown as a percentage relative to the proposed action) required for developing and implementing the alternative.

TABLE 2-9
Alternatives Eliminated From Further Study

Category	Alternative	Evaluation Criteria		
		Technically feasible[1]	Economically feasible[2]	Environmentally advantageous[3]
Changes in mining method	Underground mining methods	No	No	Yes
Changes in waste rock and processed ore disposal	Backfilling waste rock to the mine pit during mining	No	No	Yes
	Backfilling waste rock to the mine pit after completion of mining	Yes	No	Yes
	Transporting waste rock off-site	Yes	No	No
Changes in ore processing operations	Valley leach	Yes	Yes	No
	Vat leach	Yes	No	No
	Conventional milling	Yes	No	No
	Evaporative spray sprinklers	Yes	No	No

[1] Allows mining and/or processing to occur according to standard operations procedures based on location, type, extent and accessibility of ore.
[2] Allows mining and processing to occur in an environmentally sound manner without an excessive economic burden associated with non-standard operating procedures.
[3] Mitigates identified environmental effects without significantly increasing adverse effects to other resources or other areas.

Methods such as vein mining would not be feasible for recovery of the remaining deposit. The areas with sufficient grade to support these methods are not extensive and recovery of the reserves would be limited. Block caving is a method used to recover larger disseminated ore bodies. Adits and chutes for ore withdrawal are developed below the block to be caved. Support is removed from the block, causing it to cave; the waste material then caves and subsides as the ore is removed. If this method was used at Yarnell, control of ore near the hanging wall would be difficult. Mining would not be economical using block caving or any other underground mining method for the Yarnell deposit.

In addition, underground mining would reduce but not eliminate surface disposal of waste rock or processed ore, due to swelling and displacement (as much as 30 percent) of unconsolidated and broken rock. Underground extraction of gold ore is logistically unfeasible and uneconomical. Consequently, any potential alternatives involving underground mining have been eliminated from further consideration in this EIS.

2.2.5.2 *Changes in Waste Rock and Processed Ore Disposal*

YMC proposes two sites for disposal of an estimated 11 million tons of overburden waste rock and one site for the processing and disposal of approximately seven million tons of ore material. The three proposed locations (the leach pad and the NWRD and SWRD) were selected by YMC as the best ore processing and waste rock disposal sites from an operational perspective.

Backfilling Waste Rock to the Mine Pit. YMC proposes to partially backfill waste rock to the mine pit at the conclusion of mining. Additional backfilling of waste rock to the proposed open pit could reduce environmental impacts and present environmental benefits. Potential environmental benefits include a reduction in the size of the waste rock dumps, lessened visual impacts associated with a reduction in surface waste rock disposal and elimination or reduction in the size of the proposed open pit. However, the volume of waste rock and processed ore increases as much as 30 percent due to swelling. Consequently, complete backfilling of the pit would not eliminate the impact of aboveground ore and waste rock disposal.

Disadvantages associated with backfilling waste rock and processed ore include the following.

- Pit backfilling concurrent with mining or upon the completion of mining activities would result in extremely high costs, making the project economically infeasible.
- Pit backfilling during mining would make the project technically infeasible for the following reasons.
  - Mineralization in the proposed project area continues with depth, and modifications to the mining schedule could occur if mine reserves and/or the price of gold were to increase. The schedule for mining of selected locations within the pit can vary, dependent upon changes in mine reserves, exploration activities and fluctuations in the price of gold. Backfilling the pit could reduce or eliminate future flexibility to modify mining schedules, techniques and/or mining locations within the proposed pit design.
  - Mining would occur in a single pit and backfilling concurrent with operations is not feasible, due to the areal extent of the ore body and size limitations of the pit.

In any case, the heap leach and waste rock piles would still have to be constructed (as they are with permanent surface disposal) and mined materials could not be backfilled to the pit at least until the completion of mining activities. It may be technically feasible to backfill waste rock upon completion of mining activities. However, the heap leach materials cannot be backfilled until the heap has been completely detoxified. Thus, at a minimum, there would still be surface disposal of heap material and waste rock during mining activities, and heap leach material would remain on surface during the closure period.

Therefore, disposal alternatives including complete backfilling of waste rock and processed ore to the mine pit during and/or upon completion of planned mining operations were considered and rejected for full analysis within this EIS.

Transportation of Waste Rock to an Alternative Off-Site Location. During the site selection process for waste rock, YMC excluded areas further than two miles from the mine site from consideration due to excessive haul distances and public safety. Longer haul distances would result in higher fuel consumption, higher consumptive use of water for dust suppression on roads and higher maintenance costs for haul trucks.

Several potential waste rock disposal sites were identified within a two-mile radius of the mine. However, these sites were eliminated by YMC for the following reasons.

- Sites that would require transporting ore or waste rock through the communities of Yarnell and Glen Ilah were eliminated due to the increase in traffic and the corresponding noise, dust and other disturbances generated by the haul trucks.

- Sites that would require hauling ore or waste rock on State Highway 89, which is designed for automobile and commercial truck traffic, are not suitable for the large haul trucks (i.e., 60-ton dump trucks) required for project operations. The haul trucks would constitute a traffic hazard and have difficulty negotiating the steep grade of the highway.
- Operations in nearby areas of steep topography (with extended slopes of 3:1 or 33 percent) are hazardous and would present major logistical problems in engineering and reclamation. The expense associated with this approach renders the project uneconomical and infeasible for reclamation purposes.
- Areas along the bottom of major washes (lower Yarnell Creek, Antelope Creek and Fools Gulch) would require construction of new haul roads and impact surface water runoff into the headwaters of these creeks during storm events. This option likely could not be permitted by regulatory agencies.
- Development of waste rock dumps on private surface lands is not an option due to the lack of nearby available land suitable for siting waste rock dump facilities and the cost associated with land lease or purchase expenditures.

Therefore, transportation of waste rock to off-site locations would be economically infeasible and result in a greater magnitude of environmental impacts. This alternative has been eliminated from further consideration.

2.2.5.3 Changes in Ore Processing Operations

Alternatives for gold recovery and extraction were considered. However, YMC's metallurgical testing of samples taken from the Yarnell deposit indicated that the oxide ores from the deposit are amenable to heap leaching. Other extraction and recovery systems are not technically, economically or environmentally feasible as summarized below.

Valley Leach. A valley leach system contains leach solutions within the heap rather than in an exterior pond. The leach pad consists of a lined basin inside a perimeter or valley embankment. The liner and monitoring system for a valley leach system are typically more extensive than for a conventional leach pad because solutions are contained within the heap. This is due to the potential for leakage from the zone of saturation or head above the liner.

Valley leach systems are often used at sites where there is insufficient space for a conventional leach pad and exterior ponds. The proposed Yarnell Project area has sufficient space to accommodate a conventional leach pad and pond system. This allows for the design of a system with features that minimize the potential for leakage from the buildup of solution from the zone of saturation above the liner. Because of this environmental disadvantage, the valley leach alternative was eliminated from further consideration.

Vat Leach. Vat leaching is similar to heap leaching, but it is conducted in large, shallow tanks. When ore in the vat has been leached, it is rinsed and then disposed of, and the vat is reloaded. It is an appropriate technique to use with ores having rapid gold dissolution rates and/or for sites which would not accommodate leach pads. The amount of leached ore residue produced is the same as in heap leaching. However, double handling of the material is required with associated increases in power consumption. This alternative does not present environmental or economic advantages over the proposed method and has been eliminated from further consideration.

Conventional Mill Flotation. Conventional milling generally consists of reducing the ore to fine grain or sand size particles that liberate minute gold particles. The finely ground particles are mixed in a slurry with water and chemical reagents in large tanks. Surfactant reagents are used to form a froth to which the gold and/or gold-bearing sulfide particles attach and gold is then extracted from the froth. This method is generally suited for some ores that contain appreciable quantities of sulfide minerals. The Yarnell ore is primarily made up of oxide minerals and is not well suited for this type of extraction process. In addition, the conventional milling process requires considerably greater energy than the heap leach process and the process produces wet tailings that would require appropriate tailings containment facilities. Therefore, conventional milling has no environmental or economic advantage over the proposed heap leach process and is not suitable for the Yarnell Project.

Use of Evaporative Spray (Impact) Sprinklers for Sodium Cyanide Solution Application. Evaporative spray sprinklers can function as an effective and efficient method for applying sodium cyanide solution to leach pads. The solution is distributed through an array of pipes on top of the heap and is applied as a spray through attached sprinkler heads. Evaporative spray sprinklers are generally used in areas with sufficient water supplies. The proposed Yarnell Project is in an arid area with limited water resources, where use of this method would result in excessive evaporation and corresponding loss of water. To conserve water, the proposed action specifies the application of cyanide solution via drip emitters, similar to drip irrigation systems used in agriculture.

In addition, the Yarnell MPO proposes that the ore be placed on a prepared pad by end dumping from a 40-ton mine haul truck. The ore would then be pushed upward by dozer into a succession of lifts approximately 20 feet high. Drip emitters would then be evenly placed on each lift. When using this construction technique, the drip emitter would ensure an even and uniform distribution of cyanide solution throughout the heap. Generally, evaporative spray sprinklers are used on projects that place ore through the use of conveyors and pivoting radial stackers. The stacker system produces a heap that is steeper and less compacted than a bench-and-lift style design. Due to the difference in compaction and heap configuration, application of spray systems on a bench- and-lift design would most likely result in solution pooling and inefficient percolation rates. In addition, stacker systems are generally used on mining projects of much larger magnitude than the proposed Yarnell Project. This alternative would not be economically feasible or have environmental advantages and has been eliminated from further consideration.

2.3 SUMMARY COMPARISON OF THE PROPOSED ACTION AND ALTERNATIVES

Table 2-10 summarizes and compares the environmental impacts among the proposed action and alternatives considered in detail in this EIS. Detailed descriptions of impacts, mitigation measures and residual effects are contained in Chapters 4, 5 and 6.

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Topography	Changes in Land Forms	Topography near the heads of Yarnell Creek and Fools Gulch would be altered by placement of NWRD, SWRD, pit, roads and heap leach facility	No effect on existing conditions	• Topography at the head of Fools Gulch would not be altered by the SWRD • NWRD would modify topography of an additional 28 acres within the Yarnell Creek drainage • Height of NWRD would increase 100 feet	• Topography of upper Yarnell Creek would not be altered by the NWRD • SWRD at the head of Fools Gulch would increase by 100 feet in height • An additional 20 acres of steep slopes would be created
Geology and Mineral Resources	Availability of Geological Resources and Geological Risks	• Planned recovery of about 180,000 ounces of gold, depleting the mineral resource • No other identifiable geological changes or risks	• Ore body would remain in place • Exploration may continue • Plans for a similar operation on private land may be developed	Same as proposed action	Same as proposed action
Soils	Availability and Productivity of Soils	• Disturbance of soil characteristics in the 201-acre disturbed area • Conversion of 46 acres to 50 percent slopes • Increased erosion • No topsoil on 35 acres of open pit and permanent roads • Loss of up to one-half of soils on steep slopes and boulder areas (not salvageable)	No effect on existing conditions	• About 20 fewer acres of soils would be disturbed • Loss of hydric soils associated with wetland • Approximately 30,000 more cubic yards of salvageable topsoil compared to proposed action	• About 22 fewer acres of soil would be disturbed • Steep slopes would occupy about 20 additional acres • Decrease in salvageable topsoil by 24,000 cubic yards compared to proposed action

Note: The primary source of cumulative effects for each resource area is the proposed action itself. Therefore, cumulative effects are not included in this table.

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Water Resources - Surface Water	Heap Leach Facility	• During operations, about 45 acres would no longer drain to Yarnell Creek • Tom Cat Tank, a range improvement, would be buried • A catastrophic event could cause release of contaminated solution to areas outside the facility	No effect on existing conditions	Same as proposed action	Same as proposed action
Water Resources - Surface Water	Waste Rock Dumps (WRDs)	• Drainage patterns would be permanently altered • About 37 acres of Fools Gulch drainage would be permanently diverted to Yarnell Creek • Seepage could appear at the toe of the dumps • Seepage could increase temporarily from the historic tailings • Increased sedimentation could occur during large precipitation events • Low potential for acid mine drainage	No effect on existing conditions	• Surface water and groundwater resources in Fools Gulch would not be affected by the SWRD • Increased erosion may occur from reconstruction of 1,200 feet of Yarnell Creek and the added area of steep slopes of expanded NWRD • Cottonwood Spring would be buried by the expanded NWRD	• Surface water and groundwater resources in Yarnell Creek would not be affected by construction of NWRD • About 20 additional acres of steep slopes would be created and potential for erosion would be increased

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Water Resources - Surface Water	Mine Pit	• Water would be collected in pit and then drain into Fools Gulch • About 15 acres of Yarnell Creek drainage would be diverted to Fools Gulch • Sediment loads could be increased, but water quality should not be degraded	No effect on existing conditions	Same as proposed action	Same as proposed action
Water Resources - Surface Water	Roads and Other Disturbances	• Drainage patterns would be permanently altered but would have little impact on water quality • Peak flows and runoff may differ from undisturbed conditions • Sediment loads could be increased from large storm events	No effect on existing conditions	Roads and other disturbance would differ slightly but impacts would be similar to proposed action	Roads and other disturbance would differ slightly but impacts would be similar to proposed action
Water Resources - Surface Water	Water Supply Wells and Pipelines	• Water levels near Cottonwood Spring could be lowered by 15 feet. • Cottonwood Spring could dry up or reappear downstream. Flows of streams and other springs would not be affected. • Water quality of streams and springs would not be affected.	No effect on existing conditions	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Water Resources - Groundwater	Heap Leach Facility	• Flow or depth to groundwater should not be significantly affected • Minimal impact on quality due to facility design and low hydraulic conductivity and transmissivity of the system • The ADEQ required discharge impact analysis resulted in 75-acre area within which TDS would exceed background level • A catastrophic event could cause the release of contaminated solution that could degrade water and soil quality down-gradient of facility	No effect on existing conditions	Same as proposed action	Same as proposed action
Water Resources - Groundwater	Waste Rock Dumps	• Seepage from historic tailings to bedrock may increase slightly, but then decrease below current rates • Impacts to groundwater flow and occurrence would be negligible • Geochemical testing indicates waste rock is inert and impacts to water quality should be minimal	No effect on existing conditions	Similar to proposed action	Seepage from historic tailings would be unaffected

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Water Resources - Groundwater	Mine Pit	• Pit water inflows would not be expected to affect groundwater quantity and flow direction due to low yield and lack of hydraulic connection within the fracture flow system • No significant impacts are anticipated because little water ponding would be expected and geochemical testing indicated that no acid generation would occur • Permanent drawdown surrounding pit in MSA	No effect on existing conditions	Same as proposed action	Same as proposed action
Water Resources - Groundwater	Water Supply Wells	• Based upon pump test results, water levels would decline adjacent to water supply wells, but no private wells would be affected. However, long-term pumping potentially could impact the Wilhite and Arrowhead Cafe wells • Based on modeling, drawdowns of approximately 5 feet at the Wilhite Well and 15 feet at Cottonwood Spring could occur • Water levels would slowly recover after pumping is discontinued and return to near pre-mining levels about two years after cessation of operations. • Well production would not affect ground-water quality • Cottonwood Spring could be impacted over the short term	No effect on existing conditions	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Water Resources - Waters of the U.S.	Dry Stream-beds and Desert Washes	Proposed facilities would affect about 2,550 feet of streambed in the MSA, of which 1,000 feet affected by the solution pond would be mitigated upon reclamation	No effect on existing conditions	About an additional 900 feet of streambed designated as Waters of the U.S. would be buried by the expanded NWRD	The NWRD would not fill about 900 feet of streambed delineated as Waters of the U.S.
Water Resources - Waters of the U.S.	Wetlands	• Delineated wetlands along Yarnell Creek and Fools Gulch would not be affected by project facilities • Pumping of water supply well YMC-04 combined with pit dewatering may adversely impact Cottonwood Spring and the associated delineated wetland	No effect on existing conditions	• Cottonwood Spring and approximately 800 feet of the Yarnell Creek delineated wetland would be buried • An additional wetland area would be damaged by construction of the sediment retention structure and other activity	Same as proposed action
Vegetation	Chaparral and Desert Vegetation Type	• Disturbance of 182 acres of vegetation at the mine site and an additional 18 acres along the pipeline corridor • Permanent loss of about 7 acres of vegetation in the pit area • Long-term loss of vegetative productivity and cover, especially on steep slopes	No effect on existing conditions	• About 20 acres less vegetation disturbed compared to proposed action • Destruction of a 0.1-acre delineated wetland	• About 22 acres less vegetation would be disturbed compared to the proposed action • About 20 additional acres would be reclaimed on steep slopes that would be difficult to establish productivity and diversity compared to the proposed action
Vegetation	Protected Plants	16 species of plants protected by the Arizona Native Plant Law occur in areas that would be disturbed and could be impacted	No effect on existing conditions	Same as above	Same as above

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Wildlife	Habitat Loss	• Loss of 182 acres of habitat • Elimination of current underground mine workings habitat for bats • Fragmentation of about 100 acres of undisturbed habitat • Adverse effects on wildlife from increased competition in undisturbed areas	No effect on existing conditions	• Habitat disturbance reduced by about 20 acres compared to proposed action • Loss of delineated wetland • Sedimentation could affect habitat for lowland leopard frog and Arizona Southwestern toad	Habitat disturbance reduced by about 22 acres compared to proposed action
Wildlife	Direct Mortality	• Less mobile species and bats could be killed by construction of mining activities • Loss of several dozen birds, reptiles and small mammals annually from exposure to CN solutions • Loss of animals struck by vehicles on mine roads	No effect on existing conditions	Same as proposed action	Same as proposed action
Wildlife	Threatened, Endangered and Sensitive Species	Desert tortoise and chuckwallas could be killed or injured by mining activities or activities along water supply corridor	No effect on existing conditions	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Air Resources	• Particulate Matter (PM_{10}) • Oxides of Nitrogen • Carbon Monoxide • Sulfur Dioxide • Hydrogen Cyanide • Mercury	Total concentrations of each emission type would not exceed regulatory standards	No effect on existing conditions	Total air quality impacts would be similar to or slightly less than those for the proposed action for each emission type	Total air quality impacts would be similar to those for the proposed action for each emission type
Air Resources	Visibility	Short-term, intermittent and localized visibility degradation may occur in the project vicinity during periods of high winds or very stable atmospheric conditions	No effect on existing conditions	Same as proposed action	Same as proposed action
Air Resources	Public Health	Risk of exposure to Hantavirus and Valley Fever from particulate emissions would be low	No effect on existing conditions	Same as proposed action	Same as proposed action
Land Use, Transportation and Access	Conformance with BLM and County Land Use Plans	• In conformance with BLM land use plan except for VRM objectives • Not in conformance with county conceptual plan • In conformance with Arizona law (ARS 11-830) exempting mining facilities larger than five acres from county zoning	No effect on existing conditions	Same as proposed action	Same as proposed action
Land Use, Transportation and Access	Land Use Compatibility	Conversion of project area from open space/wildlife habitat to mining resulting in conflict with nearby residential areas	No effect on existing conditions	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Land Use, Transportation and Access	Access To and Within Project Area	• Access to project area restricted • 10-minute delays along State Highway 89 during blasting events	No effect on existing conditions	Same as proposed action	Same as proposed action
Land Use, Transportation and Access	Grazing	• Restricted access to 300 acres of Congress allotment • Loss of Tom Cat Tank stockpond • Short-term loss of access to Cottonwood Springs pool	No effect on existing conditions	Permanent loss of access to Cottonwood Spring pool	Same as proposed action
Land Use, Transportation and Access	Traffic Flow and Safety	• Effects from project-related traffic would be minimal • Slight increase in potential for accidents	No effect on existing conditions	Re-routing of Mina Road	Same as proposed action
Visual Resources	Conformance with VRM Objectives and Effects on Views	• Strong visual contrast from 4 of 7 KOPs, not in conformance with VRM objectives • Major sources of visual effect are mine pit and waste rock dumps	No effect on existing conditions	Overall visual effect would be slightly less than proposed action since SWRD would be eliminated	Overall visual effect would be slightly greater than proposed action since SWRD would be larger

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Cultural Resources	Effect on Quality of Cultural Resources and Eligibility for NRHP Listing	• Historic Biedler Mine and Edgar Shaft would be directly impacted, but these resources have been fully documented • Yarnell Overlook, a historic Native American site, would not be directly impacted but adverse effects could occur from artifact collection or site disturbance • Mina-Genung Road is NRHP-eligible, but would not be impacted (outside disturbance area) • Historic Yarnell Mine site would be affected, but has poor integrity and identified cultural resources are documented	• No impact from proposed action • Deterioration of the sites would continue • Alteration or destruction of sites could result from mining exploration and actions of recreationalists	• Bielder Mine site would not be disturbed • The overall number of sites and isolated occurrences destroyed would be reduced compared to proposed action, but resources have been fully documented and little additional information would be gained • Relocation of the eligible Mina-Genung Road would affect its integrity of place (one of the qualities making it eligible), a significant impact to this site	Overall number of sites and isolated occurrences that would be destroyed would be reduced compared to proposed action, but resources have been fully documented
Noise	Increased Noise Levels	• Major increase in noise levels in areas adjacent to mine site • Increase at some receptors in Glen Ilah could exceed EPA's criteria for human health and welfare	No effect on existing conditions	Higher noise levels at one receptor location compared to the proposed action	Reduced noise levels at two receptors compared to the proposed action
Blasting	Ground Motion	Ground motion would not occur at a level to cause damage to the nearest residences and other structures	No effect on existing conditions	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Blasting	Flyrock, Dust and Gas	• Flyrock would be a hazard mainly to mine personnel and equipment • Off-site damage would be unlikely • Dust from blasting would dissipate but would be noticeable to residences • Carbon dioxide and nitrogen oxides would result from blasting, but these gases would dissipate quickly	No effect on existing conditions	Same as proposed action	Same as proposed action
Blasting	Annoyance	• Vibration, airblast and traffic delays would cause annoyance to persons near the mine site • Degree of effect would be subjective	No effect on existing conditions	Same as proposed action	Same as proposed action
Blasting	Falling Rocks and Boulders	• Blasting operations could increase rock movement and add to the existing falling rock problem along State Highway 89 • Degree of hazard is unknown, but no property damage would be expected and potential hazards should not increase near Glen Ilah residences	No effect on existing conditions	Same as proposed action	Same as proposed action
Hazardous Materials	Spill and Exposure Potential	Minor increase in potential effects to the public and environmental resources such as water, air, vegetation and wildlife	No effect on existing conditions	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Socioeconomics	Study Area and Assumptions	• Socioeconomic effects would occur in both Yavapai and Maricopa counties • Primary study area is Yarnell because it is more vulnerable to growth • ESTIMATES BELOW ARE WITH BASE CASE ASSUMPTIONS SPREAD OVER ENTIRE TWO-COUNTY STUDY AREA (YAVAPAI AND MARICOPA COUNTIES)	• No effect on existing economic conditions • Lost opportunity for expanded employment and income • Existing conflict over social and economic pros and cons of mining will remain for some period of time	Same as proposed action	Same as proposed action
Socioeconomics	Employment	• An estimated 100 construction and 91 operations direct workers • Peak of 44 indirect workers	Same as above	Same as proposed action	Same as proposed action
Socioeconomics	Income	An estimated $3.9 million annually in total direct and indirect income during operations phase	Same as above	Same as proposed action	Same as proposed action
Socioeconomics	Population	• An estimated 36 new residents during construction • 74 new residents during operations	Same as above	Same as proposed action	Same as proposed action
Socioeconomics	Housing	• Need for an estimated 24 additional units during construction • 26 units needed during operations • Some properties near mine site may drop in value	Same as above	Same as proposed action	Same as proposed action

TABLE 2-10
Summary of Potential Effects of Proposed Action and Alternatives (Continued)

Environmental Resource	Resource Subtopic/Issue	Effects from Proposed Action	Effects from Alternative 1 (No Action)	Effects from Alternative 2 (Eliminate SWRD)	Effects from Alternative 3 (Eliminate NWRD)
Socioeconomics	Demand for Public Services	• Negligible increase in new demand for public services because population increases over large study area are small • Largest effect may be in area of public safety services in Yarnell area (responsibility of County Sheriff's Office)	Same as above	Same as proposed action	Same as proposed action
Socioeconomics	Tax Revenues	• YMC would pay severance, property, income and sales taxes – revenues from project should cover any new public sector costs • Since Yarnell is in unincorporated Yavapai County, the county would be the primary affected jurisdiction	Same as above	Same as proposed action	Same as proposed action
Socioeconomics	Social Effects/Quality of Life	Major adverse effects on some residents' perceived quality of life – effects would vary among persons and be based on group and individual values, goals and beliefs	Same as above	Same as proposed action	Same as proposed action
Socioeconomics	Environmental Justice	• Projected effects would be greatest in areas closer to the mine, which do not include any specifically identified minority or low-income populations • Any minority or low-income persons or groups would not be disproportionately affected	Same as above	Same as proposed action	Same as proposed action

2.4 AGENCY PREFERRED ALTERNATIVE

This draft EIS presents descriptions and analyses of four alternatives, including YMC's proposed action. The BLM will not reach a final decision to select a specific agency-preferred alternative at this early stage of analysis. Section 1502.14(e) of the CEQ regulations requires that the agency identify its preferred alternative in the final EIS. However, Department of the Interior policy (516 DM 4.10A) requires the identification of a preferred alternative in the draft EIS, unless another law prohibits such an expression. This requirement applies whether a project is initiated by the agency or the agency is responding to a proposal from an external entity.

The following considerations relate to defining an agency-preferred alternative in this draft EIS. In the case of a proposed mining plan, the no action alternative can be defined as the preferred alternative only in the event of a determination that the project would cause undue or unnecessary degradation of surface resources on public land. To date, the BLM has made no formal determination. Among the other three alternatives, the proposed action is the BLM's preliminary identification of an agency-preferred alternative.

In the final EIS, the BLM may modify the alternatives analyzed in the draft EIS, develop additional alternatives if justified by public comments or new information, change the identification of its preferred alternative or maintain the preliminary identification. After the publication of the final EIS, the BLM must a issue a record of decision documenting the decision made and the rationale for the decision.

CHAPTER 3

AFFECTED ENVIRONMENT

3.0 AFFECTED ENVIRONMENT

This chapter describes the existing condition of the area that would be affected by the proposed Yarnell Project. This information is presented primarily to assist the reviewers in understanding the environmental consequences of the proposed action and selected alternatives as presented in Chapter 4, Consequences of the Proposed Action and Alternatives. Descriptions of resources focus on specific issues or topics that would potentially be affected by mining and ore processing and water supply activities.

The current physical, biological, economic and social attributes and conditions of the ecosystem in and surrounding the proposed project area have been described by resource specialists based on intensive ground surveys of the area and laboratory evaluations.

The chapter is organized by elements of the human and physical environment including:

- physiography, topography, geology and soils,
- water resources,
- biological resources (vegetation and wildlife),
- air resources,
- land use,
- visual resources,
- cultural resources,
- transportation,
- noise and
- socioeconomic conditions.

These elements relate directly to the issue categories identified in Section 1.5. Relevant issues such as cyanide management and reclamation are addressed as they relate to specific elements of the human environment (e.g., wildlife). Elements of the human environment which do not exist in the project vicinity are not discussed in this EIS. These include:

- Areas of Critical Environmental Concern designated by the BLM,
- Eligible or Congressionally Designated Wild and Scenic Rivers,
- Congressionally Designated Wilderness Areas and
- Prime Farmlands

Whenever possible, the basic dynamics of the natural environment are described to establish the interrelationships of the resources and to establish a basis for analyzing the impacts that would result from the proposed activities.

For certain resources, such as soils, vegetation and cultural resources, the environmental study area was considered to be essentially the area of potential direct disturbance. However, the study area for these disciplines was increased to approximately 400 acres to include the immediate vicinity of the proposed mine site and an additional 18.5 acres along the proposed water supply pipeline corridor to allow for refinements in the proposed surface disturbance as the MPO was being completed. For other resources, such as wildlife, visual resources and socioeconomics, a regional environmental study area was used to encompass the potential off-site aspects of issues related to these resource categories. The environmental study area for each resource encompasses the area within which most potential direct and indirect effects to a specific resource would be expected to occur.

For clarification purposes, the following definitions apply throughout this chapter.

- Mine site study area (MSA): the specific area (approximately 400 acres) within which all surface disturbance and development activities would occur, either for the proposed action or selected alternatives (see Figure 3-1).
- Water resources study area (WRSA): the environmental study area established for water sources and use areas within a reasonable distance from the mine site:
  - north and west of the mine site to include the towns of Yarnell and Glen Ilah,
  - about four miles east of the mine site to include Antelope Creek and several perennial springs and
  - about three and one-half miles south of the mine site to include the town of Stanton and the Parker Dairy.

Environmental studies of the site have been completed by many technical specialists for a number of resources and conditions. Because many of the studies used in the preparation of the EIS are lengthy and technical in nature, the results are summarized for disclosure within this EIS. Documents incorporated by reference are available for public review at the BLM's Phoenix Field Office. Selected studies also are available for review at the Yarnell Public Library.

3.1 PHYSIOGRAPHY, TOPOGRAPHY, GEOLOGY, SOILS

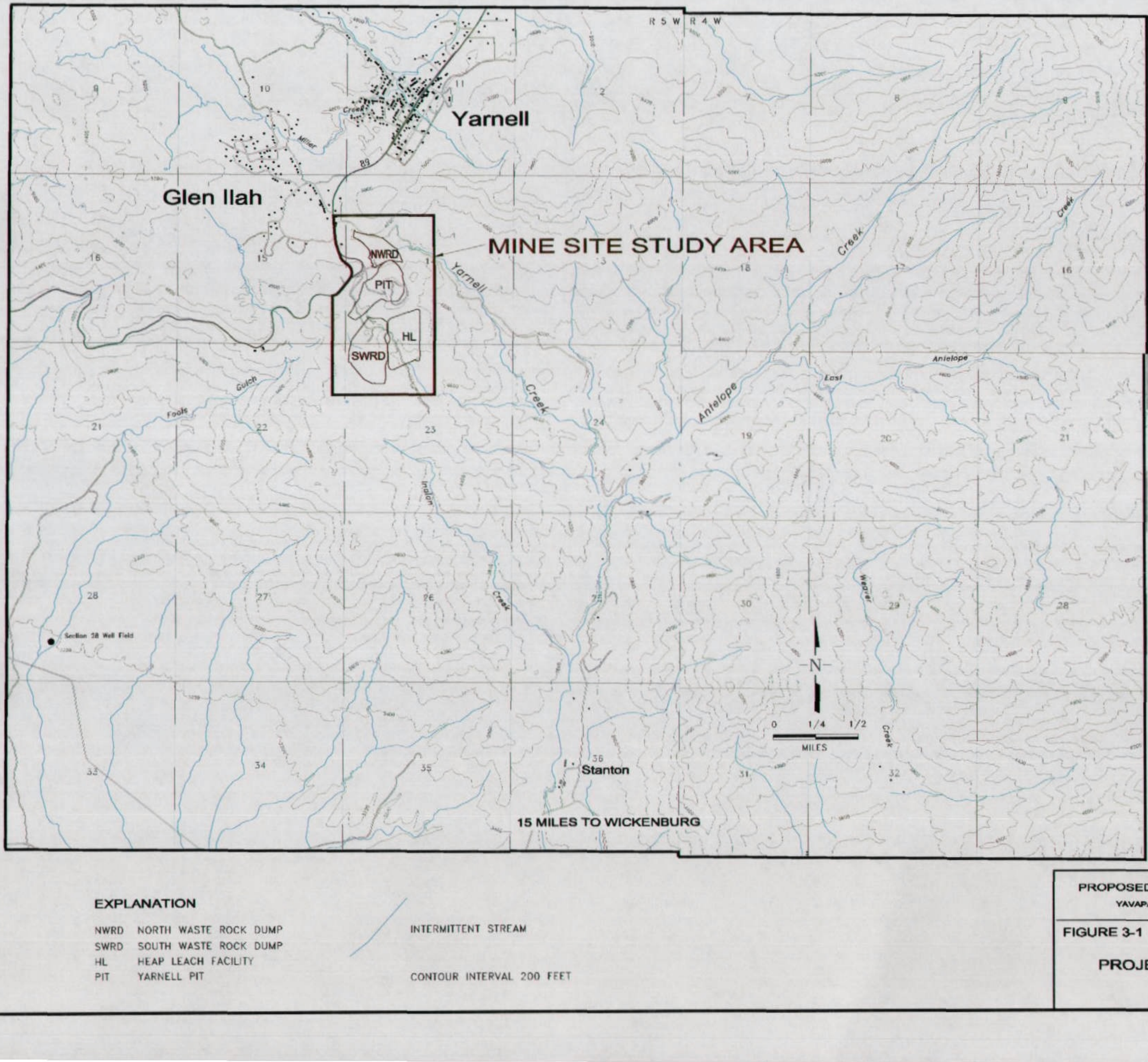
3.1.1 PROJECT LOCATION AND PHYSIOGRAPHY

The proposed Yarnell Project is on the southern slope of the Weaver Mountains of Yavapai County, Arizona, along the southern boundary of the Transition Zone (Pierce 1985). This physiographic province is so named because it is between the Colorado Plateau and the Basin and Range physiographic provinces. The Transition Zone extends about 350 miles across the central part of Arizona and averages about 50 miles in width. It has been informally termed the central mountain region because of its topographic diversity which includes steep canyons and high mountain peaks.

3.1.2 TOPOGRAPHY

The topography of the area is characterized by the steep upper slopes of the Weaver Mountains, with steep hills and relatively flat saddles near drainage divides.

The elevations range from about 3,240 feet above mean sea level (MSL) at the south end of the water supply corridor to 5,100 feet MSL in the southernmost part of the MSA to about 6,000 feet MSL in the northeast. The MSA is on the south slope of the Weaver Mountains and straddles the proximal end of a major ridge running south of the main mountain range. Areas proposed for water supply pipeline corridors extend to well fields in mountainous terrain to the east and to the relatively flat plain below to the west and south of the mountains. Local topography includes a steep knoll that rises 300 feet above the surrounding



EXPLANATION

NWRD NORTH WASTE ROCK DUMP
SWRD SOUTH WASTE ROCK DUMP
HL HEAP LEACH FACILITY
PIT YARNELL PIT

INTERMITTENT STREAM

CONTOUR INTERVAL 200 FEET

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-1

PROJECT VICINITY MAP

terrain to an elevation of 6,000 feet. This conical hill, the site of past mining activity, occupies about one-half of the MSA and has steep slopes to the north and east, and a gentler topography to the west and south. The slopes range from the relatively gentle saddle at the south end of the MSA to the 66-percent slopes draining eastward into Yarnell Creek. The slopes draining to Yarnell Creek are typically 40 to 60 percent while the slopes draining into Fools Gulch at the western end of the area are shallower, ranging from approximately 20 to 40 percent. The south half of the MSA is characterized by numerous small, knobby outcrops of granite amid a relatively rolling topography.

Yarnell Creek, an ephemeral (only flows part of the year, such as during major precipitation events) tributary to Antelope Creek, drains southeast across the MSA, north of the conical hill. North of Yarnell Creek, the lower south-facing slopes of Antelope Peak extend into the MSA. The upper reaches of Fools Gulch and a tributary to Fools Gulch each originate on the western portion of the MSA and flow westward. Cottonwood Canyon Creek is a tributary to Fools Gulch and flows south from the MSA. Numerous dry, sand washes flow southward from the Weaver Mountains into and across the flat plains.

The pipelines proposed for water supply, as shown previously in Figure 2-9, include an eastern corridor and a western corridor. The east pipeline corridor rises 760 feet in elevation from a low of 4,040 feet along Yarnell Creek to a high of 4,800 at the eastern MSA boundary. The west pipeline corridor rises 1,360 feet in elevation from a low of 3,240 feet at the south well field to a high of 4,600 feet at the western side of the MSA boundary. The west pipeline corridor, from the south well field to the west well field, crosses five dry washes in a landscape with only minor topographic relief along sandy, often braided, channels. Proceeding north, the corridor follows Fools Gulch, crosses braided channels and rises about 600 feet in elevation to cross a west-extending slope of the Weaver Mountains. North from this point, the corridor is within a dry stream channel for about 1,000 feet, follows an old dirt road east for about 2,000 feet, proceeds further east along the steep slopes of the Weaver Mountains, re-crosses Cottonwood Canyon Creek, proceeds east paralleling Fools Gulch, crosses a south-flowing tributary to Fools Gulch and, finally, crosses the western MSA boundary.

3.1.3 GEOLOGY

3.1.3.1 Regional Geologic Setting

The geologic structure of the Transition Zone is complex and characterized by intense deformation, as is evident by the foliated and deformed rock outcrops. These rocks expose some of Arizona's oldest geologic history. A regional geologic map inclusive of the area within the boundary of the WRSA is presented in Figure 3-2. A geologic cross section running roughly perpendicular to the overall structure of the WRSA and inclusive of the MSA is presented in Figure 3-3.

Most of the southern and western portions of the WRSA are underlain by Precambrian Age (over 1,400 million years old), intrusive igneous rocks that range in composition from granite to granodiorite. These rocks are subdivided into the Yarnell granodiorite (Ygd), the granodiorite of Wilhoit (Xgdw), the granite of Antelope Creek (Xga), undifferentiated granitic rocks (Xgu) and the granite of Rich Hill (Xgrh). Less than a mile from the MSA, the igneous granitic rocks intrude into even older, metamorphosed sedimentary rocks

(Xpel and Xms) and metavolcanic rocks (Xmv) of the Bradshaw Mountains Group.

There is a gap in the geologic record between the Precambrian and the Tertiary Ages. In the time period from about 25 to 45 million years before the present, lava flows and deposits of sediment were laid on top of the Precambrian rocks. These much younger, Tertiary Age volcanic rocks (Tb), interbedded volcanic and sedimentary rocks (TVS) and sedimentary rocks (Tls and Ts) are shallow dipping and undeformed. They cap the mountains in the northeastern quarter of the WRSA. The volcanic rocks are predominantly basaltic and andesitic flows with localized rhyolite flows and tuffs. The sedimentary rocks are composed of fine-grained lake sediments and coarser fluvial sediments and channel gravels.

Recent (less than one million years old) unconsolidated to semi-consolidated alluvial sediments ranging in age from Pleistocene to Holocene were deposited in the southwestern corner of the WRSA. Recent alluvial sediments are also found as minor, discontinuous lenses along the stream valleys that drain the WRSA. The alluvial sediments are composed of poorly-sorted mixtures of sand and gravel within a clay matrix. Cobble-size material is common in the alluvium. The recent sediments thicken southward from a featheredge along the mountain front to approximately 1,000 feet at the southern edge of the WRSA.

3.1.3.2 Geologic Structure and Seismicity

Structural features include probable faults and fracture zones. Four distinct fracture trends have been identified. The oldest trend runs northwest to southeast. Although moderate to intense fracturing is present, fractures are usually very small to closed.

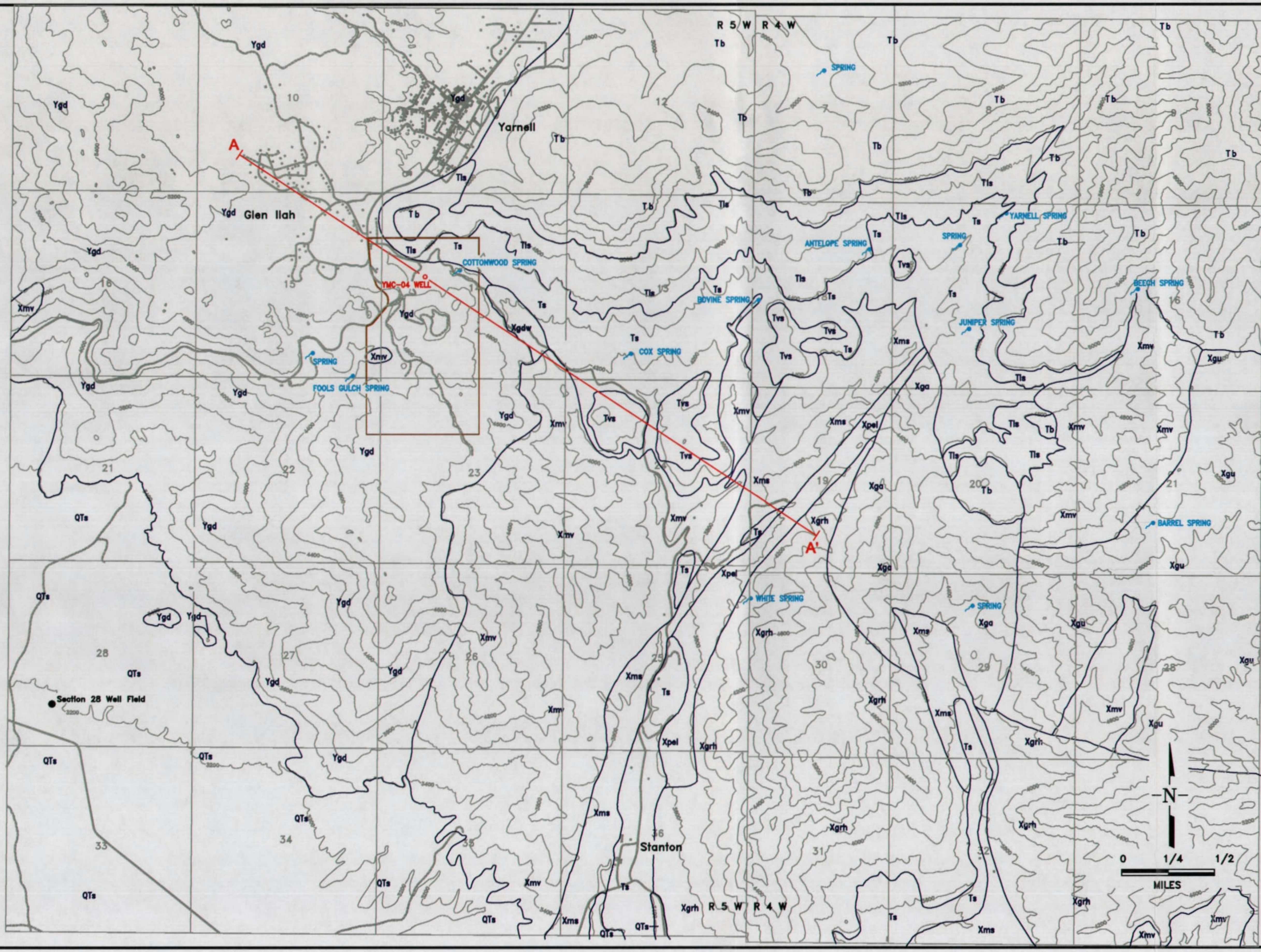
The Yarnell Fault is related to one of the major northeast-trending lineaments. The fault can be traced over two miles in the vicinity of the proposed mine site and dips approximately 30 to 50 degrees to the northwest as shown in Figure 3-3.

A band of intense deformation corresponds closely to the metasedimentary and metavolcanic rock outcrops. This band is characterized by intense sub-vertical, northeast-striking mylonite foliation, tight folds and northeast-plunging lineations among other shear zone features. The axis of Antelope Creek transects much of the deformed zone.

The proposed project is in an area of low seismicity, as shown from generalized maps in ICBO (1991), U.S. Army Corps of Engineers (1982) and Algermissen et al. (1982). From information in Euge et al. (1992), the site is within the Arizona Mountain Zone area. Recorded seismic activity in the area has been limited to events along the Verde Fault Zone and an isolated event (1976) in the Prescott area. The maximum acceleration from seismic activity that would be expected to recur every 50 years and 250 years is 0.05g and 0.11g, respectively (g is the acceleration of gravity) (Algermissen et al. 1982).

3.1.3.3 Geology and Mineralization of the Mine Site Study Area

The Yarnell ore deposit is contained in the Precambrian Age, intrusive igneous rock, informally termed the Yarnell Granite by Anderson (1989) and more formally designated the Granodiorite at Yarnell by DeWitt (1989). Gold mineralization in the orebody



EXPLANATION

SPRINO

LITHOLOGIC CONTACT (APPROXIMATE LOCATION, SHOWN AS SOLID LINE FOR VISUAL CLARITY)

LINE OF GEOLOGIC PROFILE

MINE SITE STUDY AREA

CONTOUR INTERVAL 200 FEET

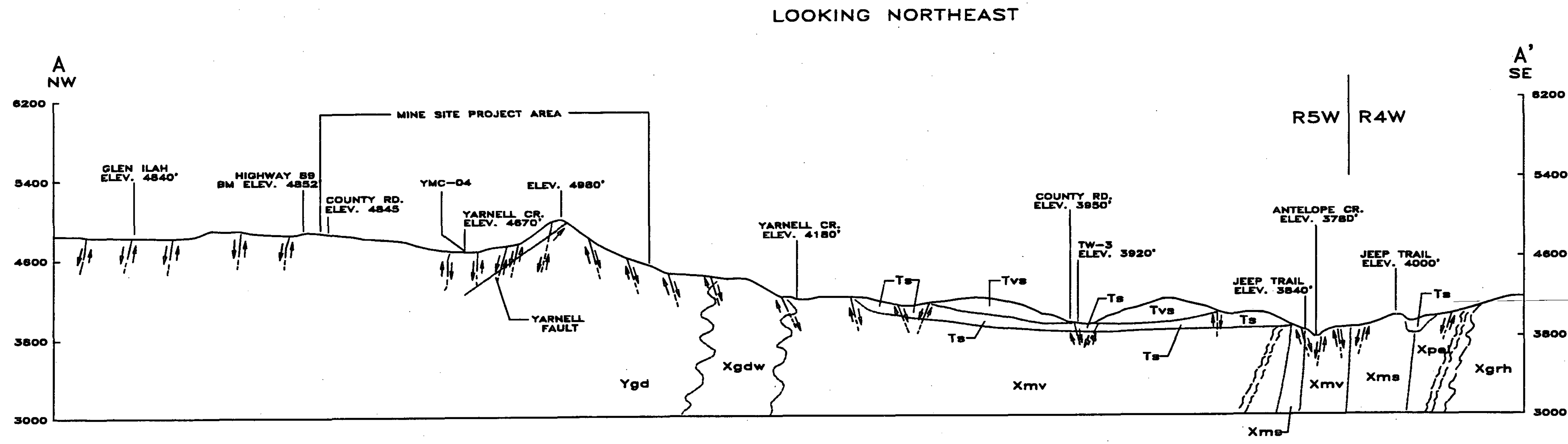
QTs	Alluvium, Colluvium and older surficial deposits
Tb	Basaltio Rooks
Tvs	Voloanio and Sedimentary Rooks
Tls	Fluvio—lacustrine Sedimentary Rooks
Ts	Sedimentary Rooks
Ygd	Granodiorite of Yarnell
Xgdw	Granodiorite of Wilhoit
Xga	Granitio of Antelope Creek
Xgu	Undifferentiated Granitio Rooks
Xgrh	Granitio of Rich Hill
Xpel	Pelitio Metasedimentary Rooks
Xms	Metasedimentary Rooks
Xmv	Metavoloanio Rooks

NOTE: SEE FIGURE 3—3 FOR GEOLOGIC CROSS SECTION A — A'

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

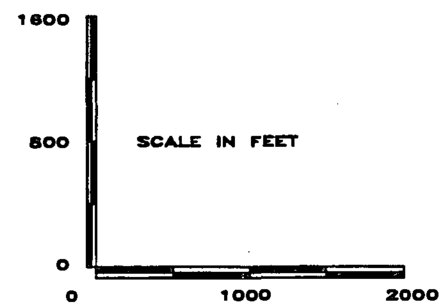
FIGURE 3-2

REGIONAL GEOLOGY MAP



EXPLANATION

- QTs — Alluvium, Colluvium and older surficial deposits
- Tb — Basaltic Rocks
- Tvs — Volcanic and Sedimentary Rocks
- Tls — Fluvio—lacustrine Sedimentary Rocks
- Ts — Sedimentary Rocks
- Ygd — Granodiorite of Yarnell
- Xgdw — Granodiorite of Wilhoit
- Xga — Granitic of Antelope Creek
- Xgu — Undifferentiated Granitic Rocks
- Xgrh — Granitic of Rich Hill
- Xpel — Pelitic Metasedimentary Rocks
- Xms — Metasedimentary Rocks
- Xmv — Metavolcanic Rocks



VERTICAL EXAGGERATION 1.25:1

Upward Thrust — Known Fault — Downward Thrust — Inferred Fault

NOTE: SEE FIGURES 3-2 OR 3-7 FOR CROSS SECTION LOCATIONS.

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-3

GEOLOGIC CROSS SECTION

is structurally controlled by the Yarnell Fault and confined to sheared rocks that have been hydrothermally altered. Faulting is believed to have occurred concurrently with gold mineralization about 69 million years ago (Page et al. 1994).

The mineralized portion of the fault zone is characterized by intensely sheared and hydrothermally altered gouge, mylonite, micro-breccia and quartz veining ranging in thickness from three to more than seven feet. In order of increasing alteration, these zones are propylitic, sericitic and potassic. The primary alteration mineral in all three zones is sericite. The highest grade gold mineralization occurs in the sericite-altered fault zone, where the primary igneous minerals have been altered to clayey minerals through the action of hydrothermal solutions. Gold is commonly associated with quartz veins in the altered zone. There are several generations of quartz veining, some of which contain iron-oxide (hematite) and iron-sulfide (pyrite). Lower grade gold mineralization is contained in a 150-foot-thick zone above the high-grade zone and is locally present in the footwall of the Yarnell fault.

The surrounding granodiorite is of uniform composition, containing microcline as the dominant feldspar mineral and biotite as the only mafic mineral. Total combined iron-oxide and iron-sulfide are generally low and only locally exceed four to five percent of the rock mass beyond the mineralized portion of the Yarnell Fault. Dikes and sills are associated with the orebody and represent intrusions of magma into the Yarnell Granodiorite. Many of the fractures and thin dikes in the proposed mine site area reflect the trend of the Yarnell Fault.

Monitoring well YMC-04 intercepts the mineralized area of the fault zone (Figure 3-3). The mineralization of the rock surrounding the YMC-04 well is reflected in a water chemistry signature that differs from the water chemistry and water quality found in other wells within the WRSA (a point that will be discussed in detail in the groundwater quality section of this chapter).

3.1.4 SOILS

Soil information for the proposed project is based on a detailed soil inventory by Walsh (1996). The inventory was a refinement of the USDA Soil Conservation Service (SCS) Order III soil survey for the western part of Yavapai County (USDA-SCS 1976). Areas to be potentially affected by mining were mapped at an Order I level and all other areas were mapped at an Order III level. Soils were mapped at a scale of one inch equals 2,000 feet, and soil descriptions were conducted in accordance with USDA standards (USDA, 1981 and 1983). Nine typical soil profiles within the MSA were described and sampled for laboratory analysis. Soil series, map unit descriptions and soil interpretation records for series and families potentially present in the permit area were obtained from the SCS to assist with soil identification, mapping and interpretation.

Soil information for the pipeline corridors is based on the Soil Inventory of the Water Pipeline Corridor Report (WER, 1996). This report was based on the Order III soil survey of the Western Part of Yavapai County, Arizona (USDA-SCS, 1976). No field verification was conducted along the pipeline corridors. In a few locations bordering the MSA, the soil map units were refined to correlate with the mapping units of the detailed MSA soil inventory.

The soils within the MSA originated from the weathering of the existing bedrock and rock formations, which are predominantly coarse-grained granites and granodiorites. Angular coarse-grained fragments of disintegrated granite underlie the soil substratum in most areas. The southern half of the MSA consists mostly of very shallow and shallow soils with abundant surface boulders. The northern half of the MSA has very shallow to moderately deep soils and few surface boulders. All soils at the MSA exhibit a low erosion potential because they contain a large proportion of rock fragments greater than two millimeters in diameter.

Soils along the northern segment of the pipeline corridor are predominantly shallow or very shallow and formed in place from granite and granodiorites. These soils are commonly associated with abundant surface boulders and rock outcrops. Soils along the southern segment of the pipeline corridor are generally deep and formed from mixed alluvium weathered from granite and basic igneous rocks or formed in place from basalt flows.

An area of existing mill tailings is in the upper portion of Yarnell Creek in the area of the proposed NWRD. These tailings are comprised of an upper and lower terrace and an area of the upper terrace covered with an existing crushed ore pile that was leached, and that is underlain by a thin geomembrane.

3.1.4.1 Soil Types

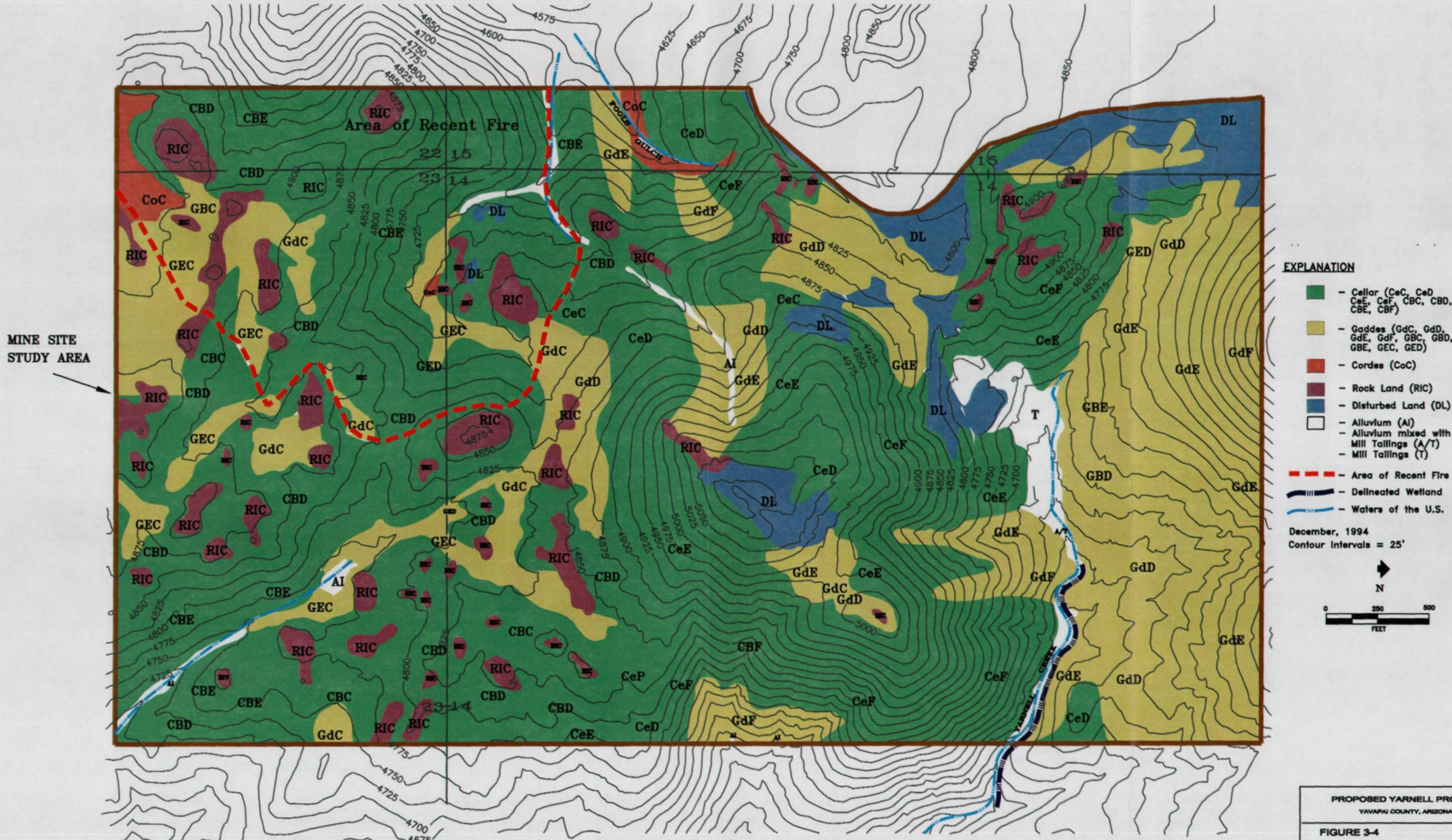
Soils within the MSA and along the pipeline corridors vary in age, depth and development. Very shallow and shallow soils are found on hills and rocky knobs and are the dominant soils in the MSA and along the northern segment of the pipeline corridors. On the southern half of the MSA, these soils are associated with abundant surface boulders and rock outcrops. These shallow soils are relatively young, do not possess distinct horizons and have a sandy texture and a near-neutral pH.

Older, moderately deep soils with strong profile development are found on slopes throughout the MSA, but are most common on the northern half. They also occur in wider drainageways, but are eroded. The moderately deep soils have a very gravelly sandy loam topsoil, a very gravelly, sandy clay loam subsoil and a pH range from 5.5 to 8.0. Soils within the MSA are both shallow and moderately deep, generally well-drained, deficient in nitrogen, but sufficient in phosphorus and potassium for natural vegetation on dryland sites. Deep, well-drained soils on alluvial fans and basalt flows occur along the southern segment of the western pipeline corridor. These soils commonly have a gravelly, coarse-loamy surface layer and a clayey or coarse-loamy subsoil that overlies a layer of lime accumulation.

Classifications of the soils occurring both within the MSA and along the pipeline corridors are presented in Table 3-1. The distribution of soils within the MSA and along pipeline corridors is shown in Figure 3-4 and Figure 3-5.

Characteristics of the MSA soil types include the following.

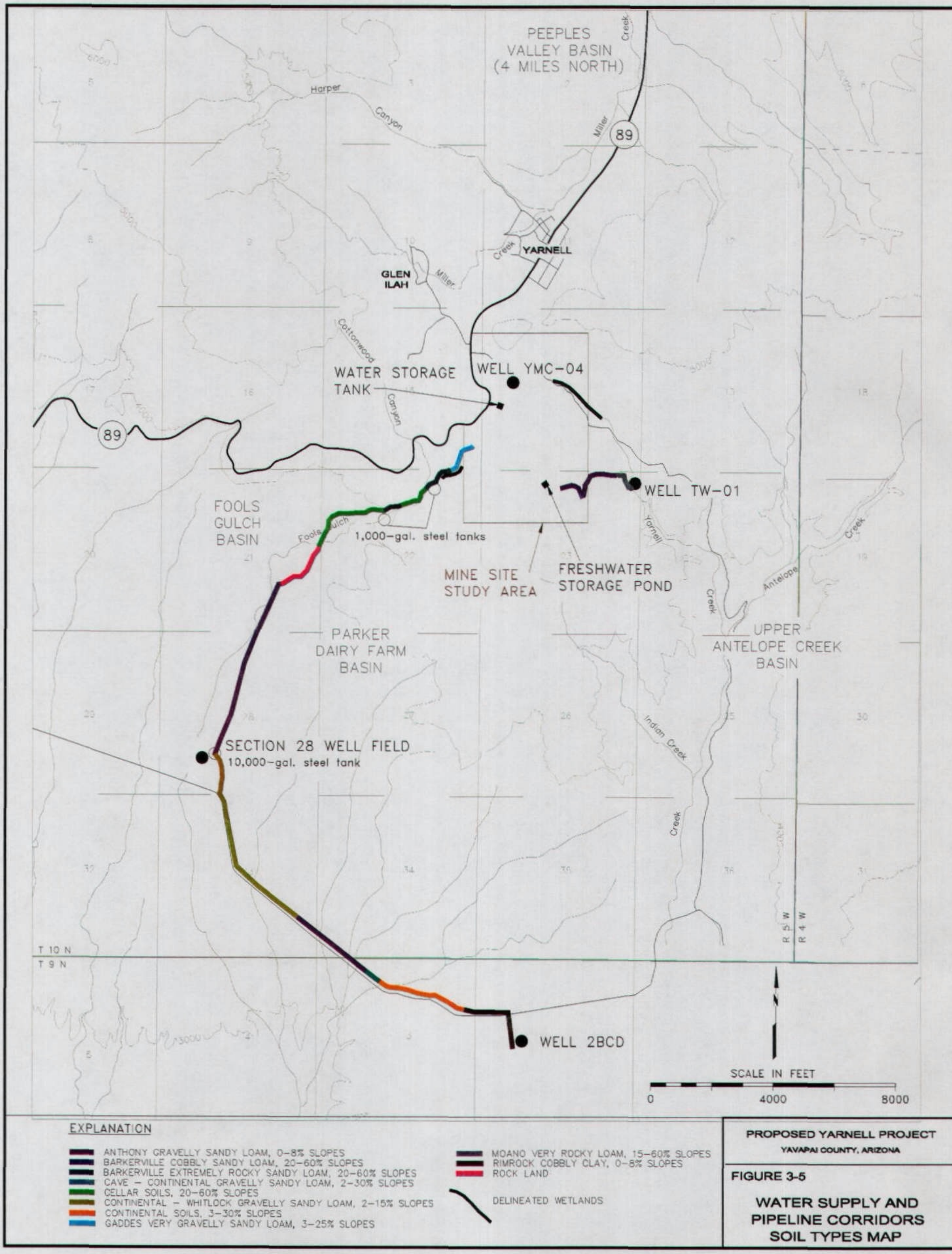
- ***Cellar soils (taxadunct).*** Cellar soils are shallow or very shallow, well-drained, formed over granite and occur on slopes ranging from four to 70 percent. Within the MSA, these soils have two to seven inches of very gravelly sandy loam or gravelly sandy loam topsoil overlying



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-4

MINE SITE STUDY AREA
SOIL TYPES MAP



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-5

WATER SUPPLY AND PIPELINE CORRIDORS SOIL TYPES MAP

TABLE 3-1
Classification of the Soils

Soil Name	Classification
Mine Site	
Cellar (taxadunct)	Loamy-skeletal, mixed, non-acidic, mesic, Lithic Torriorthents
Cordes	Coarse-loamy, mixed, non-acidic, mesic, Cumulic Haplustolls
Gaddes	Loamy-skeletal, mixed, non-acidic, mesic, Ustollic Haplargids
Pipeline Corridor	
Anthony	Coarse-loamy, mixed (calcareous), thermic, Typic Torrifluvents
Barkerville	Loamy, mixed, mesic, shallow, Udorthentic Haplustolls
Cave	Loamy, mixed, thermic, shallow, Typic Paleorthids
Cellar	Loamy-skeletal, mixed, non-acidic, thermic, Lithic Torriorthents
Continental	Fine, mixed, thermic, Typic Haplargids
Gaddes	Fine-loamy, mixed, mesic, Ustollic Haplargids
Moano	Loamy, mixed, non-acidic, mesic, Lithic Torriorthents
Rimrock	Fine, montmorillonitic, thermic, Typic Chromusterts
Venezia	Loamy, mixed, mesic, Lithic Haplustolls
Whitlock	Coarse-loamy, mixed, thermic, Typic Calciorthids

zero to 13 inches of very gravelly sand loam. Depth to hard bedrock is between three and 16 inches. These soils are the dominant soils of the site. Eight map units of Cellar soils occur on the site and are categorized by slope and the amount of surface boulders.

- **_Cordes._** Cordes soils are deep, well-drained, formed from alluvium and weathered granite and found on slopes ranging from four to 10 percent. Within the proposed project area, these soils have four to seven inches of loam or sandy loam topsoil overlying about 16 inches of sandy loam. The Cordes soil map unit is of very limited extent occurring on the site in drainageways and on gently rolling areas.
- **_Gaddes._** Gaddes soils are moderately deep, well-drained, formed from granite and occur on four to 70 percent slopes. Within the MSA, these soils have three to five inches of very gravelly sandy loam or gravelly loam topsoil overlying five to 25 inches of gravelly clay loam. Underlying this material is four to 24 inches of gravelly sandy loam. Granite bedrock is between 20 and 40 inches. These soils cover about one-quarter of the site. Nine map units of Gaddes soils occur at the site and are categorized by slope, amount of surface boulders and degree of erosion.
- **_Miscellaneous Map Units._** Five additional miscellaneous map units were recognized, including disturbed land, mill tailings, alluvium, alluvium mixed with mill tailings and rock land (rock outcrops).

Soils occurring along the pipeline corridors can be grouped as alluvial fan soils, basalt flow soils and hill soils. The alluvial fan soils include Anthony, Cave, Continental and Whitlock. These soils are well-drained, generally deep, commonly have lime accumulation in the subsoil and occur on alluvial fans with zero to 30 percent slopes. These soils are formed from mixed alluvium weathered from granite and basic igneous rocks.

Rimrock is the only soil belonging to the basalt flow soils. It is well-drained, moderately deep, formed in place on basalt flows with one to eight percent slopes and has a clayey texture. Hill soils include Barkerville, Cellar, Gaddes, Moano and Venezia. Also included with this group is rock land, which consists of rock outcrops and very shallow soils. The hill soils are very shallow to moderately deep, but are generally very shallow or shallow. They are well-drained, formed in place predominantly from granite and occur on hills with three to 60 percent slopes.

3.1.4.2 Soil Mapping Units

Soil mapping units were defined based on the above soil types in combination with slope, presence of surface boulders and degree of erosion. A total of 23 mapping units, five of which are miscellaneous map units, were delineated within the MSA (Table 3-2) and 12 map units were delineated along the pipeline corridors (Table 3-3).

TABLE 3-2
Soil and Miscellaneous Map Units of the Proposed Mine Site Study Area

Soil Map Unit Code	Soil Map Unit Name
CeC	Cellar very gravelly sandy loam, four to 15 percent slopes
CeD	Cellar very gravelly sandy loam, 15 to 25 percent slopes
CeE	Cellar very gravelly sandy loam, 25 to 45 percent slopes
CeF	Cellar very gravelly sandy loam, 45 to 70 percent slopes
CBC	Cellar very gravelly sandy loam, four to 15 percent slopes
CBD	Cellar very gravelly sandy loam, 15 to 25 percent slopes, bouldery surface
CBE	Cellar very gravelly sandy loam, 25 to 45 percent slopes, bouldery surface
CBF	Cellar very gravelly sandy loam, 45 to 70 percent slopes, bouldery surface
CoC	Cordes sandy loam, four to 10 percent slopes
GdC	Gaddes very gravelly sandy loam, four to 15 percent slopes
GdD	Gaddes very gravelly sandy loam, 15 to 25 percent slopes
GdE	Gaddes very gravelly sandy loam, 25 to 45 percent slopes
GdF	Gaddes very gravelly sandy loam, 45 to 70 percent slopes
GBC	Gaddes very gravelly sandy loam, four to 15 percent slopes, bouldery surface
GBD	Gaddes very gravelly sandy loam, 15 to 25 percent slopes, bouldery surface
GBE	Gaddes very gravelly sandy loam, 25 to 45 percent slopes, bouldery surface
GEC	Gaddes very gravelly sandy loam, four to 15 percent slopes, severely eroded
GED	Gaddes very gravelly sandy loam, 15 to 25 percent slopes, severely eroded
Soil Map Unit Code	**Miscellaneous Map Unit Name**
Al	Alluvium, five to 60 percent slopes
A/T	Alluvium mixed with mill tailings, five to 60 percent slopes
DL	Disturbed land
RlC	Rock Land - Cellar Complex, four to 70 percent slopes
T	Mill tailings

TABLE 3-3
Soil Map Units Along
the Water Supply Pipeline Corridor

Map Unit Code	Soil Map Unit Name
ApB	Anthony gravelly sandy loam, zero to eight percent slopes
BmF BoF	Barkerville cobbly sandy loam, 20 to 60% slopes Barkerville extremely rocky sandy loam, 20 to 60% slopes
ClD	Cave - Continental gravelly sandy loams, two to 30% slopes
CrF	Cellar soils, 20 to 60% slopes
CuC CwD	Continental - Whitlock gravelly sandy loams, two to 15% slopes Continental soils, three to 30% slopes
GdD	Gaddes very gravelly sandy loam, three to 25% slopes
MkF	Moano very rocky loam, 15 to 60% slopes
RkB	Rimrock cobbly clay, zero to eight percent slopes
Rr	Rock land
VrF	Venezia very stony loam, 30 to 60% slopes

3.1.4.3 Soil Suitability and Revegetation Potential

The suitability of a soil type for a particular use is rated on a relative scale. A low rating means the soil is ideally suited for the intended use; a moderate rating indicates constraints on the intended use that can be overcome through project design or management practices; and a severe rating indicates constraints on the intended use that can only be overcome with special designs and intensive management. An unsuitable rating implies that the soil constraints cannot be mitigated at a reasonable cost.

Topsoil Suitability. The term topsoil refers to soil material that is used to cover an area to improve soil conditions for establishing and maintaining vegetation. Generally, soils rich in organic matter make the best topsoil, but ease of excavation, loading and spreading were also considered in the ratings. Topsoil suitability was determined only for the soils occurring within the MSA.

Surface soils in the MSA are all moderately suitable for topsoil reclamation purposes, based on characteristics that affect plant growth, such as pH, soil texture, organic matter content, field estimated hydraulic conductivity, saturation percent and salinity, as well as ease of handling. Cellar soils contain about six inches of suitable topsoil and Cordes and Gaddes soils about 30 inches each. Only the surface layer of Cellar soils is deemed suitable topsoil, whereas the entire profile of Cordes and Gaddes soils is suitable. Suitable topsoil at the proposed mine is not abundant. The soils with the most available topsoil are also the least extensive.

Revegetation Potential. Revegetation potential refers to the ease in re-establishing or maintaining a vegetative cover under natural conditions after removal from the soil surface. The soils of the MSA exhibit a moderate to severe revegetation potential based on their capability of supporting the growth of grass and shrubs. The revegetation ratings are based on inherent soil fertility, erosional potential, shrink-swell potential, rock fragments, pH and slope. Cellar soils have a severe rating due to their low inherent fertility, and all soils on slopes of 60 percent or greater are rated severe for revegetation. All other soils at the site have a moderate revegetation potential.

3.2 WATER RESOURCES

3.2.1 SOURCES OF INFORMATION

Hydrogeologic data have been collected to characterize and evaluate the groundwater and surface water resources of the MSA and the Water Resources Study Area (WRSA). The proposed development activities and surface disturbance would occur within the MSA and pipeline and water supply corridors. The hydrogeologic conditions of the study areas have been evaluated using information from exploration borings, existing and new wells and private wells. This data falls into the following general categories.

- Pump tests and/or slug tests were conducted on eight wells in 1995-1996. These tests estimate the capacity of the rock units to store and transmit water. Appendix A lists the wells and the pump/slug test results.
- Groundwater levels were monitored in a number of wells from 1995-1998. Appendix B lists those wells and recorded groundwater elevations.
- Groundwater quality was monitored in a number of wells in 1995-1996. Appendix C lists those wells and the water quality of samples taken from those wells.
- Samples of waste rock and existing mill tailings were analyzed to evaluate their geochemical characteristics. The results are presented in Appendix D.
- Appendix E contains water rights information for groundwater (Table E-1) and surface water (Table E-2).
- A number of springs and streams were monitored for flow rate and/or water quality in 1996. Appendix F lists the water sources and the measurements recorded.

The hydrogeologic data used to characterize the existing water resources and use in the MSA and WRSA are documented in the following reports:

- Groundwater Resources Consultants, Inc. (June 1996) - Baseline hydrogeologic characterization report for the proposed Yarnell Mine Project.
- Shepherd Miller, Inc. (August 1995) - Baseline geochemical characterization report for the Yarnell Project.
- Shepherd Miller, Inc. (September 1995) - Baseline hydrologic characterization report for the Yarnell Project.
- Yarnell Mining Company (1994 updated in 1995 and 1996) Mining Plan of Operation for the Yarnell Project, Yarnell, Arizona.
- Shepherd Miller, Inc. (April 1996) - Facilities Design Report for the Yarnell Project.
- Shepherd Miller, Inc. (April 1996) - Facilities Summary Report for the Yarnell Project.

- ♦ Shepherd Miller, Inc. (October 1996) - Responses to ADEQ, comments on hydrologic and BADCT technical review of the APP application for the Yarnell Project.

3.2.2 SURFACE WATER OCCURRENCE, FLOW AND QUANTITY

3.2.2.1 Water Resources Study Area (WRSA)

Most of the WRSA is contained within the northwest corner of the Hassayampa River watershed; the northern edge of the WRSA is contained within the Bill Williams River watershed (Figure 3-6). The principal drainages in the WRSA are Antelope Creek, Fools Gulch and Weaver Creek, all of which are part of the Hassayampa River watershed. Drainages other than Antelope Creek were observed to be non-flowing, except near springs. Antelope Creek drains southward toward Wickenburg, merging with Fools Gulch about 18 miles south of the MSA and seven miles upstream of the confluence with the Hassayampa River. Antelope Creek drains into the Hassayampa River about two miles northwest of Wickenburg.

Antelope Creek. Antelope Creek drains an area of approximately 9.75 square miles before it joins Yarnell Creek. About 13 square miles are drained by Antelope Creek where it exits the southern boundary of the WRSA. Tributaries to Antelope Creek in the WRSA include East Antelope Creek, Yarnell Creek and Indian Creek. These flow seasonally in the winter and spring of some years. Summertime flows only occur sporadically following storm events and convey primarily surface runoff.

The only potentially perennial drainage reach within the WRSA is an approximately two-mile reach of Antelope Creek (Figure 3-6) extending upstream of the Michael Ranch (eastern border of Section 24) to the northeast quarter of Section 1 (GWRC June 1996). Groundwater discharge makes up the baseflow of the perennial reach.

Streamflow measurements for the Antelope Creek watershed began in December 1995 following the installation of three temporary gaging stations (Figure 3-6). Streamflow measurements for these stations are tabulated and presented in Appendix F.

In general, streamflows tend to peak in the winter and decline steadily during the spring. Flows at the lower gaging station on Antelope Creek ranged from 28 to 400 gallons per minute (gpm) from December 1995 through April 1996. Flows steadily declined from early April and by early June had decreased to about two gpm. Flows in upper Antelope Creek ranged from about 30 to 37 gpm from mid-March through mid-April 1996. By early June, the flow had decreased to about six gpm. Flows in East Antelope Creek ranged from 25 to 50 gpm from December 1995 through April 1996 and by early June, the flows and ponding had ceased.

Springs. Springs in the WRSA were identified by a review of the comprehensive surface water rights and claims database maintained by the Arizona Department of Water Resources, U.S. Geological Survey topographic maps, aerial photos and during field reconnaissance. Nine of the 15 mapped springs (Figure 3-6) are in the Antelope Creek watershed, two (Fools Gulch Spring and an unnamed spring) are within the Fools Gulch watershed, two are in the Bill Williams River watershed (Juniper Spring and a nearby unnamed spring) and two are in the Weaver Creek basin to the east of the Antelope Creek basin (Barrel Spring and an unnamed spring).

Historic spring flow data is not available. Flows were measured at eight of the nine springs within the Antelope Creek, Fools Gulch and Bill Williams River watersheds beginning in December 1995. The measurements are tabulated and graphed in Appendix F. Table 3-4 presents a summary of the locations, elevations, geology and flow ranges for the monitored springs.

3.2.2.2 Mine Site Study Area

Streams. The MSA is drained by Yarnell Creek to the east and Fools Gulch to the southwest. Approximately 55 percent of the MSA drains to Yarnell Creek; the remainder drains to Fools Gulch. Yarnell Creek discharges to Antelope Creek about 1.75 miles southeast of the MSA. The portion of the MSA that drains into Yarnell and Antelope creeks includes the proposed Heap Leach Pad and the North Waste Rock Dump (Figure 3-6). The South Waste Rock Dump would drain into Fools Gulch.

A 1,700-foot stretch of Yarnell Creek beginning in the area of Cottonwood Spring displays wetland-type features (see Section 3.2.8). Otherwise, the MSA drainage channels have no groundwater baseflow component and convey flow mainly as runoff from storm events.

Tom Cat Tank, a pond used for livestock watering, provides water seasonally.

Springs. Cottonwood Spring is within the limits of the proposed mine site at the intersection of Yarnell Creek and the contact between Tertiary sediments and Precambrian granite; its source is believed to be mainly from the TSV aquifer unit described in Section 3.2.5.1. Cottonwood Spring discharges peaked in the winter, gradually decreased through spring, and ceased to flow by early June.

TABLE 3-4
Summary of Spring 1996 Data

Name	Location	Elevation Feet (msl)	Geologic Unit	Flow Range 12/95 - 4/96 (gpm)*	Flow 6/96 (gpm)	Watershed
Yarnell	T10N, R4W, S17	5,780	Tb	51 to 63	19.5	Antelope Creek
Juniper	T10N, R4W, S17	4,520	Ts	3.6 to 6.4	4.0	Bill Williams River
Antelope	T10N, R4W, S18	4,400	Tls/Ts	3.8 to 5.3	0	Antelope Creek
Bovine	T10N, R5W, S13	4,240	Ts/Xmv	0.94 to 1.9	0 (ponding only)	Antelope Creek
Cox	T10N, R5W, S13	4,080	Ts	1.03 to 2.5	0.58	Antelope Creek
Cottonwood	T10N, R5W, S14	4,580	Ts/Ygd	0.36 to 5.0	0	Antelope Creek
White	T10N, R5W, S25	4,040	Xgrh	0.7 to 1.75	0.5	Antelope Creek
Fools Gulch**	T10N, R5W, S 5	4,540	Ygd	0.75 to 1.5	0.6	Fools Gulch

* gpm - gallons per minute
** Monitoring began in late March 1996

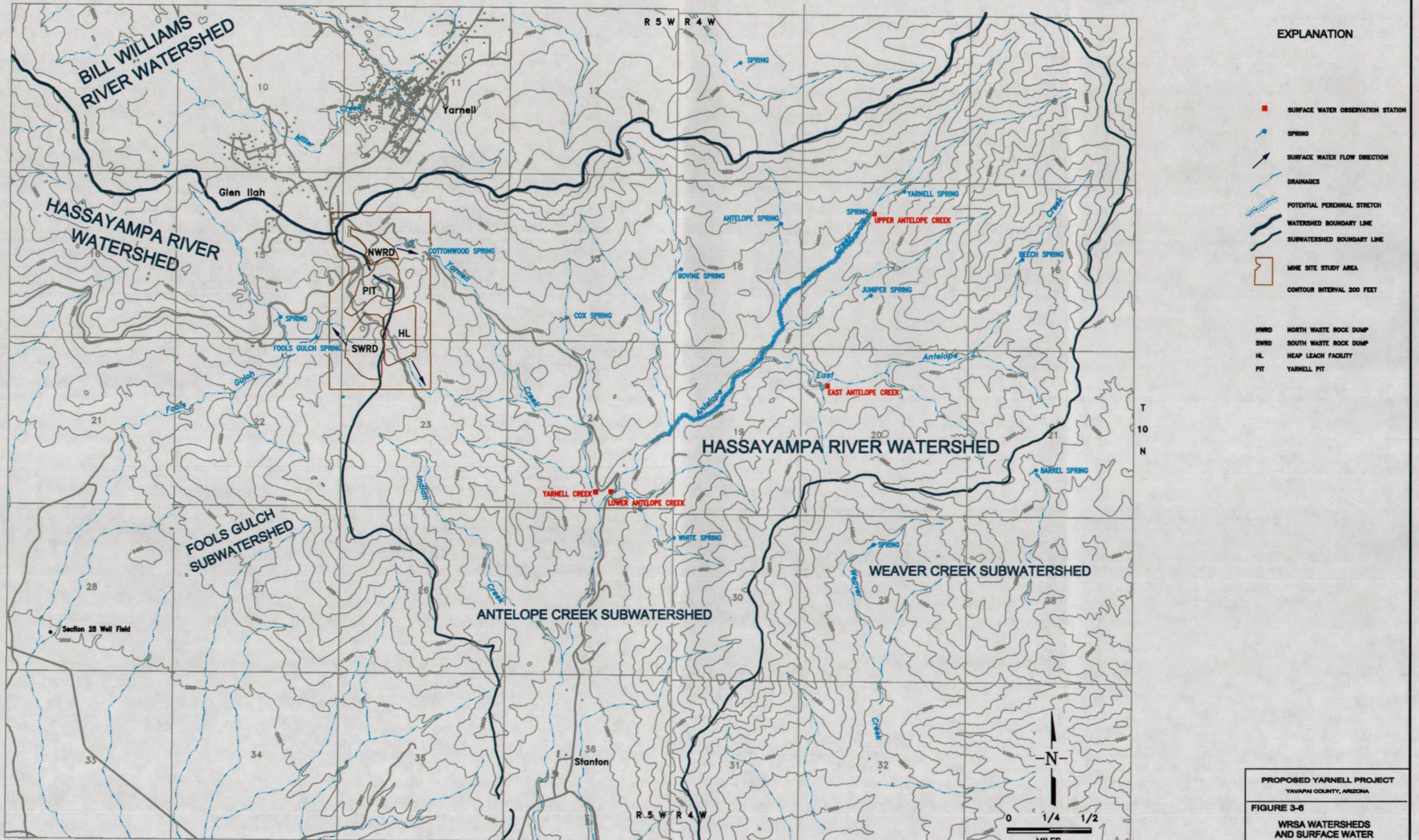


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FIGURE 3-6
WRSA WATERSHEDS AND SURFACE WATER OBSERVATION STATIONS

3.2.3 SURFACE WATER QUALITY

The Arizona State Water Quality Designated Use Standards for Antelope Creek and the Federal Drinking Water Standards are provided in Table 3-5 for comparison to the data collected from springs and surface water. The range of conditions exhibited by the stream and spring monitoring stations are also shown on the table. The important characteristics are summarized as follows.

- The water quality of the perennial stretch of Antelope Creek, which includes the sampling stations at Upper and Lower Antelope creeks, met all of the Arizona State Designated Use Standards for that stream (Table C-6 of Appendix C).
- The water quality of Yarnell Creek and East Antelope Creek met all of the Primary Federal Drinking Water Standards (Table C-6 of Appendix C). In Yarnell Creek, the total dissolved solids (TDS) of 570 parts per million (ppm) slightly exceeded the Secondary Federal Drinking Water Standard of 500 ppm.
- The springs met all Primary Federal Drinking Water Standards. In Cottonwood, Cox and Bovine springs, manganese concentrations of 0.136-0.553 milligrams per liter (mg/l) exceeded the Secondary Federal Drinking Water Standard of 0.05 mg./l.

3.2.4 SURFACE WATER RIGHTS AND USE

Water rights are claimed by the BLM, Arizona State Land Department and many private entities on surface water sources in the WRSA. These sources are in portions of two major stream basins -- the Bill Williams River Watershed and the Hassayampa River Watershed of the Lower Gila River. At present, water rights in the Bill Williams River are not subject to a general state water rights stream adjudication. However, the Lower Gila River is a sub-basin of the ongoing Gila River General Water Rights Stream Adjudication. To date, no water rights claimed in the Gila River have been adjudicated (e.g., the validity, relative priority dates and ownership of these rights have yet to be fully determined by the courts).

Rights to use water from springs, stockponds and streams in the WRSA have been filed by YMC for domestic, mining, irrigation, livestock, wildlife and recreation purposes with the ADWR. Table E-2 (Appendix E) lists water rights and claims information such as the registration, owner, water source, designated use, allotted volumes, etc. A BLM grazing permittee holds stockpond claim 38-62572 for livestock watering at Tom Cat Tank.

3.2.5 GROUNDWATER OCCURRENCE, FLOW AND YIELD

3.2.5.1 Water Resources Study Area (WRSA)

The rock units in the WRSA, described in Section 3.1.3, have been grouped into three separate aquifer systems based upon their ability to store and transmit water. The following discussion of these aquifer systems, shown in Figure 3-7, will largely center around their hydraulic conductivity and transmissivity. Both quantities reflect the ease with which water moves through an aquifer. The ease of movement of water is important to know because it allows prediction of how fast pollutants could move through an aquifer under a hydraulic gradient (i.e., driving force).

TABLE 3-5
Arizona Water Quality Designated Use Standards for Antelope Creek and Federal Drinking Water Standards

Parameter	Designated Use Standards (ug/l)						Federal Standards	Antelope Creek Springs[5]
	Fish Consumption	Full Body Contact	Aquatic & Wildlife Warm Water Fisheries		Agricultural Irrigation	Agricultural Livestock Watering	Primary Maximum Contaminant Level (MCL) (mg/l)	Range of March 1996 Sampling[6] (mg/l)
			Acute	Chronic				
Antimony	140 T	56 T	88 D	30 D	NNS	NNS	0.006	-0.005
Arsenic	1450 T	50 T	360 D	190 D	2,000 T	200 T	0.05	-0.003 to 0.003
Barium	NNS	9,800 D	NNS	NNS	NNS	NNS	2	-0.01 to 0.046
Cadmium	41 T	70 T	140,000 T	47	50 T	50 T	0.005	-0.0005
Chromium III	67,000 T		4788 D[1]	571 T[1]	NNS	NNS	NNS	
Chromium VI	3,400 T	700 T	16 D	11 D	NNS	NNS	NNS	
Chromium (Total)	NNS	NNS	NNS	NNS	1,000 T	1,000 T	0.1	-0.010 to 0.021
Copper	NNS	5,200 D	57 D[1]	34 D[1]	5,000 T	500 T	1.3[3] (1.0[4])	-0.010 to 0.015
Cyanide	210,000 T	2,800 T	41 T	9.7 T	NNS	200 T	0.2	-0.01
Fluoride	NNS	NNS	NNS	NNS	NNS	NNS	4.0 (2.0[4])	0.18 to 0.40
Lead	NNS	NNS	395 D[1]	15 D[1]	10,000 T	100 T	0.015[3]	-0.002
Manganese	NNS	19,600 T	NNS	NNS	10,000	NNS	0.05[4]	-0.010 to 0.424
Mercury	0.6 T	42 T	2.4 D	0.01 D	NNS	10 T	0.002	-0.0002
Nickel	730 T	2,800 T	4,043 D[1]	449 D[1]	NNS	NNS	0.1	-0.020
Nitrate	NNS	224,000	NNS	NNS	NNS	NNS	10	-0.06 to 1.09
Selenium	9,000 T	700 T	20 T	2.0 T	20 T	50 T	0.05	-0.005
Silver	NNS	NNS	34 D[1,2]	NNS	NNS	NNS	0.1[4]	-0.01
Thallium	41 T	12 T	700 D	150 D	NNS	NNS	0.002	-0.002
Zinc	22,000 T	42,000 T	334 D[1,2]	303 D[1]	10,000 T	25,000 T	5	-0.05

NNS = No Numeric Standards
T = Total
D = Dissolved
mg/l = Milligrams (one thousandth of a gram) per liter
ug/l = Microgram (one millionth of a gram) per liter

1 = Based on an average hardness of 345 mg/l
2 = Based on an average pH of 7.7
3 = Action level
4 = Secondary Maximum Contaminant Level (SMCL)
5 = Includes Antelope, Juniper, Yarnell, White and Bovine springs
6 = A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
7 = February 1997 Arizona Designated Use Standards

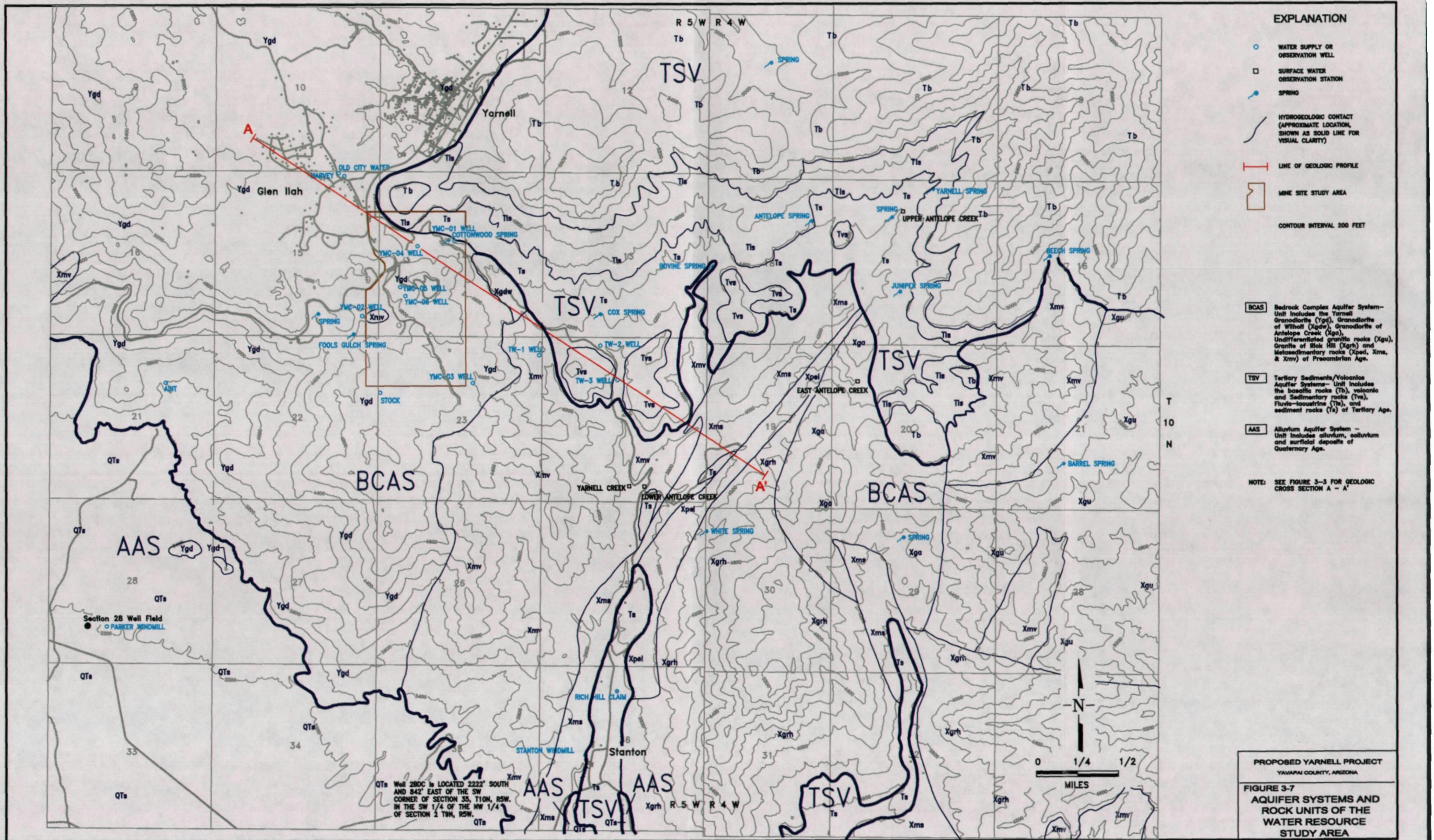

FIGURE 3-7
AQUIFER SYSTEMS AND ROCK UNITS OF THE WATER RESOURCE STUDY AREA

Bedrock Complex Aquifer System (BCAS). The Precambrian granitic, metasedimentary and metavolcanic rocks, described in Section 3.1.3 and shown in figures 3-2 and 3-7, have been grouped into a single aquifer system. Groundwater in these rocks occurs and flows through joints, fractures and faults which developed after the formation of the rock. Primary openings (spaces between mineral grains) in the BCAS are non-existent.

Based on the aquifer tests presented in Table A-1 of Appendix A, the occurrence and movement of water in the BCAS can be summarized as follows.

- The bulk hydraulic conductivity and transmissivity (the ability of the aquifer to transmit water) are low and within the range normally encountered with unfractured and fractured crystalline rocks.
- The effective porosity (aquifer storage) is low, and based on professional judgment is estimated to be on the order of 0.1 to one percent.
- The presence of hydraulic boundary conditions in two of the pumping tests probably indicates the limited storage of water in the rock fractures.
- A lack of response in the observation wells to pumping of the test wells supports the conclusion that hydraulic connections between fractures are poor.

Tertiary Sediments/Volcanics Aquifer System (TSV). The rocks in the TSV, described in Section 3.1.3 and shown in figures 3-2 and 3-7, have been segregated as a distinct aquifer system because, unlike the BCAS described above, groundwater mostly occurs and flows within spaces between mineral grains. Although well pump tests were not conducted in the TSV, the occurrence and movement of water in that aquifer system is described as follows.

- The rate of movement of water is variable from location to location. This is because the TSV includes a number of rock types — fluvial sediments, lacustrine sediments, volcanic flows and tufaceous sediments. In addition, the degree of consolidation and clay content of the sediments, which affects the rate of water movement, is variable.
- Some of the rock units in the TSV contain little or no water. The Tertiary basalt is generally dry.
- The TSV is in hydraulic communication with the BCAS. This means that groundwater can flow between the two aquifer systems.

Alluvial Aquifer System (AAS). The AAS is comprised of alluvial sediments found in two general locations.

- The drainage channels in the mountains, where the occurrence of the AAS is limited to thin, discontinuous lenses. Groundwater may be temporarily stored in these lenses following runoff events. Along Antelope Creek south of the confluence with Yarnell Creek, the alluvium thickens and may remain partly saturated throughout the year.
- The valley in the southwestern part of the WRSA, where the AAS is an extensive aquifer that thickens southerly in the direction of Wickenburg.

Based on well pump tests presented in Table A-1 of Appendix A, the occurrence and movement of water in the AAS in the valley in the southwest part of the WRSA can be summarized as follows.

- Groundwater moves more readily through the AAS than in the BCAS as indicated by hydraulic conductivities of 0.24 to 0.67 ft/day and by transmissivities from 500 to 2,000 gpd/ft.
- More water is stored in the AAS than the BCAS. This is indicated by wells in the AAS (Section 28 wellfield and Well 2BCD) which can produce more water than wells in the BCAS, and estimated aquifer storage coefficients in the range of 0.005 to 0.01.

Groundwater Flow Directions. Regional groundwater elevations and inferred directions of groundwater flow are illustrated in Figure 3-8 and summarized in the paragraphs below. Figure 3-8 is based on water levels from wells measured in April 1996 (Table B-1, Appendix B), the elevation of springs and surface drainage patterns.

Groundwater levels in the WRSA are a subdued expression of the land surface topography. Groundwater elevations range from just over 4,800 feet MSL in the northern part of the WRSA at Glen Ilah to less than 3,000 feet MSL in the southwest corner of the WRSA near the Parker Dairy. Depths to groundwater range from a few feet along the deeper drainage channels (such as Antelope Creek) to more than 500 feet in the AAS to the south of the Parker Dairy.

In general, directions of groundwater flow are toward the channels of Yarnell Creek, Fools Gulch, Indian Creek and Antelope Creek. Groundwater near the axis of Antelope Creek flows southward toward Stanton.

A groundwater divide has been inferred to exist approximately parallel to and 2,000 feet north of the surface drainage divide that separates the Hassayampa River and Bill Williams River watersheds. The location of the divide, which is more accurately described as a zone of groundwater divergence, is based on topography and groundwater elevations from nearby wells. A groundwater divide profile along Section Line A-A' of Figure 3-8 is illustrated in Figure 3-9. The implications of the groundwater divide are as follows.

- Groundwater north of the divide (or zone of divergence) migrates in a northerly direction, while groundwater south of the divide migrates, in general, in a southerly direction.
- Groundwater under the towns of Glen Ilah and Yarnell moves to the north toward Peeples Valley, which is north of the WRSA.
- Groundwater under the MSA migrates in a southerly direction and away from the towns of Glen Ilah and Yarnell.

3.2.5.2 Mine Site Study Area (MSA)

Groundwater elevations and inferred directions of groundwater flow in the MSA are illustrated in Figure 3-10 and summarized in the paragraphs below. Figure 3-10 is based on water levels from monitoring wells measured in January 1998, the elevations of springs and surface drainage patterns.

Groundwater beneath the MSA does not flow to Glen Ilah and Yarnell. The reasons for this are discussed in Section 3.2.5.1.

A groundwater divide exists in the MSA, as shown in figures 3-10 and 3-11. The groundwater divide coincides with the topographic high of Yarnell Hill. Groundwater north and east of the divide flows toward

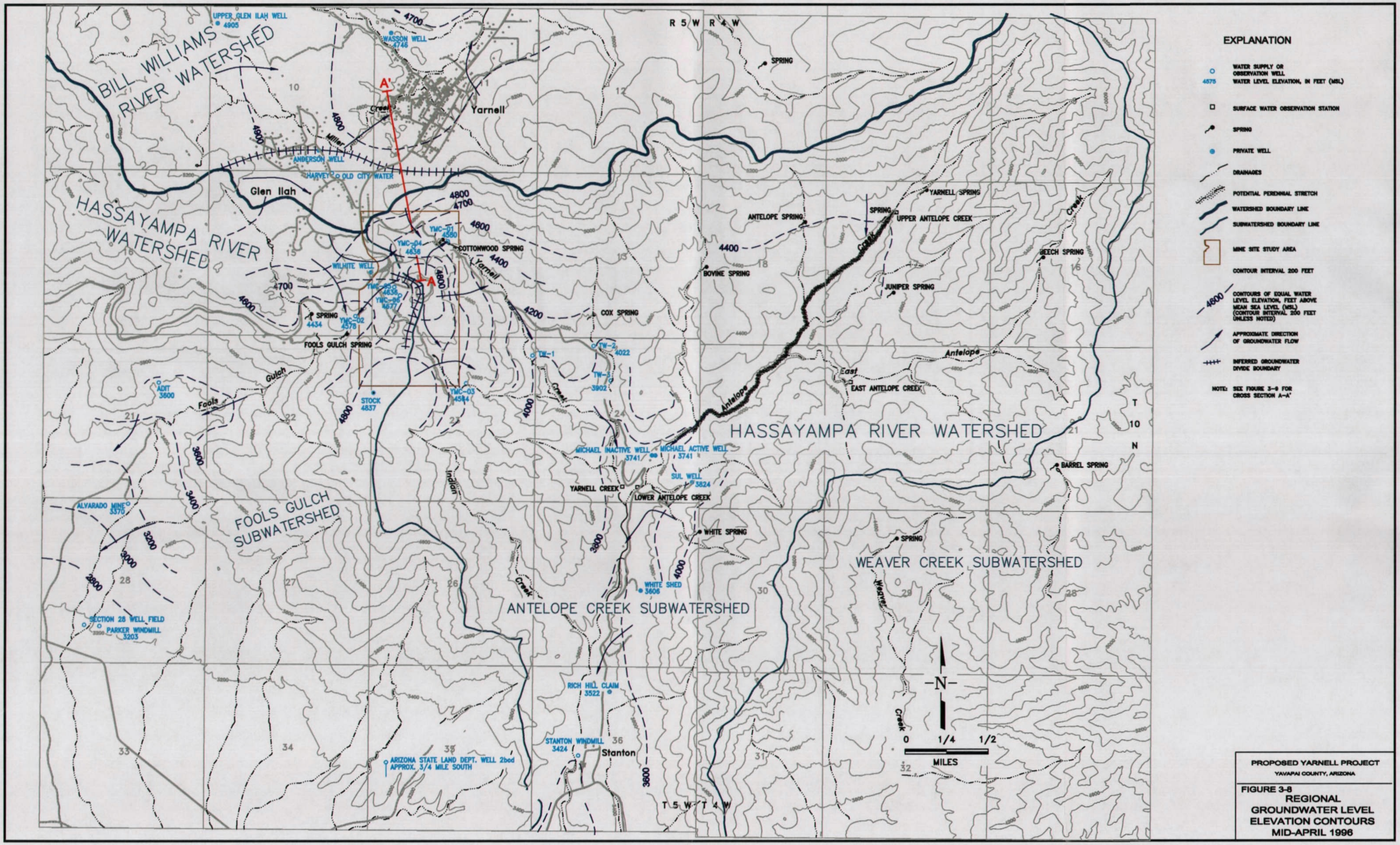

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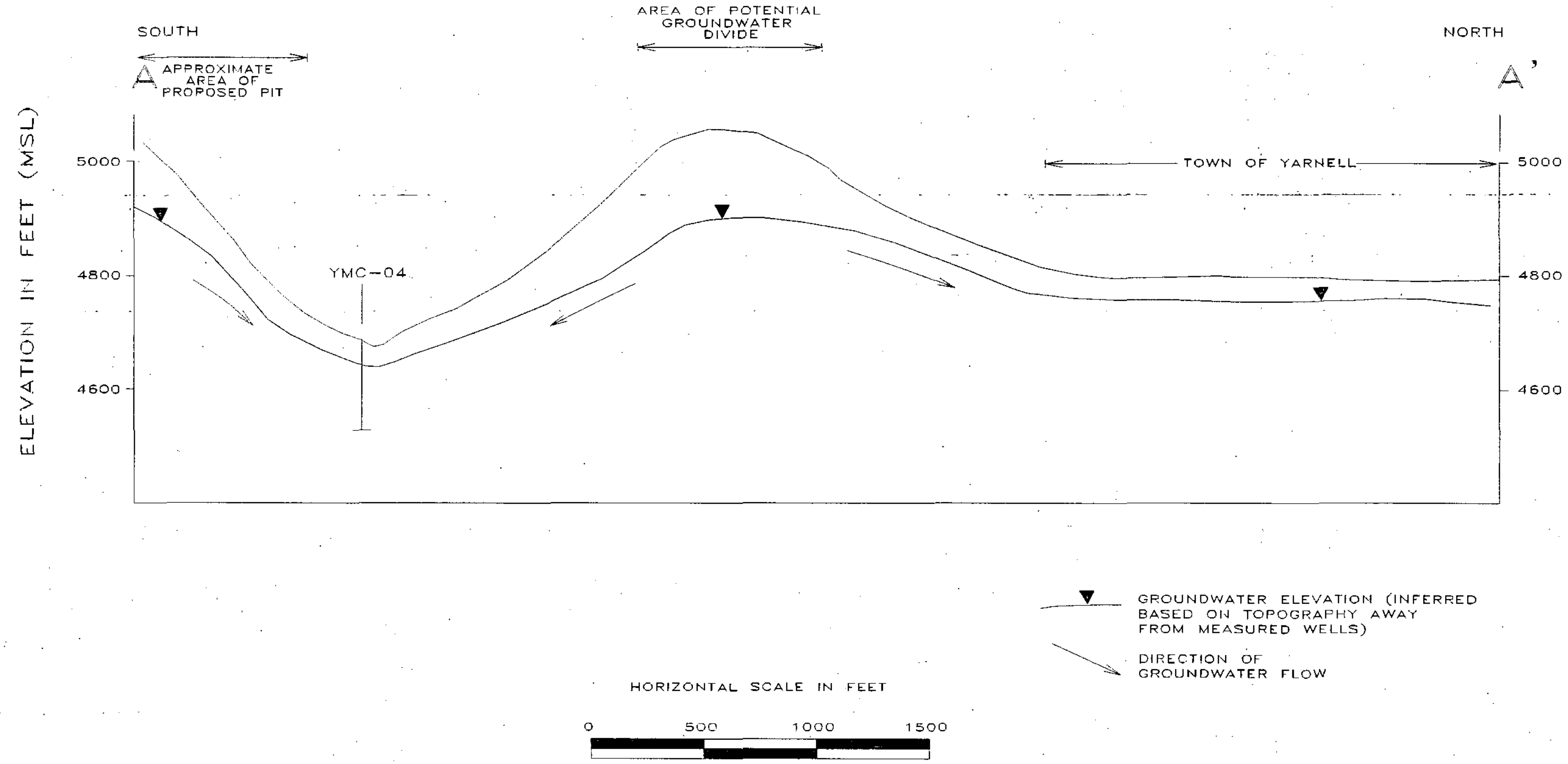
FIGURE 3-8
REGIONAL GROUNDWATER LEVEL ELEVATION CONTOURS
MID-APRIL 1996



NOTE: Line of section shown on Figures 3-8 and 3-10

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FIGURE 3-9

REGIONAL GROUNDWATER DIVIDE PROFILE

Yarnell Creek; groundwater south and west of the divide flows toward Fools Gulch.

Groundwater exists fairly close to the surface in the MSA. Groundwater elevations of four monitoring wells from 1995 through 1997 ranged from about 0.5 to 83 feet below ground surface (bgs). Two of the wells always show water less than 25 feet bgs (Table B-1 of Appendix B). In addition, seeps were encountered in weathered soils on top of the bedrock in some locations in the spring of 1995, particularly in the area of the proposed heap leach pad. This represents temporary perched groundwater that is not connected to the zone of saturation in the bedrock. It should be noted that these seeps were observed immediately after nearly 20 inches of rain fell in the preceding two months.

The depth to groundwater is not uniform throughout the MSA at any given time. Table B-1 of Appendix B shows that the depth to groundwater in the four wells can vary by as much as 43 feet.

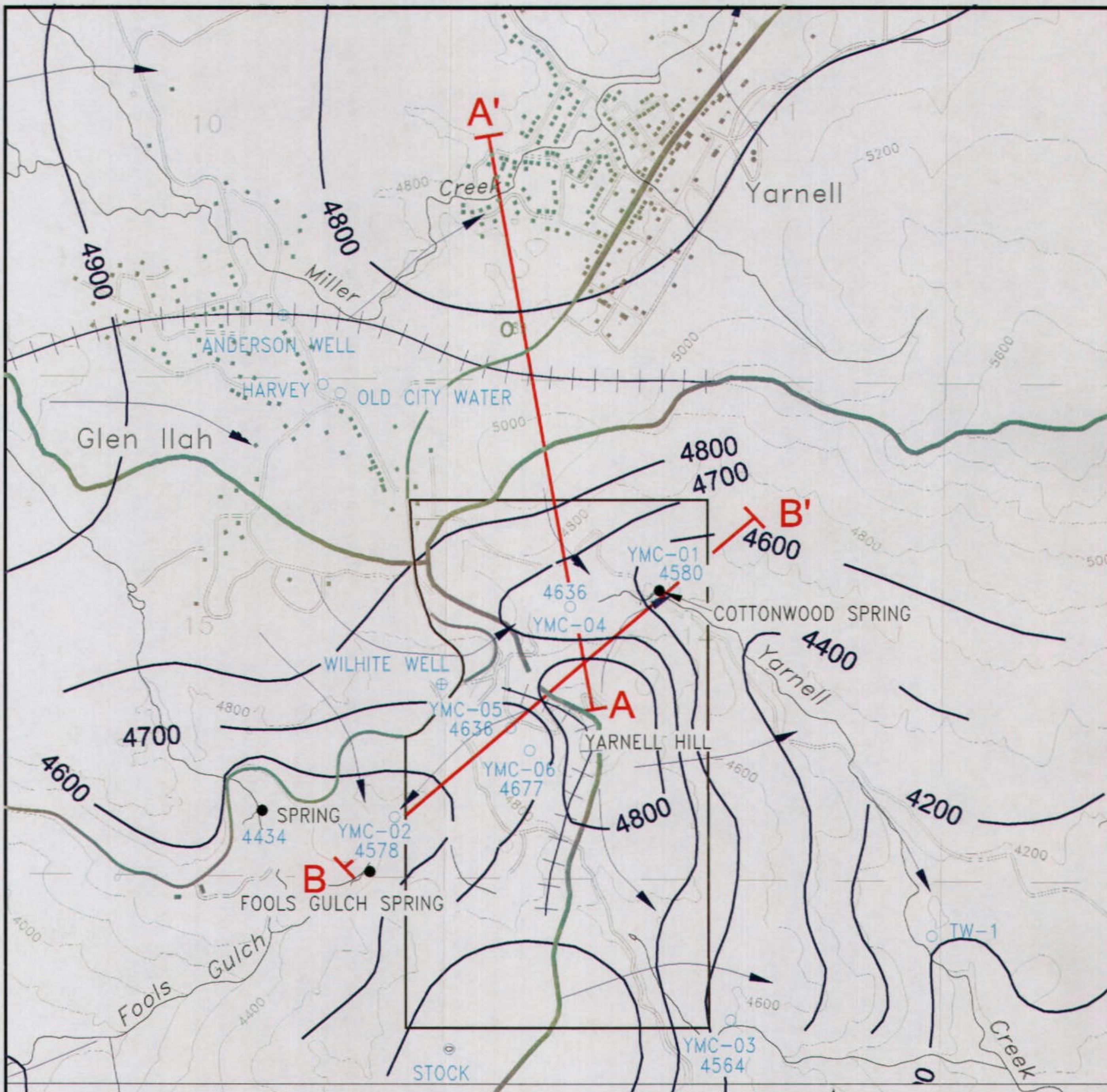
The depth to groundwater varies significantly by season and year, largely as a function of rainfall. In the spring of 1995, which followed a wet winter, groundwater levels in all four wells were less than 50 feet bgs.

3.2.6 GROUNDWATER QUALITY

Most groundwater in the WRSA is a calcium-bicarbonate type. There are two exceptions. Water from the Michael Well is a sodium/magnesium-bicarbonate type, and water from Well YMC-04 is a calcium-sulfate type. Appendix C contains tables listing the results from groundwater quality testing of wells in the WRSA; the locations of those wells are shown in figures 3-7 and 3-8.

The Arizona State Aquifer Water Quality Standards (AWQS) and federal secondary drinking water standards are provided in Table 3-6 for comparison to data collected from wells in the WRSA. The range of conditions for each well is also shown in the table. The important characteristics of groundwater quality in the WRSA are summarized as follows.

- The water from Well YMC-04 has a lower pH (5.85 to 6.53) and higher total dissolved solids (TDS) concentration (720 to 1,200 mg/l) than water from any other sampling site in the WRSA. There are two likely reasons for this: the well is drilled through historic mill tailings, and it intercepts the mineralized zone of the Yarnell Fault. Rock samples from where the well intercepts the fault contain sulfide-bearing minerals; these minerals react with groundwater to produce sulfate and acidity.
- With the exception of Well YMC-04, the pH of all water samples from wells in the WRSA was within the secondary drinking water standard of 6.5 to 8.5.
- Sulfate concentrations in Well YMC-04 exceeded the federal secondary drinking water standard of 250 mg/l.
- Total and free cyanide was detected in a few samples from Well YMC-04. The concentrations were below regulatory thresholds. The source of cyanide may be from historic mill tailings near the well.
- Metals were below the AWQS and the federal secondary drinking water standards, with two exceptions. Manganese exceeded the federal secondary drinking water standard in wells



EXPLANATION

WATER SUPPLY OR OBSERVATION WELL

4575 WATER LEVEL ELEVATION, FEET ABOVE MEAN SEA LEVEL (MSL)

SURFACE WATER OBSERVATION STATION

SPRING

PRIVATE WELL

DRAINAGES

WATERSHED DRAINAGE LINE

MINE SITE STUDY AREA

4600 CONTOURS OF EQUAL WATER LEVEL ELEVATION, FEET ABOVE MEAN SEA LEVEL (MSL) (CONTOUR INTERVAL 200 FEET UNLESS NOTED)

APPROXIMATE DIRECTION OF GROUNDWATER FLOW

INFERRED GROUNDWATER DIVIDE BOUNDARY

NOTE: SEE FIGURE 3-9 FOR CROSS SECTION A-A'
SEE FIGURE 3-11 FOR CROSS SECTION B-B'

N

0 1,000 2,000
FEET

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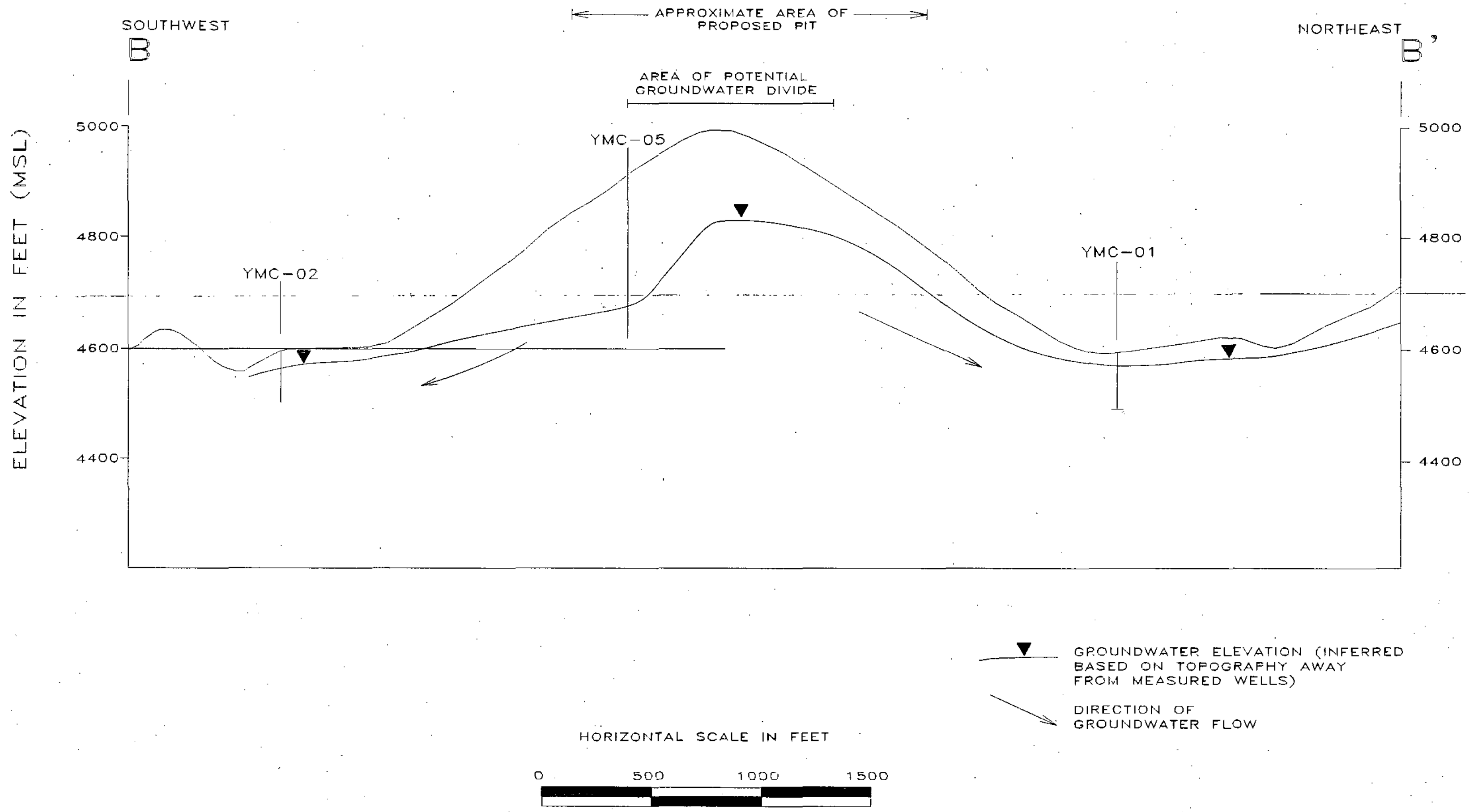
FIGURE 3-10

MINE SITE STUDY AREA GROUNDWATER MAP
JAN 1998



NOTE: Line of section shown on Figure 3-10

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FIGURE 3-11

MINE SITE STUDY AREA GROUNDWATER PROFILE

TABLE 3-6
Water Quality of Four Wells in the Yarnell Mine Site Study Area
Compared with the Arizona State Aquifer Water Quality Standards

Parameter (milligrams per liter)	AWQS*	Range in Wells** YMC 01, 02, 03 and 04
Field pH	[6.5 to 8.5]	5.56 to 7.05
Field Conductivity (umhos/cm)	NNS	675 to 1,422
Field Temperature (°C)	NNS	15.6 to 25.9
Lab pH	[6.5 to 8.5]	6.6 to 7.9
Lab Conductivity (umhos/cm)	NNS	665 to 1,800
Total Dissolved Solids	[500]	440 to 1,200
Sulfate	[250]	50 to 720
Chloride	[250]	25 to 90
Fluoride	4.0	0.48 to 2.6
Carbonate ($CaCO_3$)	NNS	-5 to -1
Bicarbonate (as $CaCO_3$)	NNS	128 to 412
Hydroxide ($CaCO_3$)	NNS	-1
Total Alkalinity ($CaCO_3$)	NA	128 to 412
NO_2/NO_3 - N_1 Total (as N)	10.0	0.11 to 7.3
Calcium	NA	88.1 to 240
Magnesium	NA	10.8 to 42
Potassium	NA	1 to 4.1
Sodium	NA	30 to 102
Antimony	0.006	-0.005 to 0.005
Arsenic	0.05	-0.003 to 0.013
Barium	2.0	0.012 to 0.489
Beryllium	0.004	-0.004 to -0.005
Cadmium	0.005	-0.0005 to 0.0008
Chromium	0.1	-0.005 to 0.017
Copper	[1.0]	-0.005 to 0.017
Iron	[0.3]	-0.02 to 8.7
Lead	0.05	-0.002 to 0.008
Manganese	[0.05]	-0.01 to 5.87
Mercury	0.002	-0.0001 to -0.0002
Nickel	0.1	-0.005 to -0.020
Selenium	0.05	-0.005
Silver	[0.1]	-0.0002 to 0.015
Thallium	0.002	-0.002 to -0.005
Zinc	[5.0]	-0.025 to 1.780
Gross Alpha (pCI/L)	15	-11 to 19.8
Gross Beta (pCi/L)	50	-19 to 12.9
Cyanide, Free	0.2	-0.01 to 0.02

* Aquifer Water Quality Standards; numbers in brackets are federal secondary water quality standards.
NNS = No Numeric Standards
** A negative value indicates a result is below detectable limits. Numerical value is detection limit.
umhos/cm = A measure of electrical conductivity. A mho is the reciprocal ohm. Micro = one millionth
°C = Degrees Centigrade Milligram = one thousandth of a gram
$CaCO_3$ = Calcium Carbonate pCi/L = Picocurries per liter
N = Nitrogren

YMC-02 and YMC-03 in seven samples. Iron exceeded the federal secondary drinking water standard in wells YMC-02 and YMC-03 in one and seven samples, respectively.

- Gross alpha exceeded the AWQS in Well YMC-03 in one sample.

3.2.7 GROUNDWATER PERMITS AND USE

Groundwater in Arizona is not appropriable. It is owned by the state and use is authorized through a permit process with the ADWR. The WRSA is outside of any of the state's intensively-managed groundwater areas (called Active Management Areas). Groundwater use in the WRSA includes domestic, livestock, mining and commercial dairy withdrawals. Table 3-7 presents the estimated groundwater use in the WRSA.

Known active water wells within one mile of the MSA are limited to the Stock Well, Wilhite Well and domestic wells in the towns of Glen Ilah and Yarnell. The location of all active wells is not well known because it appears from a review of the Arizona Department of Water Resources Well Registry (Table E-1 in Appendix E) that there may be numerous unregistered wells. The closest active well downgradient from the MSA is at the Michael Ranch, approximately 2.5 miles southwest of the MSA. The well is reportedly used infrequently for domestic and stock purposes. Continuing downstream, several active wells in the Stanton area are primarily used for domestic supply and placer mining.

TABLE 3-7
Estimated Groundwater Use in the Vicinity of the Proposed Yarnell Project

Type of use	Gallons per day	Acre-feet per year	Percent of total current use
Commercial Dairy - Parker Dairy	300,000 - 450,000	338 - 504	57 - 66
Domestic - Glen Ilah and Yarnell, public water supply[1]	57,534	64.5	8 - 11
Domestic - Glen Ilah and Yarnell, individual wells[2]	25,000	28	4 - 5
Domestic south of the mining site study area[3]	156,000	158	21 - 27
Mining - current use	Negligible	Negligible	--
Livestock	1,800 - 2,700	2 - 3	< 1%
Totals, without the Yarnell Mine	540,334 - 691,234	588.5 - 757.5	100%
Yarnell Mine, proposed use[4]	144,000	161	21 - 27
Totals, with Yarnell Mine	684,334 - 835,234	749.5 - 918.5	121 - 127

[1] Water is supplied by the Yarnell Water Improvement Association, which obtains its water from wells in Peeples Valley. Peeples Valley is four miles northeast of Yarnell and outside of the WRSA.
[2] Based on an estimate of 250 wells, each pumping an average of 100 gallons per day.
[3] Based on 12 months water usage from Congress Water Improvement District (5/1/97) and an estimated 5,000 gallons per day additional usage.
[4] Based on a year-round average of 100 gallons per minute. Information on the water supply wells for the Yarnell Mine is in Table E-1 of Appendix E.

Domestic water in Glen Ilah and Yarnell is derived either from individual domestic wells or, more typically, from a public water system managed by the Yarnell Water Improvement Association. The public supply is provided from two wells in Peeples Valley and conveyed along a four-mile pipeline to storage tanks upslope from the town of Yarnell. There are approximately 485 hookups to the public system with annual groundwater usage estimated at about 21 million gallons for 1995.

Private groundwater consumption in the Glen Ilah/Yarnell area is expected to be low because of the public system and the combination of septic system use and shallow groundwater occurrence. Assuming that 250 homes pump an average 100 gallons per day, these withdrawals would account for about 25,000 gallons per day or about 25 to 30 acre-feet per year.

The Parker Dairy, in the southwest corner of the WRSA, produces from 300,000 to 450,000 gallons of water per day (325 to 500 acre-feet per year) from two wells completed in the AAS. The wells are about four miles south of the dairy.

South of the MSA, the Congress Water Improvement District provides domestic water to 530 hookups. Water usage for the year ending May 1, 1997 was 55.2 million gallons.

Small mining operations along Antelope Creek, including the Alvarado Mine north of the dairy, use negligible quantities of water.

YMC proposes to use groundwater from a number of wells. The use of Well TW-01 would require an authorization from the BLM. YMC has not yet obtained a water agreement from the Arizona State Land Department for the use of Well 2BCD on state land. Without use of this well, YMC would likely have to search for a new water source. This EIS addresses impacts assuming that YMC will obtain use of Well 2BCD. If YMC does obtain a different water source(s) in place of that well, this EIS will be modified accordingly. Well registration information for the proposed water supply wells is in Appendix E. YMC plans to pump a total of 100 gpm (year-round average) from its water supply wells; this corresponds to 161 acre-feet per year. Additional information on the water supply system is described in Chapter 2, Section 2.1.6.4.

3.2.8 WATERS OF THE UNITED STATES

Any discharge or placement of dredged or fill material into waters of the U.S. is prohibited unless carried out under a permit issued by the COE under Section 404 of the Clean Water Act. Waters of the U.S. include drainages with a defined bed and bank and wetlands adjacent to or tributary to Waters of the U.S. Waters of the U.S. and wetlands are defined in 33 CFR 328.3(a) and (b). Waters of the U.S., delineated according to procedures in the COE 1987 Wetland Delineation Manual, include Yarnell Creek, a southeast-draining tributary to Yarnell Creek, Fools Gulch, a westward-draining tributary to Fools Gulch, and 34 desert washes that would be crossed by the proposed water supply pipelines. Figures 3-12 and 3-13 show Waters of the U.S. that could potentially be affected by the proposed project.

The MSA and pipeline corridors include desert washes that have been delineated as waters of the U.S. These washes were delineated based on the observed channel width as defined by erosion, the absence of vegetation, the prevalence of water-sorted sand, sediment deposits, drift lines and water-sorted debris. Portions of four washes (Figure 3-12) in the MSA delineated as Waters of the U.S. total approximately 5,250 feet in length.

The west pipeline corridor crosses 33 desert washes and the east pipeline corridor crosses one, Yarnell Creek. The width of most desert washes ranges from one to 20 feet. However, some crossings are at an angle or parallel to the wash for short distances. As a result, two crossings are 100 and 136 feet wide and comprise 44 percent of the total 534 feet of desert washes crossed by the pipelines. With an average pipeline corridor width of 25 feet, approximately three-tenths of an acre of desert washes would be crossed. The estimated depth of the washes range from less than one foot to 30 feet. More than two-thirds of the washes have an estimated depth of five feet or less and three washes have an estimated depth of 25 to 30 feet. All of the desert washes were lined by upland vegetation, and hydrology indicators (such as erosion, mud cracks, debris, etc.) were present in most of the washes.

Wetland/riparian vegetation occurs along small sections of Fools Gulch and Yarnell Creek. In Yarnell Creek, the substrate changes from sand to exposed bedrock, and springs and seeps create shallow pools. In the upper section of the wetland in Yarnell Creek where the substrate changes from sand to bedrock, a 20-foot diameter pool (bench with an old dam) is used for livestock; several other pools, three to four feet in diameter and less than six inches deep, occur seasonally. The extent of these pools varies from year to year and seasonally during the year. The wetland/riparian vegetation begins about 300 feet west of the primitive road crossing Yarnell Creek and extends downstream for approximately 1,700 feet linearly. The jurisdictional wetlands are also shown in figures 3-12 and 3-13.

In Fools Gulch immediately west of the MSA, several springs and seeps create a small, linear, discontinuous wetland along an approximate 800-foot section of the stream channel. This stream channel varies in widths from two to 15 feet and has been severely impacted by livestock grazing. The supply of water from the spring fluctuates from year to year, resulting in a wetland that varies in size from season to season. The area of this wetland is approximately 0.15 acres.

3.3 BIOLOGICAL RESOURCES

3.3.1 VEGETATION

3.3.1.1 Vegetation Types

The MSA, east pipeline corridor and the higher elevations of the west pipeline corridor are all in the Interior Chaparral Scrub Vegetation Zone as mapped and described by Brown and Lowe (1980) and Shrieve and Wiggins (1964). The majority of the western pipeline corridor is in the Arizona Upland Subdivision of the Sonoran Desert Scrub Vegetation Zone as mapped and described by Shrieve and Wiggins (1964) and Brown and Lowe (1980).

The vegetation of the MSA and the water pipeline corridors is described from quantitative and qualitative baseline studies completed by Western Ecological Resources (1994 and 1996). The Interior Chaparral Vegetation Zone has five distinct vegetation types and the Arizona Upland Subdivision of the Sonoran Desert Scrub has two.

The small knobby granite outcrops with shallow soils in the southern half of the MSA are characterized by a mountain mahogany (*Cercocarpus montanus*) shrubland. Dry, south- and southeast-facing mountainous slopes have a dense shrub community characterized by turpentine bush (*Haplopappus larcifolius*) and wait-a-minute bush (*Mimosa biuncifera*). Shrub live oak (*Quercus turbinella*), the most abundant vegetation type, occurs throughout the southern half of the MSA and on the relatively gentle topography of the south-facing slope of Antelope Peak, north of Yarnell Creek. The very steep, mesic, north-facing slopes are dominated by a tall, dense, live oak community. Several years before the initial quantitative baseline study in 1991, about 66 acres of the live oak shrubland burned on the southwestern portion of the MSA, increasing the area of exposed soil and rock while reducing the vegetation cover.

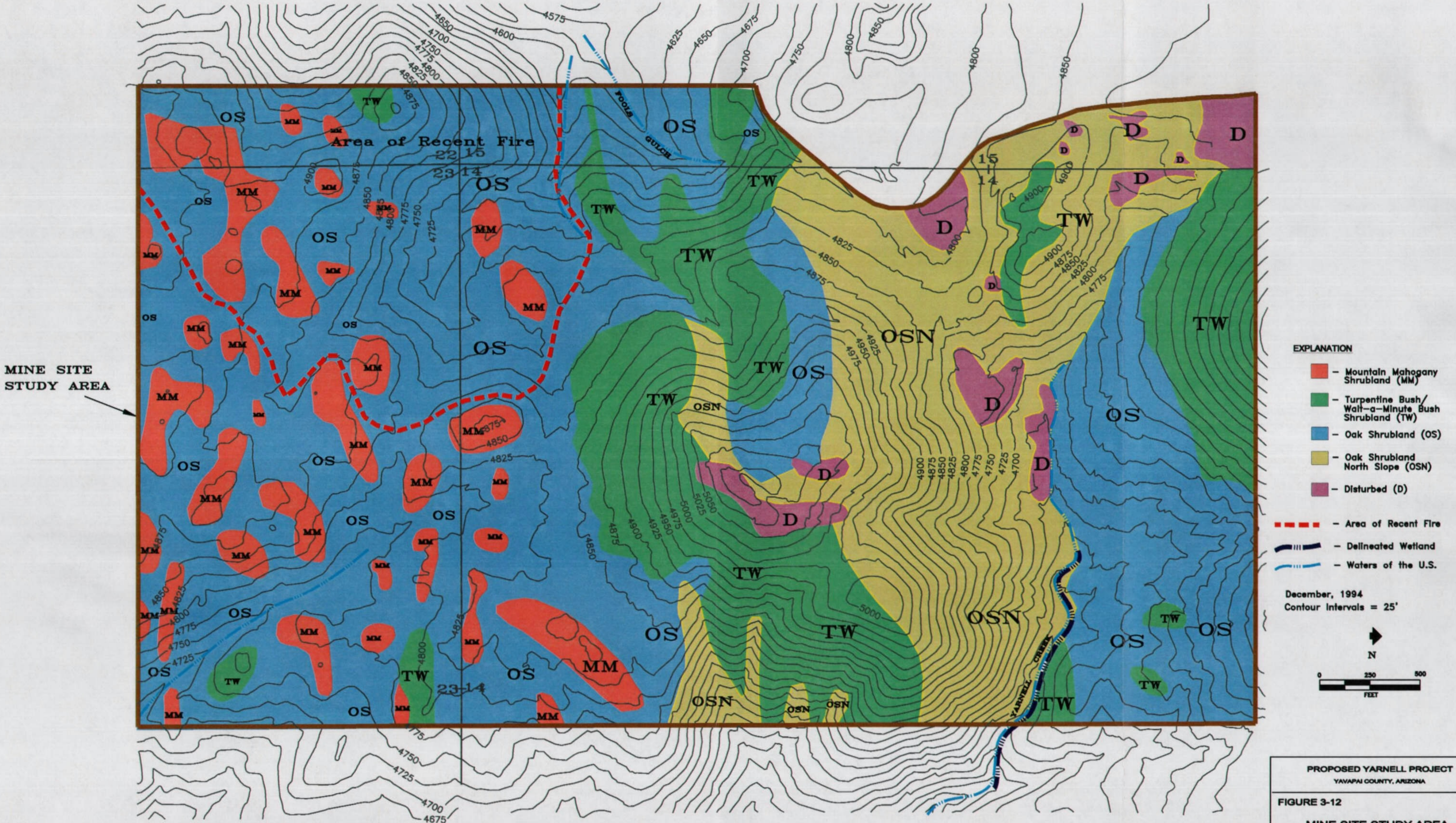
Two vegetation types occur in the Arizona Upland Subdivision of the Sonoran Desert Scrub Zone, which extends from the lowest elevations of the MSA to an elevation of about 3,900 feet. They include a paloverde-mixed cacti scrub vegetation type through the plain and a desert wash vegetation type along the many sandy, braided channels of Fools Gulch.

The seven vegetation types and wetlands are briefly described below. The vegetation types in the chaparral zone are described from quantitative data (WER 1994) and the types in the Sonoran Desert from qualitative data (WER 1996). Figures 3-12 and 3-13 illustrate the vegetation types of the MSA and pipeline corridors, respectively. Appendix G identifies the major plant species in the seven vegetation types.

Mountain Mahogany Shrubland. This vegetation type is characterized by a relatively high cover and low density of shrubs, a modest cover of perennial grasses and a low cover of succulents, nolinas and perennial forbs. Mountain mahogany is the dominant plant within the vegetation type. Other common shrubs include turpentine bush and live oak. The perennial grass cover is dominated by sideoats grama (*Bouteloua curtipendula*), the second most abundant plant in the vegetation type. Common succulents respectively include Englemann prickly pear (*Opuntia phaeacantha* var. *discata*), pancake pear (*Opuntia chlorotica*) and hedgehog cactus (*Echinocereus fasciculatus*). Beargrass (*Nolina microcarpa*) is the only nolina represented.

Turpentine Bush/Wait-a-minute Bush Shrubland. This vegetation type is characterized by a high cover and density of shrubs, a modest cover of perennial grasses and a low cover of annual grasses, perennial forbs, succulents and nolinas. Turpentine bush and wait-a-minute bush provide well over one-half the cover and density in this vegetation type. Sideoats grama is the third most abundant plant. Engelmann prickly pear, pancake pear and beargrass are all sparsely represented, but more abundant in this southern exposed community than in any of the chaparral types.

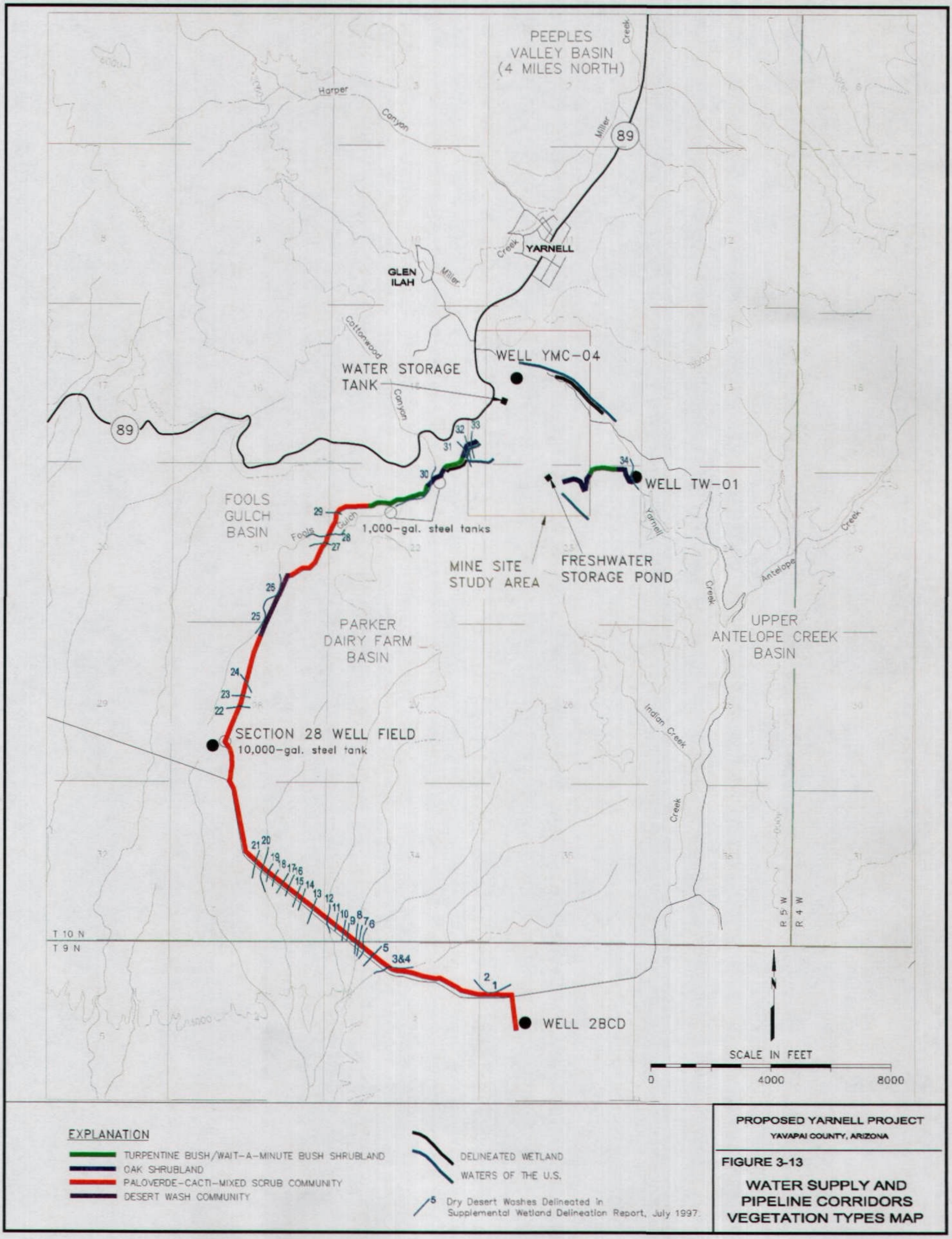
Oak Shrubland. This vegetation type, the most extensive on the MSA and in the region, is characterized by very high cover and density of shrubs, a modest cover of perennial grasses and a low cover of perennial forbs, succulents and nolinas. Shrub live oak provides more than one-third of the cover and density of this vegetation type. Major perennial grasses include muttongrass (*Poa fendleriana*) and blue grama (*Bouteloua gracilis*). Engelmann prickly pear, pancake pear and beargrass are all infrequently present.



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-12

MINE SITE STUDY AREA
VEGETATION TYPES MAP



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-13

WATER SUPPLY AND PIPELINE CORRIDORS VEGETATION TYPES MAP

Oak Shrubland - North Slope. This vegetation type is characterized by a high cover and density of shrubs, a modest cover of perennial grasses and a low cover of perennial forbs and nolinas. Shrub live oak provides more than one-half of the cover and density for this vegetation type. Reverchon threeawn (*Aristida glauca*), the dominant grass, is the second most abundant plant in the vegetation type. Beavertail prickly pear (*Opuntia basilaris*) and Engelmann prickly pear are very sparsely represented in this north slope community.

Oak Shrubland - Burned. This vegetation type is characterized by a moderately high cover and very high density of shrubs, a moderate cover of perennial grasses and forbs and a low cover of annual grasses, annual forbs and succulents. Fire reduced the total vegetation cover, significantly increased the area of bare soil and rock and reduced shrub cover, but increased shrub density. Shrub live oak is the major shrub and the dominant plant in the community, and snakeweed is the second most abundant. Major perennial grasses include spider grass (*Aristida ternipes*) and sideoats grama. The perennial forb cover is dominated by penstemon, the third most abundant plant in the community. Nearly all succulents were destroyed by the fire and today are sparsely represented by hedgehog cactus, pancake pear and Engelmann prickly pear.

Paloverde-Mixed Cacti Scrub. This vegetation type is characterized by a relatively high cover and density of shrubs, a modest density and cover of cacti and a low cover of perennial grasses and forbs. Common shrubs present include foothills paloverde (*Cercidium microphyllum*), mesquite (*Prosopis julifolia*) and catclaw acacia (*Acacia greggii*). Perennial grasses infrequently present include purple threeawn (*Aristida purpurea*), black grama and big galleta (*Hilaria rigida*).

The diverse succulent composition includes Engelmann prickly pear, buckthorn cholla (*Opuntia acanthocarpa*), teddy bear cholla (*Opuntia bigelovii*), beavertail prickly pear, pancake pear, hedgehog cactus, barrel cactus (*Ferrocactus acanthoides* var. *lecontei*) and saguaro (*Carnegiea giganteus*). Yuccas, nolinas and agaves are sparsely represented and include soaptree (*Yucca elata*), banana yucca (*Yucca baccata)*, agave (*Agave desertii*) and nolina (*Nolina bigelovii*).

Desert Wash. This vegetation type, which occurs along the sandy channels of Fools Gulch, is characterized by a high cover of large shrubs and many of the understory grasses and forbs characteristic of the paloverde-mixed cacti scrub vegetation type. Common shrubs include desert willow (*Chilopsis linearis*), mesquite, foothills paloverde, catclaw acacia and creosote bush (*Larrea tridentata*). Large stands of range ratany (*Krameria parviflora*) colonize the disturbed sandy soils along these dry desert washes.

Wetlands. Springs and seeps along small sections of Yarnell Creek and Fools Gulch have created shallow pools of water and moist soil habitats with scattered riparian vegetation. These wetlands are characterized by grass-dominated wet areas with single or isolated trees and shrubs. Fremont cottonwood (*Populus fremontii*) and Goodding willow (*Salix gooddingii*) are the only trees present. Infrequent shrubs include saltcedar (*Tamarix pentandra*) and seepwillow (*Baccharis glutinosa*). Numerous graminoids are present including Bermuda grass (*Cynodon dactylon*), rabbitfoot grass (*Polypogon monspeliensis*) and alkali muhly (*Muhlenbergia asperifolia*). Also present are cocklebur (a forb, *Xanthium strumarium*), Baltic rush

(*Juncus balticus*), bulrush (*Scirpus microcarpus*) and cattail (*Typha latifolia*).

As illustrated by figures 3-12 and 3-13, Waters of the U.S. drainages with a defined "bed and bank" but without wetland plants have been mapped along Yarnell Creek, a southeast-flowing tributary to Yarnell Creek, Fools Gulch, a west-flowing tributary to Fools Gulch and approximately six desert washes which cross the water pipeline corridor.

Disturbed Areas. Approximately 17 acres of disturbed land, most related to past mining activities, occur in the MSA and along the water pipeline corridors. Disturbed areas include tailing piles, exploration excavations, a network of abandoned and active access and exploration roads, a pond with a breached dam and an abandoned section of State Highway 89.

3.3.1.2 Threatened, Endangered and Sensitive Plants

The U.S. Fish and Wildlife Service (Spiller 1992, 1996) identified Arizona agave (*Agave arizonica*) and Arizona cliffrose (*Purshia subintegra*), both federally endangered, and Hokoham agave (*Agave murpheyi*), a former category 2 plant, as potentially present in the MSA. The Arizona Game and Fish Department (Olson 1996) identified flannelbush (*Fremontia californica*) as a sensitive plant potentially present.

None of these plants were found in the MSA. Arizona cliffrose, an evergreen shrub up to six feet tall, is restricted to tertiary limestone and hence has no habitat in the MSA. The absence of prehistoric human habitation sites, with which it is commonly associated, limits the potential presence of Hokoham agave. Arizona agave and flannelbush both occur in chaparral habitats (Kearney and Peebles 1960) (Rutman 1992); however, neither was observed during the field inventories.

3.3.1.3 Arizona Native Plant Law

Table 3-8 identifies species of plants protected by the Arizona Native Plant Law and their protective status categories. To comply with the Arizona Native Plant Law, YMC would survey areas prior to disturbance and salvage and transplant any of these species (Table 3-8) found. The foothill paloverde (*Cercidium microphyllum*), present in the paloverde-mixed cacti scrub and desert wash communities along the west pipeline corridor, is salvage assessed and harvest restricted. Saguaro (*Carnegia giganteus*), present in the paloverde-mixed cacti scrub community, is highly safeguarded. The protected nolinas, agave, yuccas and cacti scattered throughout the proposed mine site and along the west pipeline corridor are salvage restricted. The two nolinas are also salvage and harvest restricted.

3.3.2 WILDLIFE

Baseline surveys to evaluate the wildlife community were conducted in October 1991, July 1992 and September-October 1996. The 1991 and 1992 surveys were conducted within the MSA. The 1996 surveys were conducted to include the affected environment along the water supply and pipeline corridors. Survey timing was based on detecting high-interest wildlife species potentially present in the area. The results of these surveys were documented in reports dated December 1994 (Western Ecosystems, Inc. 1994) and November 1996 (Western Ecological Resources 1996). Supplemental wildlife surveys were conducted within

TABLE 3-8
Arizona Protected Plants
Yarnell Mine Project

Scientific Name	Common Name	Protective Status*			
		Highly Safeguarded	Salvage Restricted	Salvage Assessed	Harvest Restricted
Shrubs					
Cercidium microphyllum	Foothills paloverde			•	•
Succulents					
Carnegia giganteus	Saguaro	•			
Echinocereus fasciculatus	Hedgehog cactus		•		
Ferrocactus acanthoides var. lecontei	Barrel cactus		•		
Mammillaria microcarpa	Pincushion cactus		•		
Opuntia acanthocarpa	Buckhorn cholla		•		
Opuntia basilaris	Beavertail prickly pear		•		
Opuntia bigelovii	Teddy bear cholla		•		
Opuntia chlorotica	Pancake pear		•		
Opuntia leptocaulis	Christmas cactus		•		
Opuntia phaeacantha var. discata	Engelmann prickly pear		•		
Agave/Nolinas/Yuccas					
Agave desertii ssp. simplex	Desert agave		•		
Nolina bigelovii	Nolina		•		•
Nolina microcarpa	Sacahuista		•		•
Yucca baccata	Banana yucca		•		
Yucca elata	Soaptree		•		

*These terms are applicable to the Arizona Native Plant Law and are defined as follows:

Highly Safeguarded. This category includes those species of native plants and parts of plants, including the seeds and fruit, whose prospects for survival in this state are in jeopardy or which are in danger of extinction throughout all or a significant portion of their ranges, and those native plants which are likely within the foreseeable future to become jeopardized or in danger of extinction throughout all or a significant portion of their ranges. This category also includes those plants resident to this state and listed as endangered, threatened or category 1 in the Federal Endangered Species Act of 1973 (P.L. 93-205; 87 Stat. 884; 16 U.S. Codes 1531 et seq.), as amended, and any regulations adopted under that act.

Salvage Restricted. This category includes those native plants which are not included in the highly safeguarded category, but are nevertheless subject to a high potential for damage by theft or vandalism.

Salvage Assessed. This category includes those native plants which are not included in either the highly safeguarded or salvage restricted categories, but nevertheless have a sufficient value if salvaged to support the cost of salvage tags and seals.

Harvest Restricted. This category includes those native plants which are not included in the highly safeguarded category but are subject to excessive harvesting or overcutting because of the intrinsic value of their by-products, fiber or woody parts.

the MSA and water supply and pipeline corridors by BLM biologists and results of those surveys have been incorporated herein.

Field surveys were designed primarily to detect endangered, threatened and other high-interest species that had the greatest likelihood of occurrence given known habitat requirements. While survey intensity was considered adequate to detect high-interest species, if present, it is recognized that failure to locate a particular species during surveys does not necessarily indicate its absence in the study area or that it may not occur in the study area in the future.

Evidence of two amphibian, 15 reptile, 45 bird and 24 mammal species was observed during the surveys. Common and scientific names of the species are listed in tables 3-9 through 3-11. No fish were detected.

TABLE 3-9
Amphibians and Reptiles Detected Near the Mine Site Study Area and Water Supply Corridors During October 1991, July 1992 and September-October 1996 Surveys

SPECIES	SURVEY PERIOD		
Common Name, Scientific Name	October 1991	July 1992	October 1996
Lowland leopard frog, *Rana yavapaiensis**			
Canyon treefrog, *Hyla arenicolor**			
Desert tortoise, *Gopherus agassizii*			●
Western whiptail lizard, *Cnemidophorus tigris*	●	●	●
Collared lizard, *Crotophytus collaris*	●	●	
Side-blotched lizard, *Uta stansburiana*	●		
Tree lizard, *Urosaurus ornatus*	●		
Desert spiny lizard, *Sceloporus magister*	●		
Eastern fence lizard, *Sceloporus undulatus*	●	●	●
Short-horned lizard, *Phrynosoma douglassi*	●		●
Zebratail lizard, *Callisaurus draconoides*		●	●
Garter snake, *Thamnophis sp.**			
Sonoran mountain kingsnake, *Lampropeltis pyromelana*	●		
Bullsnake, *Pituophis melanoleucus*	●		
Sonoran whipsnake, *Masticophis taeniatus*	●	●	
Mohave rattlesnake, *Crotalus scutulatus*			●
Blacktailed rattlesnake, *Crotalus molossus*	●	●	

*Detected by the BLM on April 4, 1996.

Thirteen federal or state threatened, endangered and sensitive species were considered potentially present on or near the MSA. Each of these species is discussed in greater detail below.

The wildlife community in and around the proposed Yarnell Project area has been significantly influenced by historic mining activities and, to a lesser extent, by recent mineral exploration, recreational activities and livestock grazing. The effect of these activities has adversely influenced wildlife use of the area by converting native habitats to barren, unreclaimed habitats and displacing wildlife from human activity areas, although some components of the wildlife community have benefitted from abandoned underground mine workings (e.g., bats, javelina and others) and from seasonal water availability at stockponds.

3.3.2.1 Habitat Types

Habitats in the MSA, water supply and pipeline corridors are dominated by shrubs. Major habitats include: oak shrubland, burned oak shrubland, mountain mahogany shrubland, a low shrub community, wetlands along Yarnell Creek and Fools Gulch, disturbed areas and historic mine tunnels. Vegetative communities associated with these habitats were described previously in Vegetation Section 3.3.1.

Oak Shrubland. Oak shrubland is the most extensive habitat on site, occupying approximately 52 percent of the MSA. Two communities are present, based on aspect and soil moisture. The steep north-facing slopes are characterized by a dense woody community dominated by live oak with a relatively cool, moist, diverse understory, covering approximately

TABLE 3-10
Birds Detected Near the Mine Site Study Area and Water Supply Corridors
During October 1991, July 1992 and September-October 1996 Surveys

SPECIES	SURVEY PERIOD		
Common Name, Scientific Name	October 1991	July 1992	October 1996
Turkey vulture, *Cathartes aura*	●		●
Golden eagle, *Aquila chrysaetos*		●	●
Cooper's hawk, *Accipiter cooperii*			●
Red-tailed hawk, *Buteo jamaicensis*	●	●	
American kestrel, *Falco sparverius*			●
Prairie falcon, *Falco mexicanus*			●
Gambel's quail, *Callipepla gambelii*	●	●	●
Mourning dove, *Zenaida macroura*	●	●	●
Greater roadrunner, *Geococcyx californianus*	●		
White-throated swift, *Aeronautes saxatalis*	●		●
Broad-tailed hummingbird, *Selasphorus platycercus*			●
Northern flicker, *Colaptes auratus*	●		●
Gila woodpecker, *Melanerpes uropygialis*			●
Ladder-backed woodpecker, *Picoides scalaris*	●		
Western kingbird, *Tyrannus verticalis*		●	●
Say's phoebe, *Sayornis saya*	●	●	●
Violet-green swallow, *Tachycineta bicolor*	●		
Scrub jay, *Aphelocoma coerulescens*			●
Pinon jay, *Gymnorhinus cyanocephalus*	●	●	●
Common raven, *Corvus corax*		●	●
American crow, *Corvus brachyrhynchos*	●		●
Verdin, *Auriparus flaviceps*	●		
Bushtit, *Psaltriparus minimus*		●	
Bewick's wren, *Thryomanes bewickii*		●	
Cactus wren, *Campylorhynchus brunneicapillus*	●	●	●
Rock wren, *Salpinctes obsoletus*	●	●	●
Canyon wren, *Catherpes mexicanus*	●	●	
Northern mockingbird, *Mimus polyglottos*	●	●	
Sage thrasher, *Oreoscoptes montanus*	●		
Black-tailed gnatcatcher, *Polioptila melanura*	●		●
Phainopepla, *Phainopepla nitens*	●		●
Loggerhead shrike, *Lanius ludovicianus*	●		
Western meadowlark, *Sturnella neglecta*	●		
Brown-headed cowbird, *Molothrus ater*		●	
Scott's oriole, *Icterus parisorum*		●	
House finch, *Carpodacus mexicanus*		●	●
Pine grosbeak, *Pinicola enucleator*	●		
Spotted towhee, *Pipilo erythrophthalmus*	●	●	●
Canyon towhee, *Pipilo fuscus*	●	●	●
Lark sparrow, *Chondestes grammacus*	●		
Black-throated sparrow, *Amphispiza bilineata*		●	
Sage sparrow, *Amphispiza belli*	●		●
Dark-eyed junco, *Junco hyemalis*	●		
Brewer's sparrow, *Spizella breweri*	●		
White-crowned sparrow, *Zonotrichia albicollis*	●		●
			●

TABLE 3-11
Mammals Detected Near the Mine Site Study Area and Water Supply Corridors During October 1991, July 1992 and September-October 1996 Surveys

SPECIES	SURVEY PERIOD		
Common Name, Scientific Name	October 1991	July 1992	October 1996
Fringe-tailed myotis, *Myotis thysanoides*	●	●	
Western pipistrelle, *Pipistrellus hesperus*	●		●
Big brown bat, *Eptesicus fuscus*	●	●	●
Townsend's big-eared bat, *Plecotus townsendii*	●	●	●
Desert cottontail, *Sylvilagus audubonii*		●	●
Black-tailed jackrabbit, *Lepus californicus*	●	●	
Cliff chipmunk, *Eutamias dorsalis*	●		●
Harris' antelope squirrel, *Ammospermophilus harrisii*	●	●	●
Rock squirrel, *Spermophilus variegatus*	●		
Round-tailed ground squirrel, *Spermophilus tereticaudus*		●	
Pocket mouse, *Perognathus* sp.	●	●	
Kangaroo rat, *Dipodomys* sp.	●	●	
Canyon mouse, *Peromyscus crinitus*	●	●	
Deer mouse, *Peromyscus maniculatus*	●		
White-throated wood rat, *Neotoma albigula*	●	●	●
Coyote, *Canis latrans*	●	●	●
Gray fox, *Urocyon cinereoargenteus*		●	●
Ringtail, *Bassariscus astutus*		●	●
Badger, *Taxidea taxus*			●
Hog-nosed skunk, *Conepatus mesoleucus*	●	●	
Mountain lion, *Felis concolor*			●
Bobcat, *Felis rufus*			●
Collared peccary, *Tayassu tajacu*	●	●	●
Mule deer, *Odocoileus hemionus*	●	●	●

20 percent of the MSA. Large expanses of the xeric south-, west- and east-facing slopes are dominated by a lower density live oak shrubland covering approximately 32 percent of the MSA.

Burned Oak Shrubland. Several years prior to 1991, a fire burned part of the oak shrubland on the southwestern portion of the MSA. This area was mapped and vegetatively sampled in 1991 and 1994 as a separate community. This community, covering approximately 17 percent of the MSA, is dominated by live oak. Snakeweed, turpentine bush and other shrubs are also present. Surveys conducted in 1996 found that the community was well on its way toward recovery as an oak shrubland.

Mountain Mahogany. Coarse, rocky soils and boulder piles on exposed ridgetops in the southern half of the MSA are distinguished by a mountain mahogany shrubland that covers approximately eight percent of the study area. The mountain mahogany shrubland also contains numerous other shrubs.

The oak and mountain mahogany shrub communities provide the most extensive, structural, vegetative habitat on site. This structure is important for a wide variety of avian and mammalian species for shade, cover, forage and hunting and nesting sites. Mule deer and javelina commonly forage and bed in these types. Javelina forage heavily on prickly pear, an understory species, particularly as fruit is forming. The variety of shrubs in this community seasonally produce an abundance of seeds and berries. This helps support an abundance of mammals and birds, including a moderate number of Gambel's quail. Other common wildlife associated with these communities include western whiptails, eastern fence lizards, Sonoran whipsnakes, mourning doves, pinyon jays, rock wrens, northern mockingbirds, spotted and canyon towhees, desert cottontails, black-tailed jackrabbits, white-throated woodrats and a variety of other small rodents. The cover provided by the boulders associated with this community duplicates many of the shade, cover, forage and roosting functions provided by the taller vegetation.

Turpentine Bush/Wait-a-Minute Bush. Steep south- and southeast-facing slopes are dominated by a dense, low shrub community, comprising approximately 20 percent of the MSA. This community is co-dominated by turpentine bush and wait-a-minute bush. The low structural diversity of this habitat limits the value of this community for some wildlife. Some of the more representative wildlife species in this habitat include western kingbirds, Say's phoebes, sage thrashers and lark sparrows.

Wetlands. In Fools Gulch, the wetlands/riparian vegetation begins immediately west of the MSA. Several springs and seeps create a small, linear, discontinuous wetland along approximately 800 feet of the stream channel. The width of this wetland varies from two to 15 feet. It changes to xeric upland vegetation where water from the springs and seeps is not present. The wetland has been severely impacted by livestock grazing. The water supply from the spring fluctuates from year to year and results in a wetland that varies in size from season to season. This wetland, comprising approximately 0.15 acre, contains a few trees including Gooding willows and Fremont cottonwood and sparse shrubs including seepwillow and saltcedar. Graminoids, including Baltic rush, Bermuda grass and rabbitwood grass and a forb, cocklebur, are present.

The wetlands/riparian vegetation in Yarnell Creek begins about 300 feet west of the primitive road crossing and extends downstream approximately 1,700 feet linearly. This discontinuous wetland, comprising less than an acre, includes eight individual, isolated Fremont cottonwoods up to 25 to 30 feet tall, five Gooding willow shrubs 10 to 15 feet tall, some Emory baccharis and saltcedar. Localized herbaceous understory plants include rabbitfoot grass, bulrush, cattails and other herbaceous species. A 20-foot diameter pool, periodically used for livestock watering, and several smaller pools of water, three to four feet in diameter and less than six inches deep, seasonally occur in the upper section of the wetlands where the substrate changes from sand to exposed bedrock. The extent of these pools varies within and between years. This linear wetland/riparian community immediately changes to xeric upland vegetation outside of the intermittent creek channel and in portions of the channel where water from seeps is no longer available. No fish, amphibians or any other wildlife species with riparian/wetland affinities were detected in this community during wildlife or vegetative baseline surveys. This is likely due to the isolation, ephemeral nature of surface water, limited structural vegetative development and small linear configuration of this otherwise valuable habitat type. However, lowland leopard frogs were observed by BLM staff at Cottonwood Spring in April 1996.

There are no perennial water sources in the MSA or pipeline corridors. The MSA is 10 to 20 miles upstream of any perennial creeks, although some local creeks may perennially support water. Several shallow basins have been excavated to provide water for stock by retaining precipitation. Cottonwood Spring, Fools Gulch Spring and the Tom Cat Tank stockpond provide water seasonally.

Disturbed Areas. Disturbed areas on the previously mined site include historic tailings at the head of Yarnell Creek, roads and unreclaimed mined land. Excluding roads, these areas total three percent of the MSA. These areas have limited value to wildlife, but are commonly used by a wide variety of lizards, birds and some mammals for dust bathing.

Mine Tunnels. At least 3,800 feet of historic underground mine workings (50 years or older) occur within the MSA. These abandoned tunnels and additional stopes and shafts support a moderate diversity, but a low number, of bats, and represent cool, diurnal and seasonal refuge for snakes, skunks, javelina and other wildlife species. Due to reduced evaporative losses, some of the mine tunnels support small pools of infiltrated precipitation for up to several months. Although water quality is uncertain, these pools are used by wildlife, including bats, javelina and ringtails.

Sonoran Desertscrub. Habitats in the vicinity of the 2BCD well section of the water supply corridor transition from those associated with the chaparral vegetative community to those associated with the lower elevation, Sonoran desertscrub-Arizona upland community. Paloverde-mixed cacti scrub habitats in this latter community were described previously in the Vegetation section.

3.3.2.2 Threatened, Endangered and Sensitive Species

Based on regional distributions and/or habitat affinities, the U.S. Fish and Wildlife Service (USFWS) and AGFD identified 13 federal or state threatened, endangered and sensitive wildlife species as potentially present at the MSA (Table 3-12).

Except for occupied desert tortoise habitat in sections of the 2BCD well pipeline corridor and scat that may have been from a chuckwalla in the 2BCD well pipeline corridor, no other evidence of any of these species was detected during baseline surveys. Field surveys were specifically designed to detect the species of special concern that had the greatest likelihood of being present (i.e., bats and desert tortoise), based on the occurrence of potential habitats, known species' distributions and species' habitat affinities. Of the undetected species, it is possible, though unlikely, that three (peregrine falcon, Arizona Southwestern toad and Yavapai Arizona pocket mouse) may be present, but were not detected, possibly due to survey methods, survey timing and/or the short duration of use that might occur on the MSA. The AGFD's Heritage Data Management System had no records of any other endangered, threatened or other special status wildlife species in the vicinity of the MSA or pipeline corridors. The status of all 13 species potentially present is discussed below.

Under the ESA, formal consultation with the USFWS is not required if the BLM determines that the proposed action would have no impact on listed species. Pursuant to fulfilling requirements of the

TABLE 3-12
Threatened, Endangered and Sensitive Species

Species	Designation
Arizona Southwestern toad, *Bufo microscaphus*	S[a]
Lowland leopard frog, *Rana yavapaiensis*	S
Sonoran desert tortoise, *Gopherus agassizii*	S
Chuckwalla, *Sauromalus obesus*	S
Northern goshawk, *Accipiter gentilis*	S
Peregrine falcon, *Falco peregrinus*	FE[b]
Mexican spotted owl, *Strix occidentalis lucida*	FT[c]
Cactus ferruginous pygmy-owl, *Glaucidium brasilianum*	FE
Southwestern willow flycatcher, *Empidonax traillii extimus*	FE
California leaf-nosed bat, *Macrotus californicus*	S
Lesser long-nosed bat, *Leptonycterus sanborni*	FE
Cave myotis, *Myotis velifer*	S
Yavapai Arizona pocket mouse, *Perognathus amplus amplus*	S

[a] S = Sensitive Species (identified by the USFWS, BLM or AGFD as being of special concern).
[b] FE = Federal Endangered species.
[c] FT = Federal Threatened species.

ESA, project impacts were evaluated for those species listed in Table 3-12 that were identified by the USFWS and BLM as being potentially present in or adjacent to the MSA. The analysis indicated that the proposed action would have no effect on any of the listed species. Therefore, formal consultation was not required.

Arizona Southwestern Toad. The Arizona Southwestern toad (a federal species of concern) inhabits streams in rocky canyons and woodlands in the pine-oak zone of southeastern Arizona. It breeds in streams or creeks and is not directly dependent on rainfall. This species' distribution in southeastern Arizona extends toward, but does not include, the MSA in west central Arizona.

No toads were detected on or around the MSA during field surveys; however, no nocturnal surveys were conducted through the most suitable habitats during conditions when this toad would be most detectable. This level of effort was considered appropriate because the MSA is outside the toad's known distribution and in a lower life zone. There are no perennial streams within the MSA and no open water sources available to toads, except at the mouth of several adits, the stockpond (Tom Cat Tank), the pond fed by Cottonwood Spring and at several small ephemeral pools occasionally present along a section of Yarnell Creek. A small, covered pool at the entrance to an adit on the southeastern portion of the MSA was surveyed during July and October surveys. There was no evidence of any toads or their use of the pool for reproduction. July 1992, October 1991 and April and October 1996 surveys along the headwater section of Yarnell Creek within the MSA also located no evidence of toads; however, no pooled water was present along the series of seeps when the 1992 surveys were conducted. Toads would not be expected to be detectable under those conditions. A survey of these seeps by WER's plant ecologist in the fall of 1994, when pools were present, did not detect any amphibians. Lowland leopard frogs were detected at Cottonwood Spring in April 1996. No evidence of amphibians was detected during October 1996 surveys of pools of water downslope of Fools Gulch Spring in the vicinity of the water supply corridor.

More suitable, potential Southwestern toad habitat begins less than two miles down drainage from the MSA, near the confluence of Yarnell and Antelope creeks, and continues down Antelope Creek. This area supports intermittent water for longer periods, including at least intermittent pools. Reaches of Antelope (1993, 1995) and Weaver creeks (1993) were surveyed for native fish and ranid frogs by BLM biologists (T. Hughes, BLM, personal communication, L. Saylor, AGFD, Oct. 13, 1995 letter; D. Hoerath, BLM, Feb. 1997 personal communication). No Southwestern toads were located during those surveys.

Lowland Leopard Frog. Lowland leopard frogs primarily occur in permanent waters below 3,000 feet in south-central, west-central and extreme northwestern Arizona (AGFD 1988). Elevations on the MSA range from approximately 4,600 to 5,100 feet, so the site is well above the primary range of this species. As described above, there are no perennial or intermittent streams on the MSA and no open water sources available to frogs, except at the isolated entrance to the "Water Adit" and at small ephemeral pools present some years in the vicinity of Cottonwood and Fools Gulch springs. Lowland leopard frogs were detected at Cottonwood Spring on April 4, 1996. This site and adjacent reaches of Yarnell Creek were probably colonized from more permanent water sources downstream during suitable dispersal conditions.

Occupied lowland leopard frog habitat occurs downstream of the MSA. During 1993, 1995 and 1996 surveys, BLM biologists located leopard frogs as close as Antelope Creek, near the confluence of Yarnell Creek (T. Hughes, D. Hoerath, BLM, personal communication, L. Saylor, AGFD, Oct. 13, 1995 letter). Canyon treefrogs were also located in this area in 1996 (D. Hoerath, BLM, personal communication). Leopard frogs were also located in Weaver Creek in 1993. This occupied habitat is approximately two miles down drainage from the MSA.

Desert Tortoise. The MSA occurs at the upper elevational margin of the non-urban Sonoran desert tortoise distribution, outside of BLM-categorized tortoise habitat. While Sonoran desert tortoises (a federal species of concern and state sensitive species) do not generally occur within the relatively high chaparral vegetative community, the MSA is in a transition zone with lower, more typical tortoise habitats associated with the Sonoran desertscrub-Arizona upland community. These latter habitats overlap portions of the 2BCD well water supply pipeline and are classified by the BLM as category II and III tortoise habitat.

Following BLM consultation, a July 8, 1992, variable width line transect was used to systematically search approximately 143 acres of the most suitable habitat on the MSA and surrounding area for desert tortoise sign. Total transect length was 5.4 miles. No evidence of desert tortoise was located along this transect, in any of the historic mine workings or during seven other days of field surveys on the MSA. The need for this survey was based on one desert tortoise located by AGFD personnel approximately 0.47 miles south of the MSA at the head of Indian Creek drainage in 1991. Desert tortoise scat was also located around the microwave communication tower approximately 0.34 miles south of the MSA. Areas where sign was located were within the chaparral-Arizona upland desert transition zone and similar to habitats present on the MSA.

In the marginal habitats within this transition zone, tortoises may occasionally occur or be resident at low densities on the MSA, but no evidence of their presence was located during systematic and other surveys through the most suitable habitats on site. Therefore, the MSA remains outside of categorized tortoise habitat.

The upper portion of the TW-01 well pipeline alignment, extending east outside the MSA, supports shrub-dominated chaparral habitats similar to those on the project area. No sign of desert tortoise was located during a September 30, 1996, survey of the corridor. The area affected by the existing TW-01 well and proposed pipeline to the mine is considered to be non-desert tortoise habitat, similar to that characteristic of the proposed mine site.

The October 1, 1996, survey of the 2BCD well pipeline corridor determined that the vegetative "break" between chaparral-dominated, non-tortoise habitats and the Sonoran desertscrub-Arizona Upland association, more characteristic of tortoise habitat, occurred along a ridge uphill of the proposed pump station and 1,000-gallon water tank in the middle of Section 22 (Figure 3-14). This tortoise habitat "boundary" occurs on state land.

A total of two tortoises, eight scats in six groups, one piece of tortoise plastron and numerous potential shelter sites was located in the sections 22 and 21 portion of the proposed 2BCD well corridor (Figure 3-14). No sign was located in washes or below the 3,380-foot elevation, which corresponds to the toe slope of the bajadas and boulder outcrops at the base of the mountains. No burrows were detected along the alignment; however, the transect followed a linear corridor and that portion through what was considered the highest quality tortoise habitat mostly followed an old road bed or a wash. Tortoises probably occur elsewhere along the lower pipeline alignment in washes and on flats nearly one mile away from rocky bajadas and mountain slopes; however, that habitat is of lower quality where tortoises probably occur at lower densities.

BLM land affected by the 2BCD well water supply corridor include parcels on sections 28 and 33. State land affected include parcels on sections 22, 33, 34, 3 and 2. Private land affected by the pipeline corridor include parcels on sections 21, 28, 15 and 23. Tortoise habitat quality differs within these sections.

Based on field survey results and corroborated by the BLM (D. Hoerath, wildlife biologist, personal communication Oct. 2 and 25, 1996), the following tortoise category boundaries were determined (Figure 3-14). Desert tortoise habitat categories range from I to III (Desert Tortoise Compensation Team 1991). Briefly, category I habitat is essential to maintaining large viable populations. Category II habitat may be essential to maintaining viable populations, and category III habitat is not essential to maintaining viable populations. The Yarnell Mine site and the TW-01 well/pipeline are outside of tortoise habitat. Non-tortoise habitat also extends down the 2BCD well pipeline to approximately the 3,900-foot elevation on state land in Section 22. Lower pipeline segments on Section 22 and portions of Section 21 (private and BLM) containing rocky bajadas and boulder outcrops on mountain slopes support relatively high-quality tortoise habitat with at least medium tortoise densities that are important to the viability of this tortoise population. This area would be most appropriately classified as category II tortoise habitat. This finding is consistent with the results of a recent survey conducted on a contiguous property in Section 21 (T. Hughes, BLM, personal communication). The boundary between category II and III habitat occurs where the pipeline leaves rocky terrain and enters and follows the sandy bottom of Fools Gulch in the SE¼ of Section 21. Habitat along the pipeline below the category II/III boundary [in portions of sections 21 and 28 (private and BLM)] to the County Road (up to one mile from the toe slope of the mountains) should be classified as category III habitat. Unoccupied tortoise habitat extends below this point along the remainder of the 2BCD well pipeline (state and BLM land).

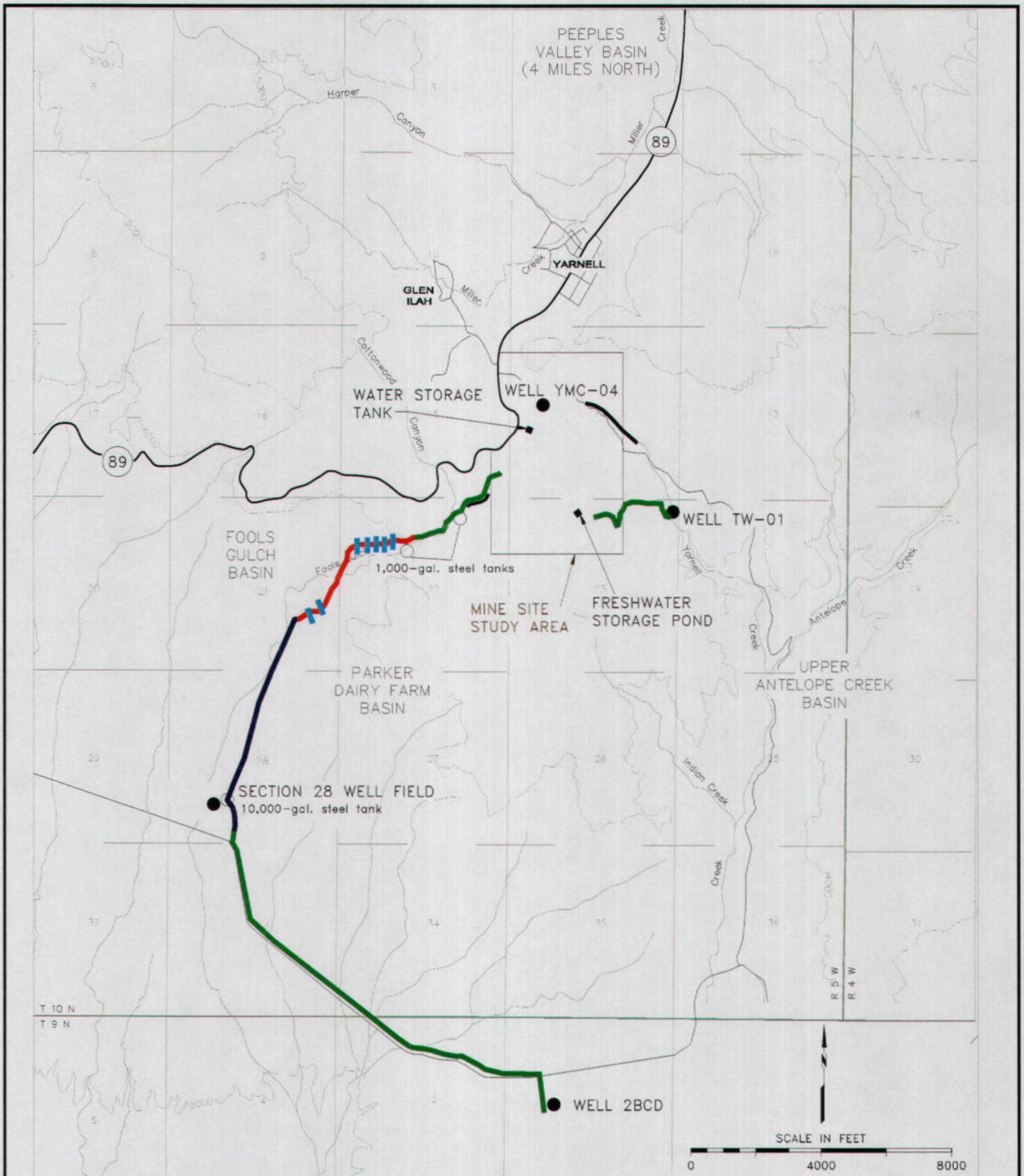
Chuckwalla. Chuckwallas (a federal sensitive species) are a widely distributed desert iguanid closely associated with rocky terrain and creosote bush, a staple food. This species is generally associated with lower elevation Sonoran desertscrub communities, more characteristic in the 2BCD well pipeline corridor, rather than the higher elevation chaparral, which is more characteristic of the MSA. Scat that may have been that of a chuckwalla was located in apparently suitable habitat on private land (Section 21) along the 2BCD well pipeline corridor on October 1, 1996.

Northern Goshawk. The northern goshawk (a federal and state sensitive species) is a forest-interior species associated with mountainous coniferous forests and high mesas in the northeastern half of Arizona (AGFD 1988). A small breeding population also occurs in suitable habitats in southeastern Arizona. The low-elevation chaparral habitats on the MSA are structurally unsuitable for this species, and there are no records of this species from the general area.

Peregrine Falcon. Peregrine falcons are a federal endangered species and state sensitive species. Two peregrine falcon subspecies occur in Arizona (AGFD 1988). *F. p. anatum* breeds on isolated cliff ledges statewide. This subspecies is recovering in the state after the adverse effects of pesticide use north of Mexico. There are no known active, inactive or historic peregrine falcon aeries or hack sites in the vicinity of the MSA or in adjacent areas where the site could be considered to be within a hunting territory. *P. f. tundrius* occurs statewide as a migrant, transient and/or (rarely) as wintering individuals. While it is possible that such use could occur in the vicinity of the MSA, there are no habitats on site that support moderate or high densities of preferred prey species, nor particularly favorable settings which can expose prey to peregrine attack. The down-drainage riparian zone along Antelope Creek, as well as some surrounding creeks in steep canyons, provide the type of prey base in physiography where prey is vulnerable to peregrines. Nevertheless, there is no evidence of any peregrine use of the study area.

Mexican Spotted Owl. Mexican spotted owls (a federal and state threatened species) inhabit steep, wooded canyons in mountains and on high mesas, primarily in the northeastern half of Arizona (AGFD 1988). They require a cool microclimate and, possibly, a permanent water source. They are threatened by logging and possibly by competition with great horned owls (*Bubo virginianus*) in thinned forests. The low-elevation, chaparral habitats on the MSA are structurally unsuitable for this species, and there are no records of this species from the general area.

Cactus Ferruginous Pygmy-Owl. Cactus ferruginous pygmy-owls (a federal and state endangered species) are now present in southern



EXPLANATION

- NON-TORTOISE HABITAT
- CATEGORY II TORTOISE HABITAT
- CATEGORY III TORTOISE HABITAT
- DESERT TORTOISE SIGN
- DELINEATED WETLANDS

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-14
WATER SUPPLY AND PIPELINE CORRIDORS DESERT TORTOISE SIGNS AND HABITAT

Arizona, in such areas as xeric riparian washes in Organ Pipe Cactus National Monument, riparian forests of the lower San Pedro River and saguaro forests near Tucson (AGFD 1988). There is no suitable habitat for this owl on or around the proposed study area, which is outside the range for the species.

Southwestern Willow Flycatcher. In Arizona, the Southwestern willow flycatcher (a federal and state endangered species) is closely associated with wooded wetland and riparian habitats within the Sonoran lifezone. It may also occur at higher elevations where structurally suitable habitats are available. This species has been extirpated from areas and is further threatened by ongoing riparian habitat losses. There is no suitable habitat for this flycatcher on or around the MSA, and there are no records of it from the surrounding area. The linear, discontinuous riparian vegetation along the 200-foot reach of Yarnell Creek on the northeastern portion of the MSA is considered to be too small a habitat block to support even one pair of these flycatchers.

California Leaf-nosed Bat. The California leaf-nosed bat (*Macrotus*), a federal and state sensitive species, is a member of a tropical family that only enters the U.S. in the southern parts of California, Arizona and Nevada (Barbour and Davis 1969). In Arizona, it inhabits Sonoran desertscrub habitats in the southern and western parts of the state (Hoffmeister 1986; AGFD 1988). The MSA, along the transition between the upper elevation chaparral vegetative community and the lower elevation Sonoran desertscrub-Arizona upland vegetative communities, is also at the upper elevational boundary of *Macrotus*'s elevational distribution.

Macrotus do not hibernate and because they poorly regulate their body temperatures, they rely on geothermally heated caves and abandoned mine tunnels (>80° F) as winter roosts (Bell et al. 1986). While roosts higher than 80° F may not be difficult to find in the desert during summer, caves and mine workings with lower temperatures are not used as winter roosts (Bradshaw 1962; Dr. Patricia Brown, pers. comm. 1991) and the species cannot tolerate temperatures in the 40s or 50s for more than a few hours (AGFD 1988). Although maternity roosts are important, winter roosts are crucial because they are so uncommon. Winter numbers and distribution of *Macrotus* are dictated not only by the availability of suitable winter roosts, but also by the quantity, quality and proximity of foraging habitat to roost sites.

No *Macrotus* were located in any of the historic mine workings on the MSA. Furthermore, these workings are not geothermally heated. The warmest October temperature measured during nearly complete surveys of all workings was 64° (range 55 to 64°), too cold for *Macrotus* roost use. While it is possible that *Macrotus* from the desertscrub zone below the MSA could forage up to the mine, perhaps using shallower, warmer adits as night roosts, evidence contraindicates that *Macrotus* utilize the historic mine workings on site as maternity, summer or winter roosts. It is most likely, based on available evidence and preliminary data on nightly foraging ranges (Brown 1993; Brown et al. 1993; Dr. Patricia Brown, pers. comm. 1993; Thompson 1993), that the MSA is elevationally above the range of the California leaf-nosed bat.

Lesser Long-nosed Bat. Lesser long-nosed bats (*Leptonycteris*) are summer residents in the south-central and southeastern parts of Arizona where they inhabit desert grasslands and scrubland up to the edge of the oaks (Hoffmeister 1986). These bats are nectar and pollen feeders that forage in areas of saguaro, agave, ocotillo, paloverde and prickly pear. *Leptonycteris* roost during the day in mine tunnels and caves. Their range does not extend into the MSA and pipeline corridors (Fleming and USFWS 1977). It is likely that the MSA and pipeline corridors are elevationally above the range of the lesser long-nosed bat. No *Leptonycteris* were located in any of the historic mine workings on the MSA and there are no records of this species from the local area.

Cave Myotis. Cave myotis inhabit mine shafts, tunnels, caves and bridges in deserts containing creosote bush, paloverde, brittlebush and cacti of southern Arizona (Hoffmeister 1986). According to Hoffmeister, their general range overlaps the MSA and there is a record of the species from one mile northwest of Congress. That location is within the Sonoran desertscrub vegetative community, which forms the upper elevational distribution of the species' range. While this bat inhabits xeric areas, it is never more than a few miles from an open water source, such as tanks, canals or creeks. Within mine workings, cave myotis are usually near the entrance. In winter, this species migrates to the southernmost part of Arizona or further south.

No cave myotis were identified during the July 1992 and October 1991 and 1996 surveys of the historic mine workings on the MSA. All portions of workings within several hundred feet of each opening were surveyed. If even a small cluster of these bats was present, it would likely have been detected, either visually or, if non-torpid, by their characteristic twitter. No historic mine workings occur on or in the vicinity of the water supply pipeline corridors that would be affected by the proposal. As suggested by Hoffmeister (1986), this species probably does not winter in the vicinity of the MSA and its summer range probably does not extend upward into the chaparral habitat characterizing the MSA.

Yavapai Arizona Pocket Mouse. In the vicinity of the MSA, the Yavapai Arizona pocket mouse (a federal sensitive species) inhabits Sonoran desertscrub (Arizona upland subdivision) (Hoffmeister 1986), the lower vegetative community that transitions into the chaparral community in which the MSA is located. Throughout most of its Arizona distribution, this pocket mouse inhabits lower vegetative communities than those found in the study area. However, on the western edge of Arizona it has been found associated with scattered scrub oak (Hoffmeister 1986), similar to habitat on the MSA. This species feeds almost exclusively on seeds.

There have been no trapping surveys conducted, which would be required to detect this species. While it is possible that this species may occur on site, it is likely that, like *Macrotus* and *Leptonycteris*, two other Sonoran desertscrub species, its distribution only extends slightly above the foot of the Weaver Mountains and does not overlap the MSA.

3.3.2.3 Other High Interest Species

Mule Deer. Mule deer are common residents on the MSA. During field surveys, they were most commonly associated with the oak shrubland and mountain mahogany habitat types where they foraged and bedded. Surveys were not timed to detect if fawning occurs on the MSA. Some deer hunting probably occurs on site.

Collared Peccary. Collared peccary, or javelina, are also common on the MSA. The abundance of cacti and other forage, seasonal fruits and other mast, cover and water sources on the MSA provides high-quality habitat. Eleven of 13 historic adits on the MSA are known to provide javelina cover, thermal refuge and/or water sources.

Game Birds. Gambel's quail and mourning dove were the only game birds detected on the MSA. Both species are residents, although the former is considerably more common. The abundance of insects, berries and seeds within various shrubby habitats provides ideal habitat for these species. Quail broods were commonly observed during July surveys. Quail were using the "Water Adit" as a watering source in July. Most hunting on site is oriented toward quail.

Lagomorphs. Desert cottontail and black-tailed jackrabbit were the only lagomorphs detected on site. It does not appear that much, if any, hunting is oriented toward these species.

Other Game Species. Black bear and mountain lion are other big game species that may occasionally range across the MSA. The former species would be attracted to the site by seasonal fruit and mast crops and for opportunistically captured prey. The latter species would be attracted by deer, javelina and other prey. There are no bighorn sheep (*Ovis canadensis*) in the Weaver Mountains.

3.3.2.4 Other Wildlife Groups

Tables 3-9 through 3-11 (shown previously) list those amphibians, reptiles, birds and mammals detected on the MSA during 11 field days on October 7 to 10, 1991; July 6 to 9, 1992; and September 30 to October 2, 1992. The timing of those surveys was primarily oriented toward important periods for bats and desert tortoise and secondarily toward discerning use by other wildlife species and groups. While specific surveys were conducted to develop a complete list of all species using the MSA, no small mammal trapping was conducted. Because of this and temporal survey limitations, tables 3-10 through 3-12 do not represent a complete list of all species that might be present.

Fish. There are no perennial water sources or permanent pools on the MSA that could support fish. All local creeks, including Fools Gulch and Yarnell, Antelope and Indian creeks are intermittent, and the MSA is 10 to 20 miles above any perennial creeks. BLM biologists searched reaches of Antelope and Weaver creeks below the MSA for native fish in 1993 (T. Hughes, BLM, personal communication). No native or other fish or permanent pools were located during those surveys.

Amphibians. Desert habitats on the MSA and along the water supply and pipeline corridors support localized amphibian habitat where springs, seeps and intermittent creeks support pools of water for extended periods. Both lowland leopard frogs and canyon treefrogs were detected, but only the former species was detected in the MSA along upper Yarnell Creek.

Reptiles. The chaparral habitats on the MSA and Sonoran desertscrub habitats along the water supply corridor support a moderate diversity of reptiles. Fifteen species were detected during field surveys, including desert tortoise, eight lizards and six snakes (Table 3-9). Additional species are probably present.

Birds. The MSA supports a moderate variety of habitats within the chaparral vegetative community.

This habitat diversity is reflected in bird diversity. Forty-five bird species were detected on the MSA during field surveys in July, September and October. The July surveys occurred following or at the end of the breeding season when some species may have dispersed from the site. September and October surveys were conducted toward the end of summer and before all winter residents, migrants and transients had arrived or moved through the site for winter. As a result, the list of birds provided in Table 3-10 is incomplete, but does include the most common species seasonally present.

Bats. Because of the historic mine workings, last used in 1942, bats were of particular interest to resource agencies. July 1992 field surveys were oriented toward detecting summer and maternity roosts, while October 1991 and 1996 surveys sought winter roosts.

There were 13 open mines/adits on the MSA at the time of the surveys with a total of at least 3,786 linear feet of tunnels, with individual tunnels ranging from 25 to more than 2,000 feet. Where intact, tunnels are approximately six feet wide and seven feet high. Stopes, raises and a few shafts are present in the four largest mines. Entrances to many of these mines have collapsed, leaving only two-foot high, unsupported earthen entrances that will continue deteriorating. Most underground workings are intact and would retain their integrity and value as bat habitat for many years. Most stopes, multi-tunnel intersections and rooms within the larger mines have experienced ceiling collapses.

Low numbers of a moderate diversity of bat species use the historic mine workings in the winter. Four bat species (totaling at least 18 individuals, including the fringe-tailed myotis, western pipistrelle, big brown bat and Townsend's big-eared bat) were detected during October 1991 surveys when most bats should have arrived at their winter roosts. Hibernating or torpid bats of all species were located in the three largest mines with the most stable environmental conditions. Because of the extent of mine workings, not all mines were surveyed on the same day. Because of survey disturbance and normal shifting among roost sites, the total number of bats on site could not be precisely determined from survey results. Guano piles, prey remains and other evidence of bat use that could have collected over 50 years in all mines suggests only an incidental level of bat use. There were probably no more than three to four dozen bats using all mines during the October 1991 survey period. October 1996 surveys were repeated in the West and Main adits, which were the mines most heavily used by bats in 1991. These surveys confirmed the previous type and level of bat use.

There was no evidence of maternity colonies in the underground mine workings. Three bat species — Townsend's big-eared bat, fringe-tailed myotis and big brown bat — totaling six individuals, were detected during July 1992 surveys after females would have congregated at maternity roosts. All six bats handled were males, suggesting that these mines represent summer bachelor roosts.

It appears that despite the extensive underground workings available to bats for the last 50 years, bat use in the Yarnell underground is quite limited. This may be partially explained by human disturbance and the proximity and visibility of the site from State Highway 89. While there is evidence of human use in some mines, there is no evidence of such use from the four larger mines and apparently no relationship between this evidence and bat use. Similar and less extensive abandoned mine complexes are common in the area. It is possible that more isolated mines receive heavier use or that local mines receive only light use because of overall abundant mine roost and natural roost sites. No historic mine workings occur on or in the vicinity of the water supply corridors that would be affected by the proposal.

Small Mammals. The baseline surveys detected a total of nine small mammal species at the MSA (Table 3-11). Due to the secretive, nocturnal nature of many small mammals, it is likely that a number of additional species were undetected. Mountain mahogany and oak habitats, which produce abundant seed and berry crops, probably support the greatest abundance of small mammals, relative to other local habitats. Small mammals are ecologically important as herbivores, seed dispersers and a prey base for predators.

Raptors. Red-tailed hawks and golden eagles were the only resident raptors detected on the MSA during baseline surveys, although other species, including Cooper's hawk, American kestrel and prairie falcon, are also seasonally present. Turkey vultures were common in the area, and other predatory avian species, including ravens, greater roadrunners and loggerhead shrikes, were also detected. The habitats present on site support a moderate diversity of reptilian, avian and mammalian prey species.

Terrestrial Predators. Evidence of coyote, gray fox, ringtail, hog-nosed skunk, mountain lion and bobcat was recorded at the MSA and along the water supply corridor. Predators are primarily nocturnal, secretive and difficult to detect. Raccoon, weasel and other species of skunk may use the area as well. Predator use of the area is dictated by the availability of prey and by cover, which is well developed on the MSA.

3.4 AIR RESOURCES

3.4.1 CLIMATE

The climate of the MSA is characterized by low to moderate precipitation, dry winds and generally warm temperatures. The annual average temperature is 60°F, and the area generally receives between 15 and 20 inches of precipitation each year. The region experiences a high percentage of sunshine and low humidity. The period from late fall through early spring has moderate daytime temperatures and sub-freezing temperatures routinely at night. The late summer months are typically quite warm with occasional thunderstorms. A mountainous region, oriented southeast to northwest, separates the state into a higher elevation plateau in the northeast and a lower, desert-like region in the southwest. The MSA (elevation 4,870 feet MSL) is at the edge of the mountainous region, resulting in highly localized climatic conditions.

3.4.1.1 Distinguishing Characteristics of the Region

From November through March, storm systems from the Pacific move across Arizona. These systems can bring snow to the Yarnell area. Summer rainfall begins in early July and can last until mid-September. April, May and June are the months with the greatest number of clear days, while December through February, July and August are the cloudiest. The humidity is generally low, with the higher values occurring during the late-summer thunderstorm season.

Cold air masses from the north sometimes penetrate into the region, bringing substantially colder temperatures. Large extremes occur regularly between day and night temperatures. This diurnal pattern is strongest during the drier months when the daily range (maximum-minimum temperature) may reach 50° F. Winds generally come from the south, typical in the Southwestern U.S., and average a moderate 10 mph [4.5 meters per second (m/s)]. During the evening, winds can switch direction and routinely come out of the north.

3.4.1.2 Project Monitoring Stations

A meteorological monitoring program was conducted at the proposed Yarnell site by Air Sciences Inc. from September 1, 1992, through August 31, 1993, in accordance with an Arizona Department of Environmental Quality (ADEQ)-approved *Air Monitoring Protocol.* The purpose of this monitoring program was to collect one year of site-specific meteorological data that would support an accurate and representative Air Quality analysis for the proposed project. Although the proposed project is not categorized as a major source for EPA's Prevention of Significant Deterioration (PSD) permitting purposes, on-site monitoring was conducted following PSD guidance that recommends one year of on-site meteorological data be collected for air quality analysis and permitting purposes. Data recovery levels exceed acceptable levels such that the Yarnell meteorological data are useful for predicting the locations where maximum air quality impacts are likely to occur due to atmospheric dispersion and emissions associated with the proposed project. The results of the one-year monitoring program were documented in a report dated September 1993.

The location of the meteorological monitoring station is shown in Figure 3-15. The monitoring station is in the northwest corner of the property (3,786.5 km N., 338.6 km E.) at an elevation of approximately 4,870 feet MSL. The station consisted of a 10-meter tower with temperature, wind speed, wind direction and directional deviation data measured.

The following discussions of the site's baseline meteorological conditions use the data collected from this station and long-term data obtained from the nearest reporting stations in reasonably comparable surroundings at Walnut Grove (3,764 feet MSL) 12 miles to the northeast (precipitation data only) and Prescott (5,510 feet MSL) 35 miles to the northeast.

3.4.1.3 Temperature

The mean annual temperature recorded at the monitoring station was 59.4° F. The highest monthly average daily maximum temperature of 85.7° F occurred in July, while the lowest monthly average daily minimum temperature of 31.8° F occurred in December. Table 3-13 compares the mean monthly temperature data collected at the Yarnell Station to long-term (1951 to 1980) data from the Prescott station. Monthly temperatures are generally similar between the two sites, although Yarnell does not record monthly minimum temperatures as low as Prescott does. The observed differences are most likely attributable to the higher elevation in Prescott.

3.4.1.4 Precipitation

Table 3-14 presents monthly average precipitation data for the Prescott (1951 to 1980), Walnut Grove (1961 to 1990) and Yarnell Hill (1981 to 1996) monitoring sites. These data suggest that the project

TABLE 3-13

Mean Monthly Temperature Summary (°F) for the Mine Site Study Area and Prescott Stations

Stations	Yarnell	Prescott	Yarnell	Prescott	Yarnell	Prescott
Month	Monthly Average	Monthly Average	Monthly Maximum	Monthly Maximum	Monthly Minimum	Monthly Minimum
January	43	36.2	49.6	50.3	36.9	22.1
February	42.1	39.2	49.3	54.1	35.8	24.2
March	50.9	42.8	60.5	57.7	41.6	28
April	58.8	49.4	68.4	65.4	48.2	33.3
May	66.6	57.2	76.3	74	55.3	40.3
June	74.3	66.8	83.9	84.7	62.9	48.8
July	76.5	73.1	85.7	88.7	66.9	57.5
August	75.7	70.4	84.5	85.2	67.1	55.6
September	73.6	65.1	82.6	81.5	64.5	48.6
October	64	55	74.2	71.9	56.2	38.1
November	46	44	57.4	59.5	37.5	28.4
December	38.8	37.2	48.3	51.8	31.8	22.5
Annual	**59.4**	**53**	**85.7**	**88.7**	**31.8**	**22.1**

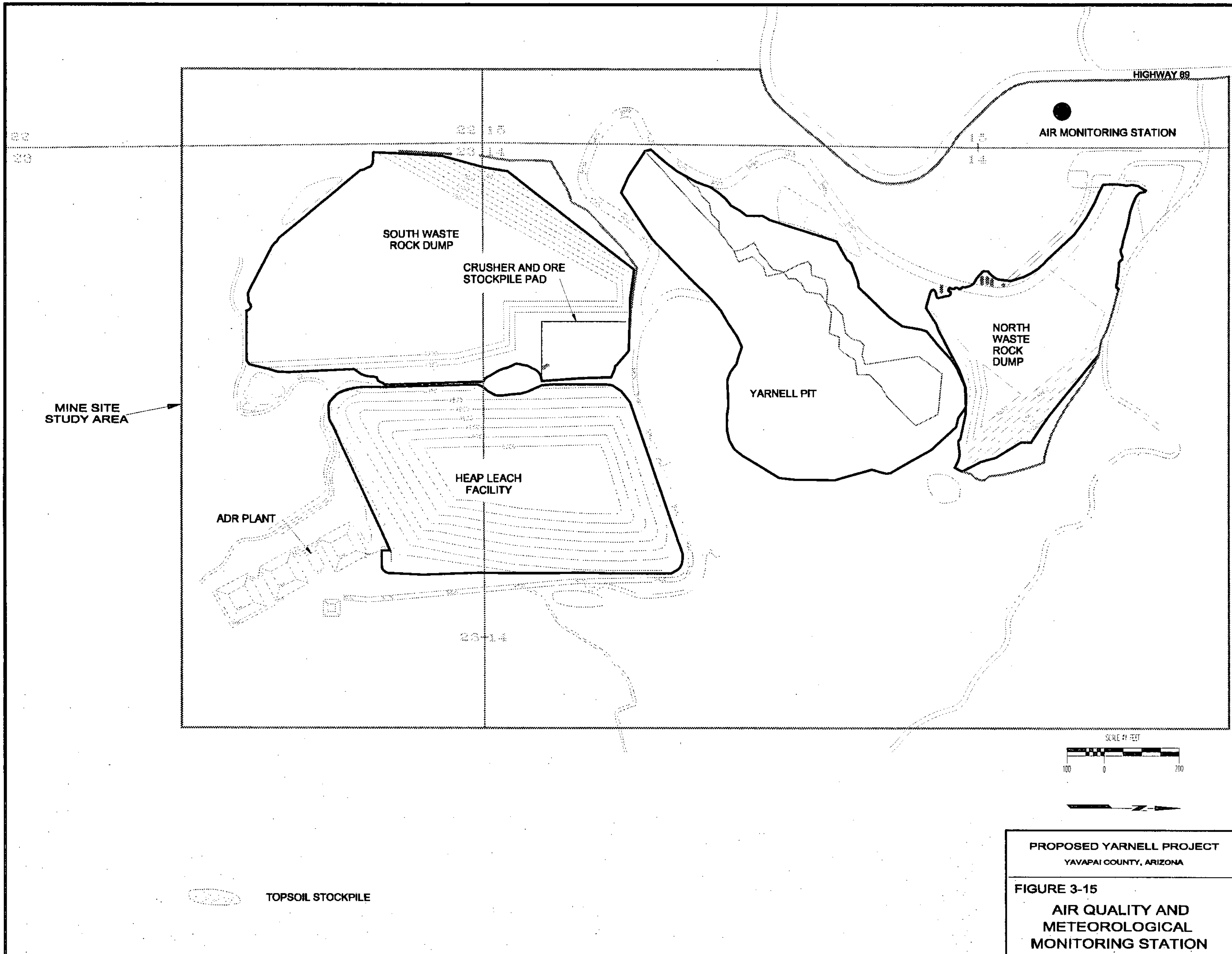
Source: Air Sciences Inc (1993) and NOAA (1985)

TABLE 3-14

Monthly Precipitation Averages for Prescott, Walnut Grove and Yarnell Hill (inches)

Month	Prescott	Walnut Grove	Yarnell Hill
January	1.72	1.52	2.25
February	1.51	1.81	2.20
March	1.53	1.93	2.34
April	0.76	0.80	0.55
May	0.50	0.39	0.33
June	0.53	0.31	0.09
July	3.15	2.19	1.06
August	3.45	2.61	1.71
September	1.49	1.59	1.18
October	1.22	0.96	0.36
November	1.33	1.61	1.20
December	1.65	1.70	1.73
Annual	**18.84**	**17.42**	**15.00**

Source: NOAA (1985), ASU (1996) and Maricopa County Flood Control District (1977)



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-15
AIR QUALITY AND METEOROLOGICAL MONITORING STATION

site receives approximately 15 to 20 inches of precipitation each year. The winter months of December through March receive much of the annual precipitation at all three locations. In 1993, the Yarnell Hill Station recorded a total of 17.7 inches of precipitation for the months of January and February. In addition, July and August are wet months as moisture is swept in from the Gulf of Mexico, and convective heating of the moisture-laden air leads to lifting and thunderstorms along the mountains. April, May and June are typically dry. Snowfall totals vary with elevation and can be extremely localized. Snowfall occurs throughout the winter months at Prescott, with an annual total of 24.1 inches. No snowfall data are available for the Walnut Grove or Yarnell Hill stations.

3.4.1.5 Severe Storm Precipitation Extremes

The 10-, 25-, 50- and 100-year expected maximum 24-hour precipitation event totals are presented in Table 3-15. These data indicate that a substantial portion (15 to 30 percent) of the annual precipitation total can occur in a single one-day event.

TABLE 3-15
Estimates for 10-, 25-, 50- and 100-Year Precipitation Events

Event	24-Hour Precipitation (inches)
10-Year	3.2
25-Year	3.8
50-Year	4.2
100-Year	4.8

Source: NOAA (1973)

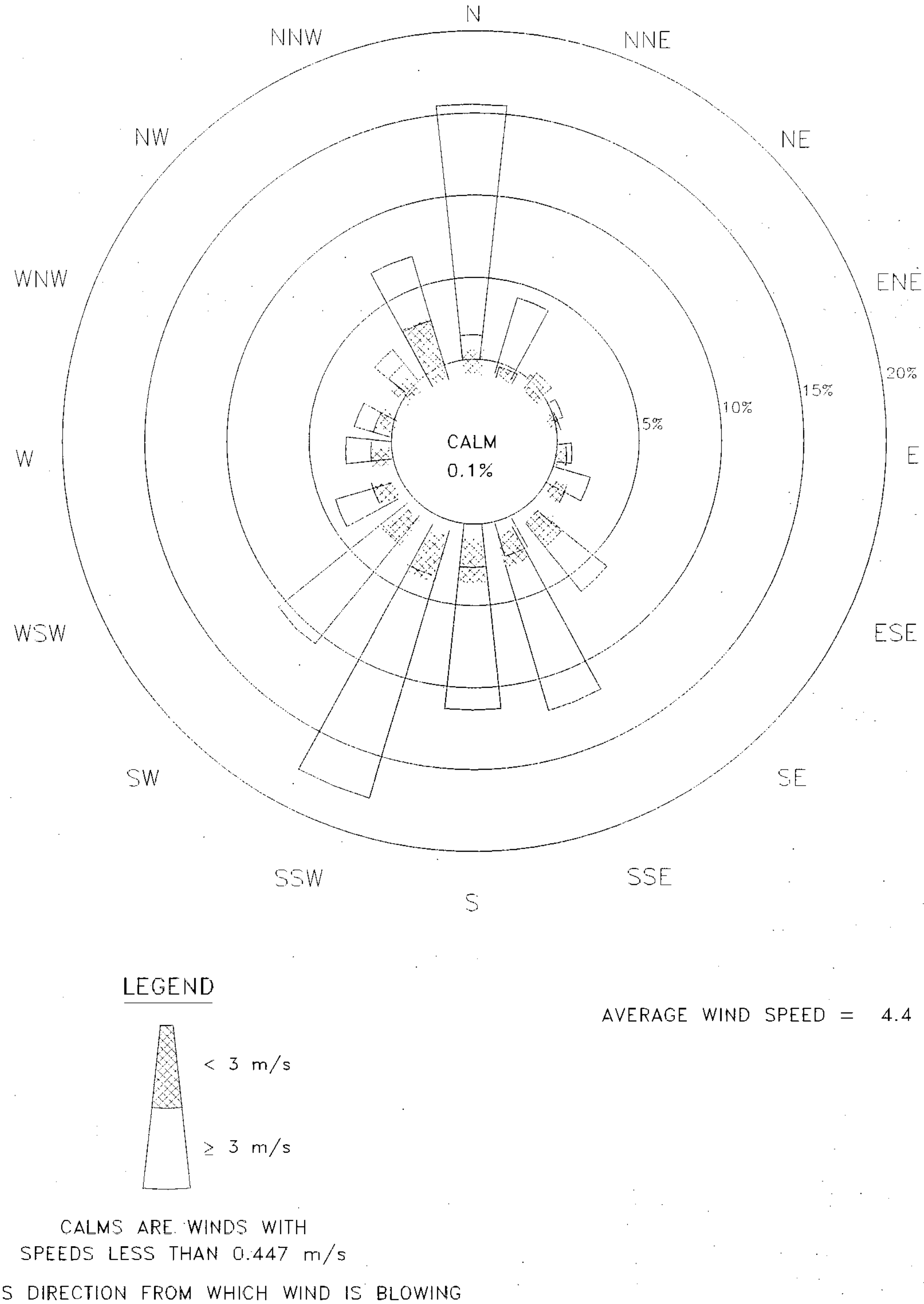
3.4.1.6 Evaporation

No on-site evaporation data was collected, but according to available evaporation-rate maps, the Yarnell area averages approximately 60 inches of total evaporation each year (NOAA 1982). Not surprisingly, the bulk of this evaporation (40 inches) occurs during May through October, when temperatures are warmest.

3.4.1.7 Winds

Wind data was collected at the Yarnell Station from September 1, 1992 through August 31, 1993. The wind speed and direction data are presented graphically as a wind rose in Figure 3-16. During the data collection period, the mean annual wind speed was 9.8 mph (4.4 m/s). The winds blow predominantly from the south-southeast through the southwest directions. These winds account for 50 percent of the total winds and averaged 10.3 mph (4.6 m/s). A secondary wind peak from the north to north-northwest accounted for 23.4 percent of the total winds. These winds averaged 11.1 mph (5.0 m/s). The strongest winds were principally out of the northern sector.

Seasonal wind roses are exhibited in Figure 3-17. During the spring (March through May), winds were predominantly from both the north and southwest to south-southwest sectors, while during the summer (June through August), over 62 percent of the winds originated from the south-southeast through southwest. The southerly winds (southwest through south-southeast) still occurred frequently during the fall (September through November), but the northerly winds increased in frequency to become the singlemost prevalent sector. The winter (December through February) wind rose shows a directional distribution that closely matches the annual wind rose; however, the



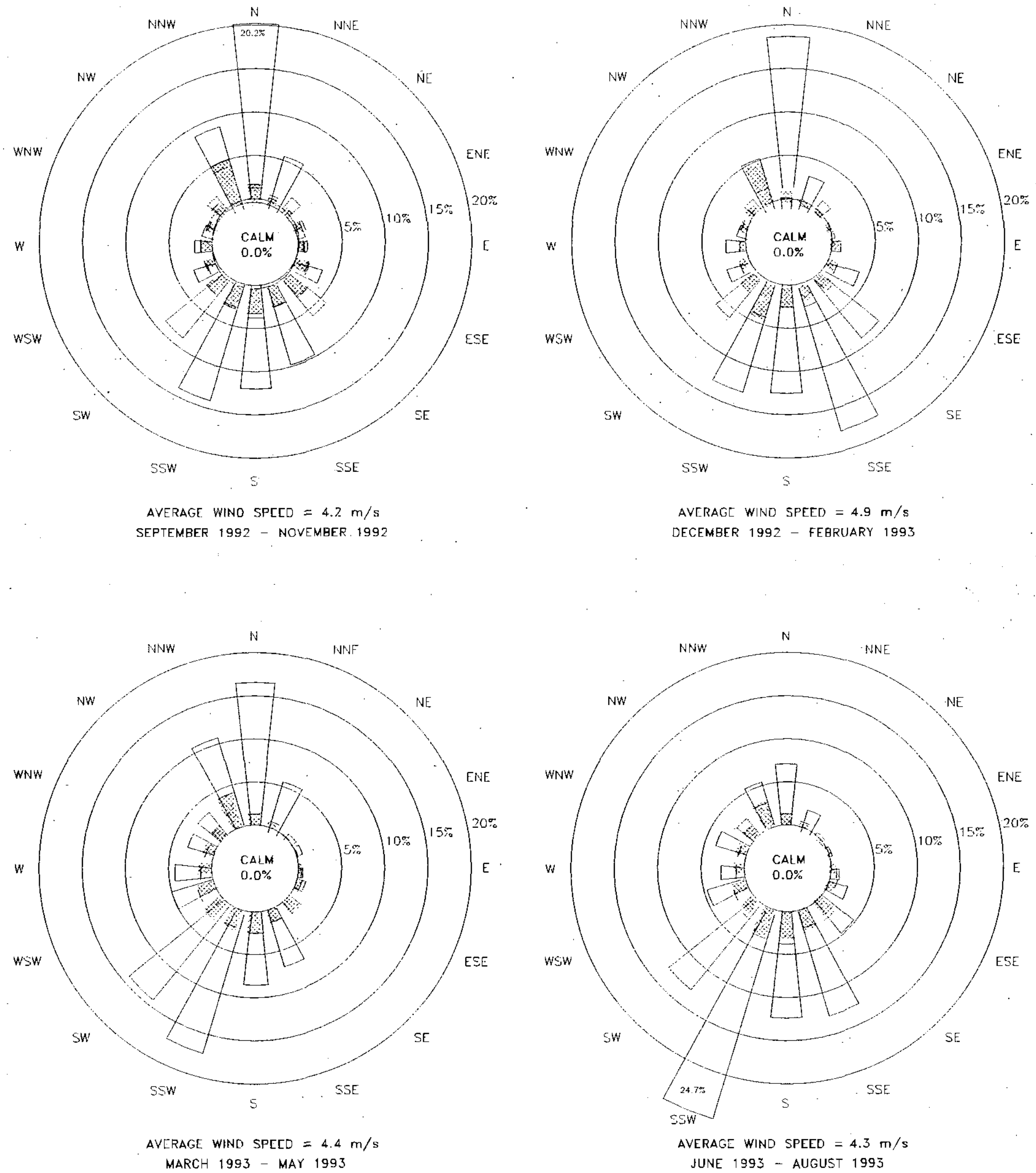
AVERAGE WIND SPEED = 4.4 m/s

CALMS ARE WINDS WITH
SPEEDS LESS THAN 0.447 m/s

SHOWN AS DIRECTION FROM WHICH WIND IS BLOWING

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-16
WIND FREQUENCY DISTRIBUTION SEPTEMBER 1992-AUGUST 1993



LEGEND

< 3 m/s

≥ 3 m/s

CALMS ARE WINDS WITH SPEEDS LESS THAN 0.447 m/s

SHOWN AS DIRECTION FROM WHICH WIND IS BLOWING

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 3-17

SEASONAL WIND ROSE

northerly winds increased in speed and matched winds from the south-southeast sector as the predominant winds.

Wind speeds were very consistent throughout the year (each month averages about 10 mph [4.5 m/s]), although the late fall and winter months of November through February have the highest average wind speeds. Also, highest maximum wind speeds generally occur during these same months. In addition, 59 percent of the maximum wind speeds recorded during the monitoring year occurred between 11 a.m. and 5 p.m. The highest wind speed recorded during the monitoring year was 54 mph (24.1 m/s) the night of February 19, 1993.

3.4.1.8 Wind Stability

Stability is a measure of air turbulence and the dispersion potential of the atmosphere. It is related to radiative energy flux at the surface, wind speed and surface roughness. Six stability classes have been defined and range from A (the most unstable) to F (the most stable). Stable air mixes the least and is the most stratified, as evidenced by little mixing or dispersion of air emissions and a noticeable layering of visible emissions. Stability class D is neutral, which is normally associated with strong winds and moderate turbulence.

The majority of the winds (more than 59 percent) at the MSA fall into the neutral or D stability class. Approximately 27 percent of the winds fall into the most stable classes (E and F). During these stable conditions, winds prevail from the north-northwest through the north with a secondary peak from the southeast through the south.

3.4.1.9 Dispersion Conditions

The wind speed, direction and stability data indicate how pollutants would disperse from the project site. Wind direction determines where the pollutants would travel. Wind speed and stability determine the degree of dilution that would occur with downwind distance. These factors help determine the dispersion potential of emissions from the project site.

Dispersion is directly related to wind speed. Doubling the speed doubles the dispersion potential and halves downwind pollutant concentrations. Stability also plays an important role in determining local dispersion potential. More stable conditions result in poorer dispersion. Based on the wind data collected at the MSA, the maximum downwind pollutant impacts would be expected along the northern and southern boundaries of the project site. The poorest dispersion conditions exist with winds from the north approximately 10 percent of the time and with winds from the southeast to south approximately eight percent of the time. These conditions would produce the highest downwind impacts due to emissions from surface level sources at the MSA.

Atmospheric stability plays a key role in determining local dispersion potential. With increasing stability, dispersion characteristics are reduced. During the monitoring period, the highest frequency of stable conditions was from the north to north-northwest. Winds occurred from these directions 23.4 percent of the time. Although winds from the north were generally at or above the overall mean wind speed, the north-northwesterly winds were usually less than the overall mean wind speed. In addition, stable conditions occurred with winds from the south through southeast (8.2 percent of the time).

3.4.2 AIR QUALITY

Air quality is frequently evaluated in terms of concentrations of the six federally defined criteria pollutants. These criteria pollutants are: particulates less than 10 microns (PM_{10}), carbon monoxide (CO), ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) and lead (Pb). Health-based standards for ambient concentrations of these pollutants (National Ambient Air Quality Standards or NAAQS) have been defined by the U.S. Environmental Protection Agency (EPA) and adopted by the state of Arizona. Yavapai County has been classified as an attainment (or unclassifiable) for all pollutants. The standards are presented in Table 3-16.

In general, the terrain surrounding the MSA should minimize air pollution impacts caused by nearby or regional sources of air pollution at or near the site. Vehicle traffic on State Highway 89, exploration and recreational activities in the surrounding region, along with agricultural and other activities associated with the nearby town of Yarnell, all contribute to the baseline air quality of the Yarnell area. There are no significant human-caused sources of air pollution in the vicinity of the MSA. Phoenix (approximately 60 miles to the southeast) is the closest major metropolitan area. Phoenix is a potential source of significant quantities of process and non-process (mobile) emissions, including carbon monoxide, ozone and particulate matter (PM_{10}). Southerly winds can bring some of these urban airshed pollutants to the north and impact the ambient air quality and visibility at the MSA. However, because of the distance and mountainous terrain separating Phoenix and the MSA, emission sources in Phoenix would rarely contribute significantly to ambient pollution levels near the site.

3.4.2.1 Air Quality Monitoring Program

Two samplers capable of sampling particulates less than 10 microns in aerodynamic diameter (PM_{10}) were operated at the MSA from September 3, 1992 to August 29, 1993 to establish baseline condition levels. The primary sampler operated for a 24-hour period every third day on the EPA sampling schedule, while the collocated or precision sampler operated every sixth day. The PM_{10} samplers were at the same location as

TABLE 3-16
National and Arizona Ambient Air Quality Standards

Pollutant	Averaging Period	National Standards
PM_{10}	24-hour annual	150 $\mu g/m^3$ (1) 50 $\mu g/m^3$ (1)
Carbon monoxide	1-hour 8-hour	40,000 $\mu g/m^3$ (2) 10,000 $\mu g/m^3$ (2)
Ozone	1-hour	0.12 ppm or 235 $\mu g/m^3$ (2)
Sulfur dioxide	3-hour 24-hour annual	1,300 $\mu g/m^3$ (2) 365 $\mu g/m^3$ (2) 80 $\mu g/m^3$
Nitrogen dioxide	annual	100 $\mu g/m^3$
Lead	quarterly	1.5 $\mu g/m^3$

Source: 40 CFR 50.4-12
(1) Not to exceed an average of once per year over three or more representative years of data.
(2) Not to be exceeded more than once per year.

the meteorological tower, in the northwest corner of the MSA (see Figure 3-15), and were operated according to an ADEQ-approved *Air Monitoring Protocol* (Air Sciences Inc., September 1992).

3.4.2.2 Prevention of Significant Deterioration Classification

The EPA has established a classification system for the prevention of significant deterioration (PSD) of air quality. This system applies to areas in attainment of the NAAQS. Areas are categorized as Class I, Class II or Class III. Class I areas are typically areas with pristine air quality, such as national parks, national monuments or wildernesses. All other areas in the country are designated as Class II. No areas in the U.S. have been designated as Class III. The MSA is designated as a Class II area. The nearest Class I area is the Pine Mountain Wilderness, approximately 40 miles east of the MSA in the Prescott National Forest.

3.4.2.3 Measured Particulate Concentrations

The on-site particulate data collected during the 1992-1993 sampling program are summarized in Table 3-17. The maximum 24-hour PM_{10} concentration was 28 µg/m^3 and occurred on August 2, 1993. Approximately 50 percent of the valid PM_{10} samples (57 of 117 samples) were below 10 µg/m^3. Less than two percent of the samples (two of 117 samples) were greater than 25 µg/m^3. The average PM_{10} concentration of 10.2 µg/m^3 for the monitoring period indicates the baseline annual average concentration would be well below the annual NAAQS (50 µg/m^3). This background level of PM_{10} is comparable to the concentrations measured at other sampling stations in similar surroundings (ADEQ 1995).

The background concentration of PM_{10} for the MSA is assumed to be the average PM_{10} concentration for the monitoring period. Acceptable data recovery levels, the duration and frequency of the particulate sampling

TABLE 3-17
PM_{10} Monitoring Summary for the Mine Site Study Area
(September 1992 - August 1993)

Month	# of Samples	Average (µg/m^3)	First Maximum (µg/m^3)	Second Maximum (µg/m^3)	Number of Measured Exceedances
January	8	4	8	7	0
February	9	4	6	5	0
March	10	8	19	10	0
April	10	12	19	17	0
May	11	14	27	22	0
June	10	11	18	15	0
July	10	11	16	13	0
August	10	13	28	17	0
September	10	15	23	20	0
October	9	15	21	20	0
November	10	7	14	11	0
December	10	5	9	8	0
Annual	**117**	**10.2**	**28**	**27**	**0**

Source: ASI (1993)

program and the fact that the baseline monitoring program met the guidance found in EPA's *Ambient Monitoring Guidelines for Prevention of Significant Deterioration* add credibility to this assumption. The Yarnell baseline PM_{10} data exhibit typical PM_{10} levels for rural areas where baseline concentrations generally attain average values under low dispersion conditions and maximum value under high dispersion conditions.

3.4.2.4 Other NAAQS Pollutant Concentrations

On-site measurements of background NO_2, CO and SO_2 concentrations have not been collected. These concentrations are probably best represented by using typical values for rural areas of Arizona. The Class II permit application submitted to ADEQ in April 1996 incorporated the following baseline concentrations: NO_x - 6.0 $\mu g/m^3$ (annual); CO - 2280 $\mu g/m^3$ (one-hour and eight-hour); SO_2 - 875 $\mu g/m^3$ (three-hour), 144 $\mu g/m^3$ (24-hour) and 10 $\mu g/m^3$ (annual). No O_3 or Pb measurements have been collected in the area. However, second highest one-hour maximum O_3 concentrations range from 0.08 to 0.10 ppm at monitoring locations throughout Arizona (ADEQ 1995). Given the low levels of particulate matter in the ambient air in the Yarnell area, background Pb levels would be expected to be similarly low.

3.4.2.5 Air Toxins

In addition to the standards set for criteria pollutants, ADEQ has established Ambient Air Quality Guidelines (AQGs) for a large number of toxins. The AQGs have been established to protect human health. An applicable AQG exists for mercury (Hg). This standard limits mercury concentrations to 1.5 $\mu g/m^3$ (one-hour average) and 0.4 $\mu g/m^3$ (24-hour average). Also, a state ambient standard exists for hydrogen cyanide (HCN) in R18-2-730(J), Standards of Performance for Unclassified Sources. This standard limits concentrations of HCN to 0.3 parts per million by volume (ppmv) over an eight-hour averaging period. No background air toxin data are available for the Yarnell area; however, background concentrations of air toxins would be expected to be negligible due to the MSA's distance from any known source of air toxins.

3.4.2.6 Visibility

The federal Clean Air Act PSD regulations mandate that federal land managers protect visibility resources and other air quality related values (AQRVs) within areas considered to have pristine air quality (Class I areas). Visibility, as an AQRV, can be defined as the degree to which ambient air pollutants obscure a person's ability to see a given reference point through the atmosphere. The more a reference point is obscured, the poorer the visibility. The federal government has chosen to protect visibility in Class I areas because vistas are a highly valued aspect of the experience of visiting pristine and scenic areas, such as national parks, monuments and wildernesses. The nearest Class I area to the MSA is the Pine Mountain Wilderness, approximately 40 miles east of the MSA in the Prescott National Forest. No formal visibility monitoring has been conducted near the MSA. However, it is apparent that haze in the vicinity of the site can cause degradation in the visual range. These conditions are most likely attributable to the atmospheric transport of the urban plume from the Phoenix metropolitan area.

3.5 LAND USE

3.5.1 LAND OWNERSHIP

Yavapai County consists of 8,091 square miles or 5,178,000 acres. About 50 percent of this area is managed by the federal government. The largest portion of federal land is managed by the U.S. Forest Service, which administers land within the Prescott, Coconino and Tonto national forests. The state of Arizona administers about 27 percent of the county, leaving about 23 percent of land in private ownership. The BLM administers approximately nine percent of county land, and less than one percent of the county consists of Yavapai tribal land. Ownership of land in the MSA is discussed in Section 1.3.

3.5.2 LAND USES

Rural areas in Yavapai County have not been developed or used intensively either because they have not been needed for urban development or because they are unsuitable for urban development or agriculture due to topographic conditions, geology and soil conditions or inadequate water resources. They are mostly used for rangeland, grazing, recreation, wildlife habitat and other open space purposes.

The historic and current land uses on and adjacent to the MSA include mining, grazing, wildlife habitat, open space and recreation. Additionally, a small portion of land is used for microwave communications towers.

As discussed in Chapter 1, mining has been a traditional land use, most intensive prior to 1942. Disturbances from historic mining activities (e.g., roads and tailings piles) and recent mining exploration activities (e.g., roads) are clearly evident on the MSA.

The proposed mining area, including the water supply system, is within a single grazing allotment, Congress (03019). The MSA includes the northernmost portion of this allotment, which encompasses 47,000 acres [about 20,500 federal (BLM) acres and about 26,500 state and private acres] surrounding Congress. Total animal unit months (AUMs) are 7,368; federal AUMs are 3,242. There is no formal allotment management plan and grazing is year-round. Range improvements include one stockpond, Tom Cat Tank, within the proposed mining area. The spring-fed pond, Cottonwood Spring, in the Yarnell Creek drainage also serves as a water source for cattle. A dam and trough, constructed at the spring in the past, are now in disrepair.

The area does not receive heavy recreational use. While there are no specifically designated recreation sites on or adjacent to the Yarnell property, dispersed recreational activities include hiking, sightseeing, rockhounding, hunting and off-highway vehicle use. Launch sites for hang gliding are accessed via roads in the southern part of the MSA. Wildlife use of the MSA is discussed in the Wildlife section of this chapter.

There are two microwave communications towers on the project site. The Burlington Northern Santa Fe (BNSF) tower is approximately 60 feet tall. The BNSF facilities, including the tower and a communications building, are on a 1.72-acre parcel. The Maricopa County tower is approximately 80 feet tall, with facilities (including the tower and a communications building) on a 0.12-acre parcel.

The water supply pipeline corridors were shown previously in Figure 2-9. The pipeline would be within and adjacent to many types of land uses including open space, wildlife habitat, historic mining, grazing, commercial and roadways. The proposed routes cross private, federal and state land.

3.5.2.1 Bureau of Land Management Planning/ Land Use Considerations

The proposed action would be in what was formerly the BLM's Lower Gila North Management Area. The BLM conducted a planning process in 1981 and developed a management framework plan (MFP) to formulate management goals and objectives for the area. Mineral resource development on the site of the proposed Yarnell Project would be in conformance with the MFP. MFP recommendation M-2.1 states that the area should be left open for potential mineral exploration and development.

3.5.2.2 Yavapai County Land Use Planning/Land Use Considerations

A General Development Plan for Yavapai County was prepared in 1975, as a policy statement for future development (Ferguson, Morris & Associates 1975). It was not written as a regulatory document and is not, therefore, a zoning plan. Instead, it depicts the general pattern of proposed land uses, both for the county and selected communities.

Ten communities including Yarnell were selected for more detailed planning beyond general county planning. Each community plan was presented to members of the communities at public meetings. Suggestions from the public were solicited and incorporated into the community plans. The Yarnell community plan states the following.

- *"Yarnell is a community of single-family residences. A more recent land activity has been the occurrence of mobile homes on individual lots. The population is mostly retirees.*
- *Commercial uses are located along State Highway 89. These uses include retail trade establishments catering to the local market, and highway oriented commerce catering to through traffic on State Highway 89. The public uses include the elementary school, fire station, community hall and parks, and the spiritually sculptured shrines on Shrine Road.*
- *Yarnell offers limited employment opportunities. The few industrial uses in the community are service type concerns which require only a few persons for their operation. Other economic interests in the area include cattle ranching, and several small producing mines.*
- *This pleasant community has opportunities for growth at a more leisurely pace than would be true for many other communities in Yavapai County. It will attract growth related to retirement living and is capable of providing homesites for people seeking the quietness of a country atmosphere.*
- *Residential uses of all types are indicated on the Yarnell Community Plan. The predominant residential type will be single family residential on small lots in the already subdivided areas of the community, and on larger lots, generally exceeding 10,000 square feet in size, in areas on the perimeter of the community. The Plan indicates areas of existing individual mobile homes/modular housing. Areas for mobile*

home/travel trailer parks and multiple family residential are recommended next to existing commercial areas.

- *The existing commercial area is on both sides of State Highway 89. The Plan recommends that commercial uses be confined to this area, and that it not be allowed to intrude into established residential areas.*
- *An area for industry is shown on State Highway 89 at the north end of the community. Industry attracted to this area will be based upon the local needs of Yarnell and ranching needs of ranchers in Peeples Valley.*
- *The Yarnell Community Plan indicates a complete system of major streets and highways to provide for vehicular movement to all parts of the community. State Highway 89 functions as the main traffic arterial through the community.*
- *The Plan retains the elementary school in its present location. A large growth in the school population is not expected to occur since Yarnell is presently dominated by a retirement population.*
- *A community park is indicated on Oak Way, opposite Shrine of Saint Joseph of the Mountain, a major attraction in the community. Neighborhood parks are indicated next to the elementary school and at the location of an existing park on Walnut Way. Areas of peak elevation, steep slopes and rugged topography are recommended to be retained as open space since the attractiveness of these areas in their present natural condition enhance the general attractiveness of the community.*
- *The Plan indicates the present location of the community center and fire station on State Highway 89. A police station is proposed next to these facilities."*

The MSA is indicated within the community plan as an area of scenic reserve. However, as noted above, the Yavapai County General Development Plan is a planning tool only; it has no regulatory force. Arizona Revised Statutes (11-830.A2) provides that:

> *"Nothing contained in any ordinance by this chapter shall: prevent, restrict or otherwise regulate the use or occupation of land or improvements for railroad, mining, metallurgical, grazing or general agricultural purpose, if the tract concerned is five (5) or more contiguous commercial acres."*

Additionally, an exemption has been established for mining/metallurgical land uses within the Yavapai County Planning and Zoning Ordinance. Therefore, a "mining or metallurgical property," such as the proposed Yarnell Project, would be exempt from any land use or zoning considerations in Yavapai County.

3.6 VISUAL RESOURCES

The MSA is adjacent to State Highway 89 and near businesses and residences in the Yarnell/Glen Ilah area. If developed, the project would be seen by persons traveling on State Highway 89 and by residents of and visitors to the Yarnell area. Currently, Yarnell Hill (the location of the mine pit) and adjacent areas which would be affected by mine/processing facilities are generally open space with vegetative cover characterized by shrubby vegetation types. The existing roads, the two microwave communication towers, historic mine excavations, tailings and buildings on Yarnell Hill also contrast with this existing vegetative cover and are noticeable visual intrusions.

The viewshed from Glen Ilah looking toward the proposed project site includes a church and a few businesses including a restaurant and a gas station. All Glen Ilah residences and businesses are to the west and northwest of the proposed mine. The majority of Glen Ilah residences are more than a quarter-mile and less than a mile from the mine pit area and the north waste rock dump, which would be the closest project facilities. There are about 100 residences in Glen Ilah, many of which would have a view of the Yarnell Project pit. Views of the mine site from some Glen Ilah residences would be blocked by ridges and small hills. A ridge of Antelope Peak blocks the view of the mine site from the rest of the Yarnell community. There are no special scenic highway designations or visual protection policies affecting views from State Highway 89 in the project vicinity.

3.6.1 VISUAL RESOURCE MANAGEMENT SYSTEM

The BLM uses a visual resource management system (VRMS) to evaluate the potential visual effects of an action upon existing visual resources. The VRMS recognizes that public land have a variety of visual values, warranting different levels of management. The system is oriented toward the systematic identification and evaluation of these values to determine the appropriate level of management. The VRMS is used as a guide to ensure that every attempt is made to minimize potential visual impacts. The basic philosophy underlying the system is described in the Visual Resource Contrast Rating Handbook (BLM 1986) as:

The degree to which a management activity affects the visual quality of a landscape depends on the visual contrast created between a project and the existing landscape. The contrast can be measured by comparing the project features with the major features in the existing landscape. The basic design elements of form, line, color, and texture are used to make this comparison and to describe the visual contrast created by the project.

The first step in the VRMS is the identification of the visual values of affected land. Land can be classified into one of four classes with general visual value management objectives. These classes range from Class I (preservation of the existing character of the landscape) to Class IV (allowing major modification of the existing character of the landscape).

Visual value objectives for the MSA were identified through a VRM inventory process and considered with other resource values in the Lower Gila North planning process. Visual management objectives were established in the MFP in conformance with the land use allocations made in the plan. Potentially affected land in the MSA were classified as Class III land. According to the Visual Resource Contrast Rating Handbook, this classification of land has the following visual objective.

The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

3.6.2 KEY OBSERVATION POINTS

The next step in the VRMS process is the identification of key observation points (KOPs) relating to a proposed development or land use. This step recognizes that contrast rating needs to be performed from the most critical viewpoints. This is usually along commonly traveled routes or from other sites which include consideration of distance, the angle of observation, number of potential viewers, length of time the project is in view, relative project size, season of use and light conditions. These factors were considered in selecting the KOPs for the Yarnell Project. Seven KOPs (see Figure 3-18) were selected as follows, based on one or more of the above criteria, particularly distance and the number of potential viewers.

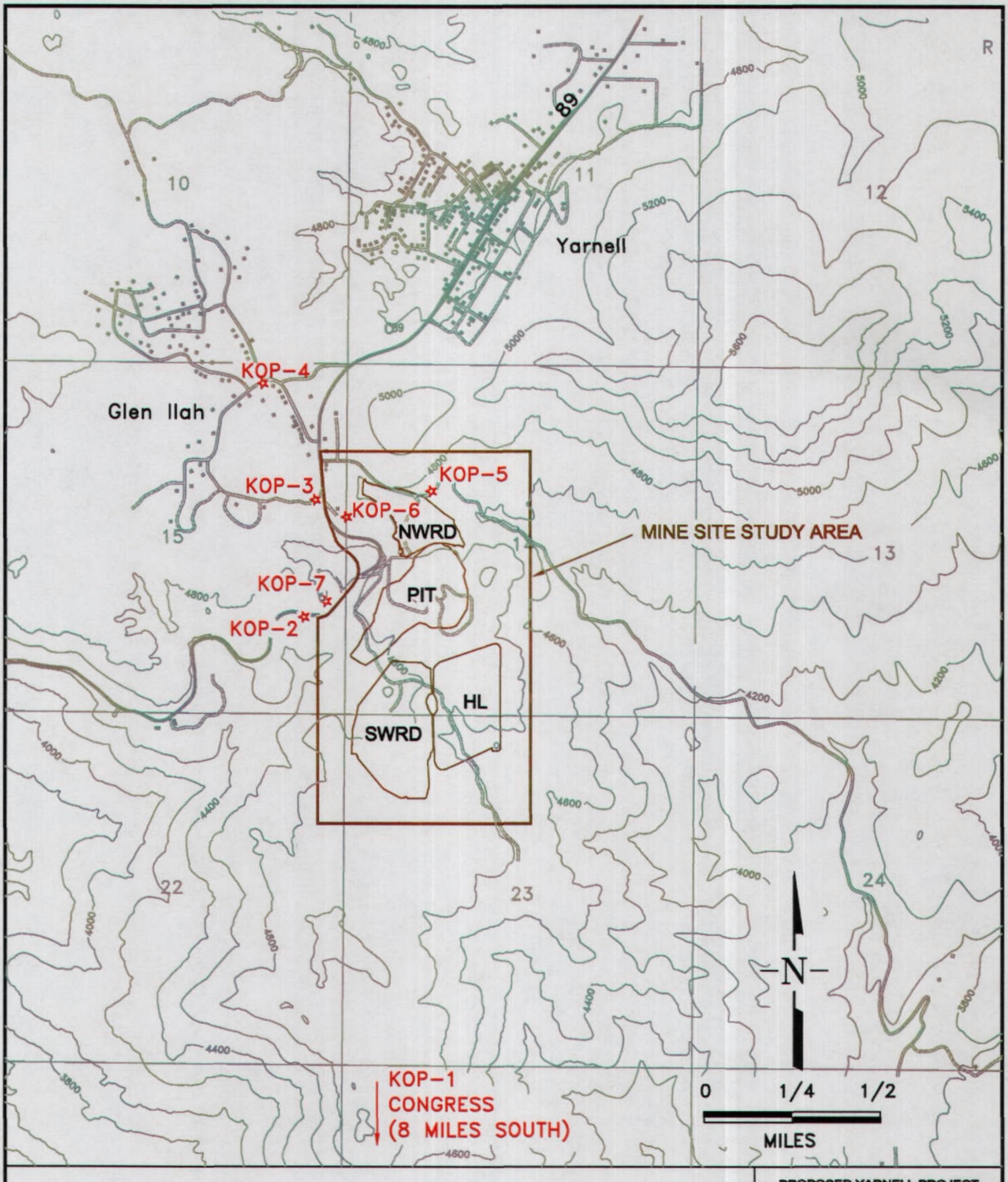
- KOP 1: A distant view (about eight miles) of the MSA from the north end of the community of Congress on State Highway 89.
- KOP 2: A view of the MSA from State Highway 89 going north toward Yarnell.
- KOP 3: A view of the proposed site looking southeast from State Highway 89 near Mina Road and St. Mary's Church.
- KOP 4: A view of the MSA from the intersection of Foothills and Lakewood in Glen Ilah, representative of the view from about 10 homes and a major access street in the community.
- KOP 5: A view of the proposed site from Mina Road, viewing the mine pit and north waste rock dump from the "side" of the proposed mine site.
- KOP 6: A view of the MSA from a residence northwest of the site.
- KOP 7: A view of the MSA from a residence directly across State Highway 89.

After KOPs have been established, visual simulations are prepared to evaluate the potential effects of a proposed project. Simulations are important to portray the relative scale, extent and contrast of a project upon the existing environment. Simulations of views of the proposed project from the seven KOPs are presented in Appendix I and discussed in Chapter 4 of this EIS.

With visual simulations available, contrast ratings can be performed. The contrast rating process is a systematic analysis of the contrasts of form, line, color and texture created by the proposed action. This analysis is summarized on a standard BLM form and makes a determination whether a project would conform with the approved VRM objectives. The contrast rating system also provides a means to identify mitigation measures that can be taken to minimize adverse visual impacts. The results of visual contrast ratings prepared for the proposed project from each KOP are discussed in Chapter 4 of this EIS.

3.7 CULTURAL RESOURCES

Cultural resources are defined as remains of human activity or occupation more than 50 years old. They may consist of sites, structures, ruins, manufactured objects (artifacts) or landscape modifications. Cultural resources may also include sites or locations of traditional cultural importance to Native Americans or other groups. Cultural resources are often classified as prehistoric or historic. Prehistoric resources were created by Native American use of the region prior to European contact. Native American utilization of the region after European contact and European/American exploration and settlement are considered historic. The primary human impact on the MSA has been from



KOP-1 * KEY OBSERVATION POINTS
NWRD NORTH WASTE ROCK DUMP
SWRD SOUTH WASTE ROCK DUMP
HL HEAP LEACH FACILITY
PIT YARNELL PIT

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FIGURE 3-18

LOCATIONS OF KEY OBSERVATION POINTS

mining, an activity that occurred during the historic period.

The MSA has been subject to two intensive archaeological inventories designed to locate and evaluate resources in terms of National Register of Historic Places (NRHP) eligibility criteria. The inventories were designed to comply with BLM and state of Arizona permits and standards for conducting archaeological inventories. The first inventory, conducted in 1995 (Hoefer et al. 1996a), covered 400 acres in and near the MSA and an additional 237 acres for water supply system alternatives. A second inventory for the revised water supply system covered 65 acres (Hoefer et al. 1996b). In summary, 702 acres were surveyed in the area of potential effect. An additional 57 acres were not surveyed due to extremely steep slopes with dense vegetation, primarily on the eastern face of Yarnell Hill.

As part of the BLM's Native American consultation responsibilities, copies of the two archaeological survey reports were provided to the Yavapai and Hopi tribes. These tribes, which either occupied the area historically or expressed a possible affiliation with prehistoric groups, are listed in Chapter 8. In response to the tribe's request, the BLM conducted a field tour for representatives of the Yavapai-Prescott tribe.

3.7.1 CULTURAL HISTORY OF THE PROJECT STUDY AREA

3.7.1.1 Native American

The cultural history of the Yarnell area has not been studied to any great degree, but archaeological investigations in the Prescott and Wickenburg areas and the Bradshaw Mountains provide an outline of the cultural historical sequence (Stone 1986).

Prior to about A.D. 1, the region was occupied by Archaic people who subsisted primarily on wild plants and game. Between A.D. 1 to 800, the appearance of pithouse villages, pottery and farming marks a shift from mobile hunting and gathering to more permanent settlement in small villages. Groups relied on both wild and cultivated foods. Later prehistoric sites in the region have been attributed to both the Hohokam tradition, centered in the Salt and Gila river basins to the south, and the Prescott Branch, centered in the present-day Prescott area. The relationship between the two cultural traditions is unclear. Villages apparently associated with both traditions existed north of the MSA in Peeples Valley, where agricultural land was abundant.

Most prehistoric sites were abandoned by A.D. 1300, and a break occurs in the archaeological record. After about A.D. 1600, the Yavapai, whose connection to the earlier inhabitants is unclear, become recognizable in historic records. Like the early Archaic groups, the Yavapai did not construct permanent villages, but moved seasonally to harvest wild resources. They practiced agriculture on a more limited basis than the Hohokam or the Prescott Branch. Known Yavapai sites in the area surrounding the proposed mine are rare, although the Yavapai inhabited the Yarnell and Congress areas. The Yavapai were moved to reservations in 1873. However, some families either stayed or returned to live along Antelope Creek and in Peeples Valley in the late 1800s.

According to local historical accounts, Yavapai workers assisted Charles Genung, a local pioneer, in constructing a road from Peeples Valley to Wickenburg sometime after 1870. During the 1890s, several Yavapai families may have resided on the Genung ranch in Peeples Valley.

3.7.1.2 Euro-American

The historic period begins with Spanish incursions in the late 1500s into what would become the state of Arizona. The Spaniards were primarily concerned with finding gold, converting Native Americans to Christianity and developing overland routes to California. The last major Spanish expedition into the area took place in 1776. From 1821 until 1848, Arizona was part of Mexico. Then, the near simultaneous acquisition of Arizona by the U.S. and the discovery of gold in California brought increasing numbers of people into Arizona Territory. A number of routes across Arizona Territory were established for travel to California, including two which passed to the north of the MSA.

Despite a growing population in Arizona and reasonably good access, the Yarnell area remained unsettled until 1863 when gold was discovered on nearby Rich Hill. By 1883, this deposit was depleted, but new mines were established in Octave and Congress. Wickenburg was settled in the mid-1870s and became the main population center in the area. The Yarnell gold deposit was first mined in the late 1880s or early 1890s. Records indicate that a bunkhouse, boarding house, barn and office were present at the site in conjunction with the mine. Mining took place until 1915, then started again in 1935 with new facilities. The literature on mining in Arizona does not detail the mining in the Yarnell area, concentrating instead on the nearby mines of Octave and Congress. The Yarnell mine operated until 1942 when it was shut down by a War Production Board order. From 1935 to 1942, 150,000 tons of ore were processed, yielding 28,000 ounces of gold. From 1981 on, a variety of companies conducted exploration activities at the site with YMC acquiring the property in 1991.

3.7.2 INVENTORY RESULTS

The inventories recorded seven historic sites, 23 isolated occurrences and 50 localities containing mining claim cairns and/or prospect pits. The sites included three gold mining locations, a trash scatter, segments of two roads and a historic period Native American site. The isolated occurrences included historic artifacts, mining features such as adits and prehistoric artifacts such as stone flakes and ceramic sherds.

In conformance with the National Historic Preservation Act, the BLM evaluated the sites' eligibility for nomination to the National Register of Historic Places. Guidelines for the evaluation of historic mining sites and roads, developed by Arizona's SHPO, were used in making these assessments (Keane and Rogge 1992). Eligibility determinations involved consultations among the BLM, the SHPO and Native American tribes. The isolated occurrences, mining features and prospect pits do not meet the site definition criteria of the Arizona State Museum and are not eligible for the National Register.

The Yarnell Overlook consists of a rock wall enclosure and a scatter of Euro-American and Native American artifacts. The function and identity of the site and its occupants is unknown, but the artifacts recovered suggest that it was used between 1878 and 1908 by Yavapai. The site may have functioned as a habitation, corral, trade location or defensive structure. It would have been near, and possibly associated with, the active Yarnell Mine. This site is considered eligible for the National Register for its potential to yield information about historic Yavapai use of the area and relationships between Native Americans and other groups.

The historic Yarnell Mine is in the northern portion of the MSA. The Yarnell Mine contained a series of structures and facilities associated with the underground mining operations and ore processing conducted between 1890 and 1945. However, older structures were destroyed during successive improvements ongoing to the 1980s, and there are no remaining historic structures and few artifacts. The locations of the underground workings have been recorded and most are now unsafe to enter. The historic Yarnell Mine is regarded as not eligible for the National Register due to its poor integrity.

Two smaller mining sites, the Biedler Mine and the Edgar Shaft, consist of shafts, adits, waste rock piles and scattered artifacts. These sites have been fully recorded and have limited potential to yield further information. They are regarded as eligible for the National Register because they contain features that may date to the 1890s, which provide locational information that corroborates archival records on early mining activities. However, most of the associated artifacts were produced between 1930 and 1960.

Site AZ N:14:18 (ASM) is a trash scatter deposited near a dirt road. It contains artifacts dating from the 1930s to about 1960. The site is regarded as not eligible for the National Register because it lacks integrity and the potential to yield important information about history.

The MSA contains two road segments, an old segment of State Highway 89 and a portion of a primitive road known as Mina Road where it enters Glen Ilah. The old highway segment was abandoned within the past 30 years and is not eligible for the National Register. The SHPO has determined that the dirt road, known as the Mina-Genung Road, is eligible for the National Register for its association with Charles Genung, an important figure in the history of Peeples Valley.

Representatives of the Yavapai-Prescott Tribe identified the Yarnell Overlook as a site of traditional cultural importance, valuable for its potential to yield information about Yavapai history. However, they had no specific knowledge of the site, and they expressed the desire to participate in any studies. No other places of traditional importance to Native American groups have been identified by the Yavapai-Prescott or other tribes.

3.8 TRANSPORTATION

The roads included in the transportation analysis are shown in Figure 3-19. They include State Highway 89 from Wickenburg to Prescott, and Mina Road and Lakewood Drive in Glen Ilah. State Highway 89 is the only major road leading to the Yarnell area and all access to the proposed project would occur from this highway. Mina Road intersects the east side of State Highway 89 near the proposed project and would form part of the mine entrance. Lakewood Drive intersects the west side of State Highway 89 in Glen Ilah, just north of the mine entrance.

3.8.1 DESCRIPTION OF ROADS AND EXISTING TRAFFIC CONDITIONS

State Highway 89 begins at U.S. 93 northwest of Wickenburg, runs approximately 50 miles north and northeast to Prescott and ends at U.S. 40 in Ash Fork (Alternate 89 runs from Prescott to Flagstaff). This section of State Highway 89, from Wickenburg to Flagstaff, was originally part of U.S. 89, but was relinquished to the state in the early 1990s. It is known as Broadway within Yarnell and White Spar Road outside of Yarnell. State Highway 89 is the main north-south transportation route through central Yavapai County, connecting the towns of Wickenburg, Congress, Yarnell and Prescott. It is used mainly by area residents, secondarily by tourists and forms part of the route used by those traveling between Prescott and points west on U.S. 60.

State Highway 89 is a paved, undivided, two-lane highway from Wickenburg through Congress. Between Congress and Kirkland Junction, which includes the Yarnell area, the only roads intersecting State Highway 89 are those which lead to small residential developments and ranches. Four miles northeast of Congress, the highway divides and climbs into the Weaver Mountains toward Yarnell/Glen Ilah. There are two northbound lanes in this section and, at times, the northbound and southbound lanes are at different elevations. At Milepost 275.5, just south of the MSA, the northbound and southbound lanes rejoin. From this point to Milepost 276, which is the section of the highway bordering the west side of the MSA, there are two northbound lanes and two southbound lanes. Just north of the proposed mine site, State Highway 89 becomes two lanes through Yarnell and for most of its remaining length, north to Prescott. Travel lane widths in each direction are generally 12 feet and shoulder widths vary from zero to eight feet.

The average annual daily traffic volumes (average vehicles per day) on four sections of State Highway 89 between Wickenburg and Ponderosa Park were compiled by ADOT and shown in Table 3-18. The most recent traffic counts (1995) vary between 1,100 and 2,200 vehicles per day. These relatively low counts reflect the sparse population of the area. Traffic volumes are greatest between Wickenburg and Congress and decrease as one travels north through Yarnell and on toward Prescott. Over the six-year period of 1989 to 1995, traffic has increased on each section of State Highway 89, as shown in Table 3-16. On a percentage basis, traffic increases have been greatest between Kirkland Junction and Ponderosa Park.

Lakewood Drive, a paved, two-lane road, is the main access road into Glen Ilah from State Highway 89. Lakewood Drive intersects the west side of State Highway 89 just north of the MSA. This intersection has no electric signal, with traffic exiting Lakewood Drive onto State Highway 89 required to stop. The 24-hour traffic counts measured on Lakewood Drive between 1989 and 1995 are shown in Table 3-19. These values are one-day counts and provide only a snapshot of the traffic on this road during one day of each year. Traffic volumes are low because this road only serves as access to local residences. Overall, traffic on this road has remained relatively constant over the six-year period of 1989 to 1995, increasing an average of only 15 vehicles per day each year. There is no known reason for the low traffic volume measures in 1991.

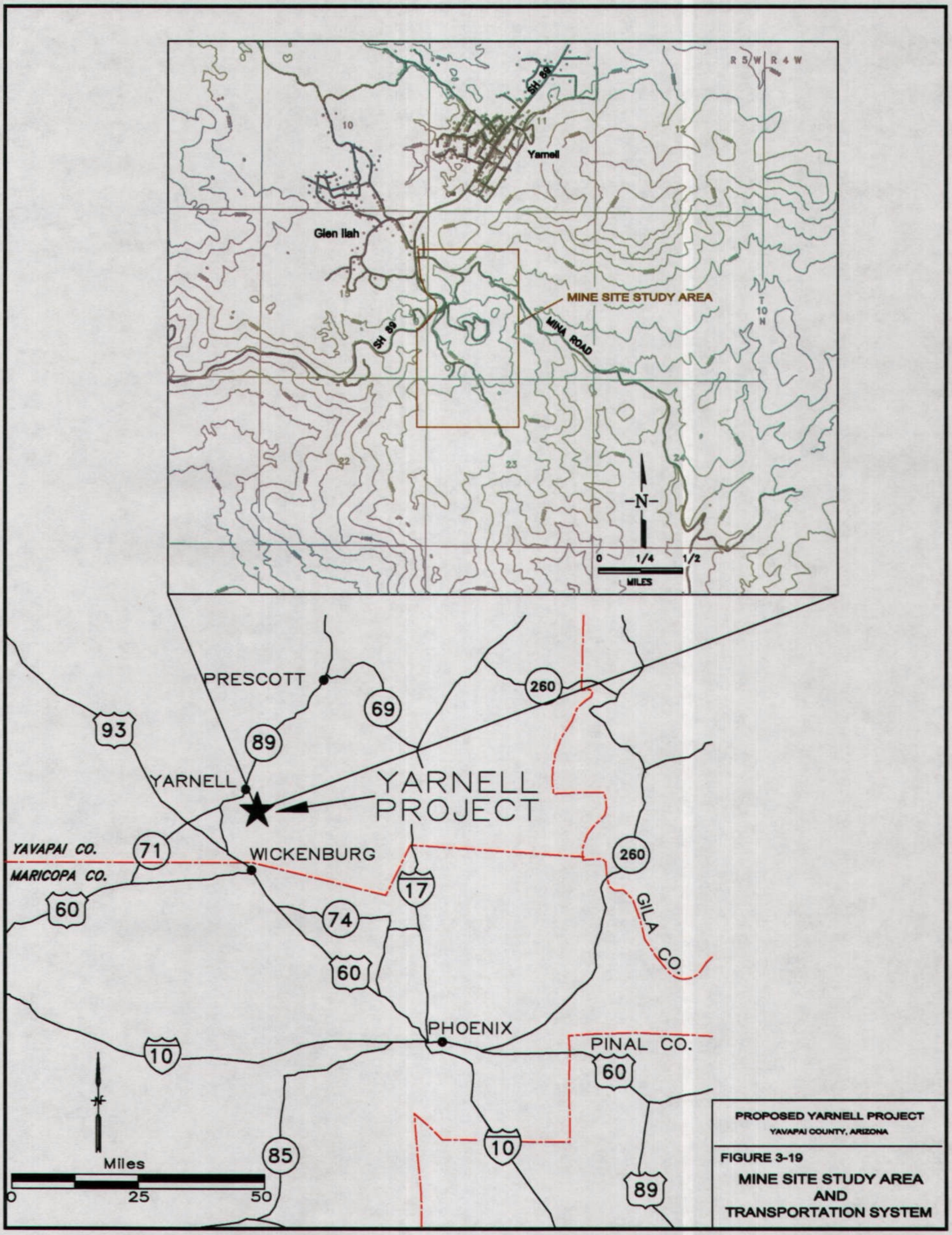

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FIGURE 3-19
MINE SITE STUDY AREA AND TRANSPORTATION SYSTEM

TABLE 3-18
Existing and Historic Traffic Volumes on State Highway 89

Section of State Highway 89	Average Annual Daily Traffic* 1989	1991	1993	1995	Average Annual Increase vehicles/day	%
US 93 to State Highway 71	1,800	2,000	2,030	2,209	68	4
State Highway 71 to Shrine Road	1,400	1,700	1,814	1,942	90	6
Shrine Road to Kirkland Junction	1,200	1,300	1,721	1,525	54	5
Kirkland Junction to Ponderosa	770	1,000	1,912	1,102	55	13

Source: Arizona Department of Transportation, 1996
* Vehicles per day

TABLE 3-19
Existing and Historic Traffic Volumes on South Lakewood Drive

Measured Daily Traffic Volume*				Average Annual Increase	
1989	1991	1993	1995	vehicles/day	%
501	232	606	588	15	17

Source: Arizona Department of Transportation, 1996
* Vehicles per day

Mina Road is the local name of the first 400 feet of the gravel road that begins at State Highway 89 in Glen Ilah and leads to Stanton. This first section of the road serves as access to the few residences in the immediate vicinity. The segment of Mina Road from State Highway 89 to the Section 14 line is under Yavapai County jurisdiction. As the road continues down the Yarnell Creek and Antelope Creek drainages, it is known as Stanton-Octave Road or Old Stage Road. It is an historic road in that it can be found on maps that pre-date Arizona's statehood and is part of the former stage-coach route in this area. Stanton is an old mining camp approximately five miles down the valley. It has recently been developed into a campground for tourists interested in panning and prospecting for gold. The Stanton Octave Road runs past Stanton and loops back to State Highway 89, approximately two miles north of Congress. Most Stanton-bound traffic uses this section of the road.

Mina Road crosses both private and public land and is owned by no single entity. Maintenance has historically been provided by Yavapai County. The county conducts periodic traffic counts at both the Yarnell and Congress ends of the road. Daily traffic counts at the Yarnell end range from approximately 150 to 450 vehicles per day. This includes traffic associated with local residents and ranching in the valley. Counts at the Congress end range from approximately 250 to 350 vehicles per day. This includes most Stanton-bound traffic.

3.8.2 ACCIDENT HISTORY

Accident data is only available for State Highway 89. The data, compiled by ADOT, is shown in Table 3-20. Accident data was analyzed for two sections of State Highway 89 for the purposes of this report. The first section, from State Highway 71 to Peeples Valley, represents the section of State Highway 89 within five miles of the MSA. The second section, from U.S. 93 to Kirkland Junction, encompasses almost the entire study area. The data for both sections and for both of the time periods analyzed show that more than 80 percent of the accidents on State Highway 89 involve only one vehicle, e.g., vehicles running off the road, hitting animals or fixed objects, etc. The data also show that the number of accidents has increased substantially. There was more than a 300 percent increase in the number of accidents on both sections of State Highway 89 analyzed between the periods of 1989 to 1992 and 1993 to 1995. This rate of increase exceeds the rate at which traffic volume has been increasing, as shown in Table 3-18. The number of injuries and fatalities has also increased.

3.9 NOISE

The following section describes the background (ambient) noise environment at the MSA and in the Yarnell and Glen Ilah areas and describes applicable noise regulations and impact criteria. However, prior to discussing ambient noise levels in the area, it is important to define noise terminology.

3.9.1 NOISE TERMINOLOGY

When a surface vibrates, such as that of a loudspeaker or engine, it causes pressure fluctuations in the air. The human ear is capable of detecting an enormous range of these pressure fluctuations.

TABLE 3-20
State Highway 89 Accident and Injury/Fatality Data

Segment of State Highway 89	1989 - 1992			1993 - 1995			% Increase (all)
	Multi-vehicle Accidents	Single-vehicle Accidents	Total Accidents	Multi-vehicle Accidents	Single-vehicle Accidents	Total Accidents	
State Highway 71 to Peeples Valley*	1	22	23	10	60	70	204%
U.S. 93 to Kirkland Junction**	2	28	30	18	91	109	263%
Segment of State Highway 89	**Injuries**	**Fatalities**	**Total Injuries and Fatalities**	**Injuries**	**Fatalities**	**Total Injuries and Fatalities**	**% Increase (all)**
State Highway 71 to Peeples Valley*	16	0	16	33	0	33	106%
U.S. 93 to Kirkland Junction**	17	0	17	53	3	56	229%

Source: Arizona Department of Transportation, 1996
* Approximately 10 miles long
**Approximately 32 miles long

Because this range is so large, noise is measured on a decibel (dB) scale, which compresses it to more manageable numbers (20 to 120 dB). The sum total of noise, which exists in communities due to traffic, industry, etc., is termed environmental noise and is most commonly measured in A-weighted decibels (dBA). A-weighting is a weighting scheme applied to measured or predicted noise levels that corresponds to the way the human ear is less sensitive to low frequency sound and more sensitive to high frequency sound. Figure 3-20 shows the typical noise level of some common noise sources.

Environmental noise is constantly fluctuating as the result of activities such as a truck passing by, a neighbor starting a lawn mower, etc. As a result, there are many ways to quantify it (e.g., minimum, maximum or average noise levels). Two of the most common noise level descriptors and those which will be used throughout this report are the energy-equivalent level (L_{eq}) and the day-night noise level (L_{dn}). The L_{eq} is the logarithmic average noise level over a given time. Unless otherwise noted, all L_{eq}s discussed in this section are A-weighted, hourly averaged levels. The L_{dn} quantifies the average noise level over a 24-hour period. It is computed by averaging the 24-hourly L_{eq}s for a given day, with 10 dBA added to the noise levels between 10:00 p.m. and 7:00 a.m. to account for heightened noise sensitivity at night. L_{eq} and L_{dn} are both expressed in dBA.

The ambient noise level and noise impact discussions are divided into daytime and nighttime periods. For the purpose of this report, daytime is defined as 7 a.m. to 10 p.m. and nighttime as 10 p.m. to 7 a.m..

3.9.2 EXISTING NOISE LEVELS

A noise survey was conducted in the vicinity of the MSA in May 1995 by Air Sciences Inc. to quantify and characterize the existing noise environment. Noise measurements were taken at six locations as shown in Figure 3-21. Hourly average noise levels were measured continuously at locations 1, 2 and 3 by an unattended monitor. Short-term (approximately 20-minute) noise measurements were taken at each location twice each day (one daytime and one nighttime measurement). The continuous monitors provided information regarding the fluctuation of noise levels over the course of the day. The short-term measurements provided information regarding the sources of noise during different parts of the day and at different locations. All noise levels were measured as A-weighted L_{eq}s.

The measurement results are presented in Table 3-21. Average daytime L_{eq}s range from 39 to 45 dBA for all locations. During the daytime, the main sources of noise over the entire study area were traffic on State Highway 89 and local roads, the activities of residents (air conditioners, lawn mowers, etc.), birds, insects and wind. The loudest daytime levels were measured at locations 2, 3, 4 and 6. All of these locations have a relatively unobstructed view of State Highway 89. The lowest levels were measured at locations 1 and 5. Both of these locations are set back from State Highway 89 and are isolated from it by small hills and other residences.

The average nighttime L_{eq}s range from 34 to 37 dBA. These levels are approximately six to seven dBA lower than daytime levels. At night, when traffic on State Highway 89 was almost non-existent and most

NOISE SOURCE	NOISE LEVEL (dBA)
Amplified rock'n roll band	- 120
Commercial jet takeoff at 200 feet	- 110
Pile driving at 200 feet	- 100
Busy urban street	- 90
Construction equipment at 50 feet	- 80
Freeway traffic at 50 feet	- 70
Normal conversation at 6 feet	- 60
Typical office (interior)	- 50
Soft radio music	- 40
Typical residential (interior)	- 30
Typical whisper at 6 feet	- 20
Human breathing	- 10
Threshold of hearing	- 0

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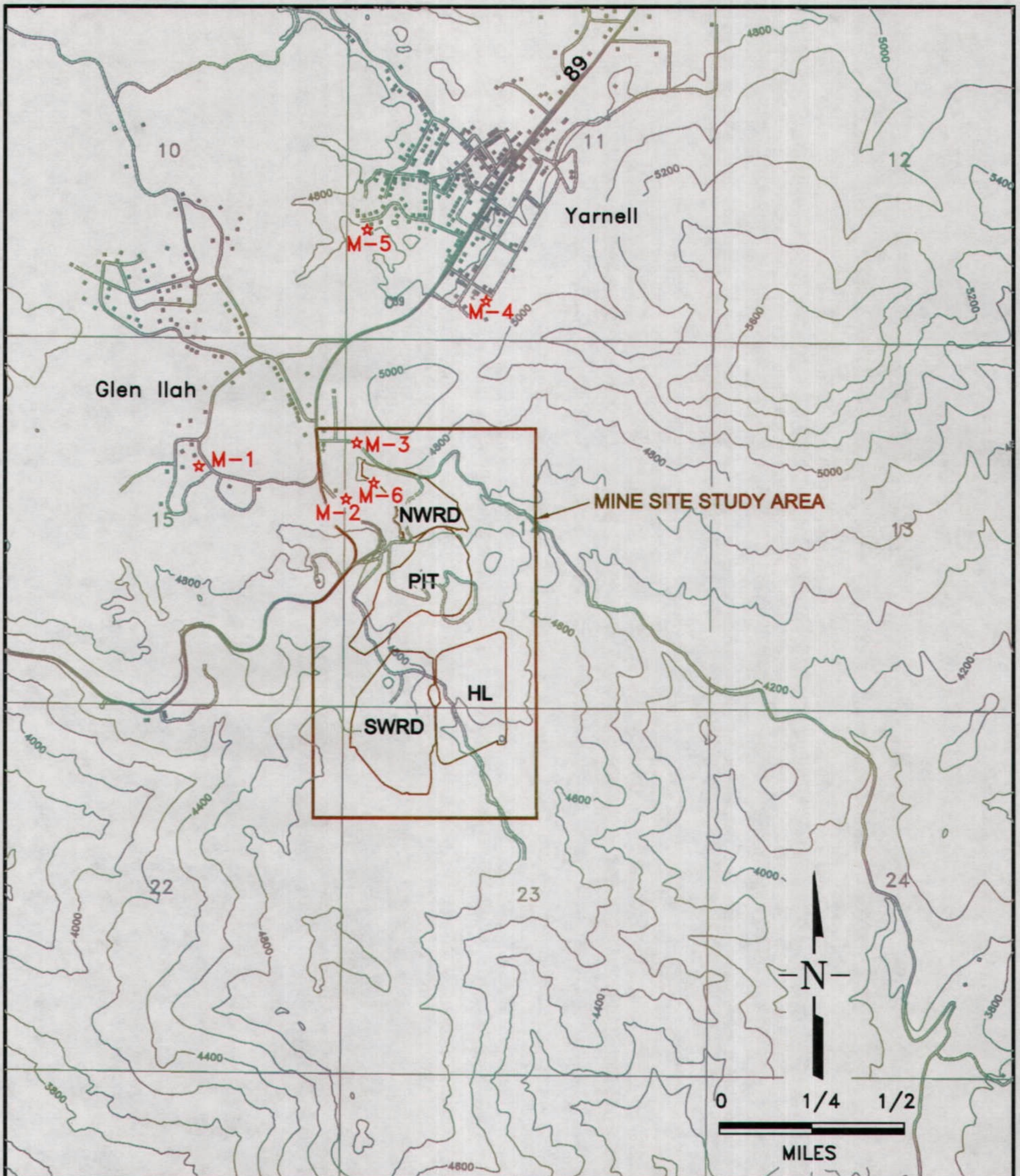
FIGURE 3-20

EXAMPLES OF TYPICAL NOISE LEVELS



M-1 ☆ NOISE MEASUREMENT LOCATIONS
NWRD NORTH WASTE ROCK DUMP
SWRD SOUTH WASTE ROCK DUMP
HL HEAP LEACH FACILITY
PIT YARNELL PIT

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FIGURE 3-21

NOISE MEASUREMENT LOCATION

residents were indoors, ambient noise levels were controlled by wind, birds and insects. As these sources are common to all locations, there was only a three dBA variation in nighttime noise levels over the entire study area.

There was some difference in continuous and short-term noise levels measured at locations 1, 2 and 3. The data measured by the continuously operating monitors should be used for assessing impact, as it is more statistically representative of background noise levels.

3.9.3 NOISE REGULATIONS

Noise regulations or guidelines typically exist on federal, state and local levels. However, neither the state of Arizona nor Yavapai County have noise regulations which would specifically be applicable to a mining operation. The relationship of noise generated by the proposed project to noise control guidelines or regulations is discussed in Chapter 4 of this EIS.

3.10 SOCIOECONOMIC CONDITIONS

3.10.1 STUDY AREA

The proposed Yarnell Project is in Yavapai County south of Yarnell and across State Highway 89 from the Glen Ilah subdivision. This location is about 26 miles north of Wickenburg (in Maricopa County) and 35 miles south of Prescott, the county seat of Yavapai County. The area has a long history of mining activity. The region is still primarily rural in nature, with a county population density of about 16.6 persons per square mile (based on a 1996 population of about 134,600 persons in the 8,091 square miles comprising Yavapai County).

Various factors would influence the location and magnitude of potential economic and social impacts associated with project implementation. These include:

- ♦ the location of and access to the ore body;

TABLE 3-21
Noise Measurement Results
(L_{eq}, dBA)

	Hand-held Measurements						Monitor Data	
	Daytime			Nighttime			Daytime	Nighttime
Loc. #	Minimum	Maximum	Average	Minimum	Maximum	Average	Average	Average
1	37	41	39	34	35	35	39	37
2	41	46	44	34	37	35	39	37
3	42	47	44	33	35	34	40	37
4	42	47	45	33	35	34	•	•
5	40	47	42	33	36	34	•	•
6	**	**	45	34	35	35	•	•

• No data measured
** Only one measurement conducted.

- the likely residence area for people working at the mine (existing residents and/or any inmigrating project employees);
- the rate and magnitude of inmigration (which would be influenced by the availability of a trained or trainable local workforce and a developer-sponsored training program);
- the rate and magnitude of population and employee turnover (including student population turnover in schools, employee turnover at the mine and employee turnover from existing jobs to employment with the project);
- the availability and location of housing and existing and potential housing sites;
- the capacity and condition of existing local services and facilities in relation to potential housing locations;
- the people directly or indirectly affected economically by the proposed mining operation (e.g., from wages and taxes);
- the willingness and ability of community residents and local government personnel to accommodate change and
- the perceived quality of life values of residents.

Based on these factors, the social and economic impact area for the proposed project consists of Yavapai County, Arizona. The area that would be most affected by the project is the unincorporated community of Yarnell (which includes the Glen Ilah and Peeples Valley areas). Residents of Yarnell would be exposed to many direct effects of mining because of the proximity of the town to the proposed mine. Therefore, Yarnell is the primary study area within this analysis.

Residents of Yarnell and immediate environs can be grouped into major segments including:

- elderly and retired persons;
- persons who have left urban areas for a more peaceful lifestyle;
- seasonal or weekend residents (e.g., not full-time residents) and
- commercial service sector, ranchers, etc.

While the area is very rural in nature, the warm weather climate and existing road system allow residents easy access to urban centers such as Prescott and Phoenix.

Other potentially affected jurisdictions include the communities of Congress, Wickenburg and Prescott. Effects to these jurisdictions would generally be much less than those which could occur in Yarnell. These other jurisdictions are discussed as appropriate in this analysis and comprise the secondary study area.

The northern Phoenix metropolitan area is also considered as a potential residency area for mine workers because of easy access to Yarnell and the abundant housing and other infrastructure in the Phoenix area. Baseline data for Maricopa County and the Phoenix area are not included in this EIS because the Yarnell Project would be of such minor scope in the context of the Maricopa County and Phoenix area economies.

The old gold-mining towns of Stanton, Octave and Weaver are several miles from Yarnell, but are not considered as possible residency locations because of the lack of modern services and housing. These areas are currently populated by only a few persons. The North Ranch area, about five miles south of Congress, is a growing retirement area of recreational vehicle camping facilities and undeveloped lots which could be developed into housing units. Since North Ranch is operated as a retirement community/travel club (known as the Escapees), it is also not considered as a potential residential area for mine-related workers.

3.10.2 ECONOMIC TRENDS AND CONDITIONS

Yavapai County is one of Arizona's oldest counties. Its economy has historically been forged from the availability of natural resources such as minerals (e.g., gold and copper), scenic pine forests providing year-round recreational opportunities, a moderate climate not as harsh in summer months compared to other parts of Arizona and opportunities for ranching.

Like Arizona as a whole, Yavapai County has grown substantially over the past few decades. Growth has taken the form of increasing population and employment opportunities, an expansion and diversification of the economy and expansion and improvement of infrastructure to serve the growing population. The area has a relatively educated and skilled laborforce, which is highly mobile because of the existing road system and warm weather climate. Yavapai County has also attracted a substantial retirement community because of the perceived high quality of life. The County contains two colleges and an aeronautical university (Arizona Department of Commerce 1996a).

Government also plays an important part in the county economy. Prescott is the headquarters of the Prescott National Forest, with other major government employers including the Arizona Department of Transportation, Yavapai County, the city of Prescott and the public school system.

Cattle ranching and mining have traditionally provided the major sources of economic activity in the Yarnell area. A growing arts, crafts and antique business has resulted in a noticeable increase in tourism (Arizona Department of Commerce 1996b). The area has many scenic driving routes including State Highway 89. The shrine of St. Joseph of the Mountains in Yarnell is open for self-guided tours and attracts hundreds of visitors annually from Arizona, neighboring states, Mexico and other foreign countries.

Yarnell has also become an attractive retirement community because of the relatively low cost of living and mild climate. Many summer visitors come to Yarnell to escape the desert heat. A small commercial and service sector exists to serve these residents and the surrounding rural area (Arizona Department of Commerce 1996b).

While there are some indicators of economic growth in the Yarnell area, economic activity in Yarnell generally has not mirrored the major growth occurring in other parts of the county. For example, growth indicators such as postal receipts, student enrollment and net assessed valuation have remained relatively stable over the 1991-1995 period (Arizona Department of Commerce 1996b). A recent report by Yavapai College (1996) notes that the rgcord levels of population growth, construction and retail activities in the county are generally confined in the central Yavapai region and the Verde Valley. (This would not include Yarnell.)

Yarnell residents use commercial, retail and medical services in Wickenburg to a large extent. Services in Prescott and the Phoenix area are also available to Yarnell residents.

3.10.3 EMPLOYMENT AND INCOME

Since 1980, Yavapai County has generally experienced a growing economy. The civilian labor force has increased steadily during this 17-year period. Unemployment rates in Yavapai County from 1980 to 1996 have varied from a low of 4.6 percent in 1990 to a high of 10 percent in 1983 (Arizona Department of Economic Security 1997).

Table 3-22 summarizes labor market data for Yavapai County during the 1991-1996 period. The data show increased employment accompanied by an expansion in the civilian labor force. During this period, unemployment has remained relatively stable.

Income growth has been steady for all economic sectors except mining and TCP (transportation, communication and public utilities). Average per capita income growth has been steady over the past 15 years. Because of the relatively large number of retired people in the study area, non-earned income (dividends, interest, transfer payments) has also been increasing (Arizona Economic Data Center 1997).

The dominant employment sectors in Yavapai County, as of mid-1997, were retail trade (at approximately 28 percent of the workforce), services (with 27 percent) and government (with 18 percent) (Arizona Department of Economic Security 1997). The construction sector has also been a major economic stimulus in the area. Construction job and income growth is a reflection of the rapid influx of migrants to the county and the corresponding need for new housing in which to accommodate them. The predominant source of new housing has been single-family homes which accounted for 90 percent of the housing permits issued in 1994 (Arizona Public Service Company 1995).

The economy is also being fueled by major growth from retiree and near-retiree age groups. Demand for goods and services from these groups is driven by pensions, Social Security payments and investment income, rather than earned wages or salary. This situation is a major reason for the growing share of the county employment base working in trade and service jobs (Arizona Public Service Company 1995).

The history of mining sector employment in Yavapai County reflects the typical peaks and valleys traditionally associated with mining. Mining employment in the county reached 1,279 in 1983, followed by a 42.4 percent drop in 1984 to 736 mining employees. By 1991, mining employment had grown to 1,185 but by 1995, it was down to 455, the lowest it has been over the last 25 years (EPA 1997). It is not known if mining workers who have lost their jobs

TABLE 3-22
Yavapai County Labor Force and Employment (Annual Average for 1991-1996)

	1991	1992	1993	1994	1995	1996
Civilian labor force	44,525	49,875	52,525	57,925	62,050	64,700
Employment	44,200	46,375	49,550	54,800	59,075	61,625
Unemployment	2,325	3,500	2,975	3,125	2,975	3,075
Unemployment rate	5.0%	7.0%	5.7%	5.4%	4.8%	4.8%

Source: State of Arizona, Department of Economic Security stayed in the county or migrated to other areas for employment opportunities. Although the Cyprus Bagdad copper mining facility is currently one of the largest employers in Yavapai County, the mining and quarrying sector accounted for only two percent of the county's total wages and salaries in 1996.

3.10.4 POPULATION AND DEMOGRAPHICS

Arizona's population grew by 34.9 percent from 1980 to 1990. Yavapai County grew 58.1 percent over this period, making it the second fastest growing county in the state. Continued growth in Yavapai County is reflected in the 1996 population estimate of 134,600, an increase of nine percent from 1994. Yavapai County contained approximately three percent of the population of Arizona in 1997. The population growth in the county can be directly attributed to large inmigrations into the state. Population projections for the years 2000 and 2015 predict continued growth for the county (Arizona Department of Economic Security 1994).

The population of Yarnell (including Glen Ilah) has traditionally been estimated in tandem with the community of Peeples Valley, approximately three miles north of Yarnell. The estimated 1980 population of Yarnell/Peeples Valley was 785. The joint population was estimated to have grown to an estimated 1,195 and 1,314 in 1990 and 1993, respectively. As of late 1994, population estimates from Yarnell area residents were 800 persons each for Yarnell and Peeples Valley, making the combined population for the two unincorporated communities about 1,600 persons.

The population of Prescott has grown substantially in recent years, reaching an estimated 31,275 in 1996, an increase of more than 50 percent since 1980. The 1996 population of Wickenburg was estimated to be about 4,845, with Congress having a 1996 population of about 750.

Based on information prepared by ABC Demographic Consultants (1994), the population within a 50-mile radius of Prescott (which would include Yarnell):

- has an average 2.45 persons per household;
- is primarily Caucasian (88.2 percent), with Hispanics being the largest minority group (8.1 percent);
- has a median age of 41.3 years and an average age of 41.5 years and
- has 49.18 percent males and 50.82 percent females.

Analysis of 1990 U.S. Census data for zip code 85362 (Yarnell/Glen Ilah) indicates similar demographics for the specific Yarnell area.

- There were an estimated 2.44 persons per household,
- the predominant race was Caucasian with 97.5 percent of the population,
- the average age was 40 years old and
- there were 51.5 percent males and 49.5 percent females.

Additionally, analysis of 1990 Census data describing the population within this zip code indicated that:

- about 46 percent of households had no wage or salary income,
- about 51 percent of households had social security income,

- about 27 percent of households had interest/dividends/rental income,
- about 28 percent of households had other retirement income, and
- of all persons 16 years of age and older, about 49 percent were not in the labor force (e.g., not seeking work).

Compared to 1980, these data reflect an older population, but similar household size and similar mixes of race and gender. The largest portions of population growth to the year 2005 is forecasted to be in the 45 to 64 and 65+ age categories (Arizona Public Service Company 1995), which will continue to cause increases in median and average age in the area.

3.10.5 HOUSING

The most recent comprehensive housing data describing Yavapai County is from the 1990 census. The census counted 54,805 housing units in the county, of which 44,778 were occupied (81.7 percent of the total). With the large population growth and record new construction levels since 1990, the total housing stock in the county is currently substantially higher than this 1990 census count. The substantial population growth and associated demand for housing has led to major increases in housing costs, especially in the Prescott area. The average cost of a home in Prescott rose to $151,059 in 1994 and the cost of living in Prescott was 9.3 percent above the national average as of the third quarter 1994 (Prescott Chamber of Commerce 1995).

The most recent comprehensive survey of housing in Yarnell was conducted in association wivh the development of the Yavapai County General Development Plan in 1975. While this data is obviously somewhat dated, it still provides a relevant discussion of the number and types of housing since the housing stock has not changed dramatically since 1975. The 1975 data showed an estimated total of 434 dwelling units, of which 331 (76 percent of the total) were single family homes. The remaining 103 units were mobile homes. About 88 percent of this housing stock was classified as being sound structurally, with about 12 percent classified as deteriorating or dilapidated.

A housing count was performed in 1996 using both aerial photos and field reconnaissance. No effort was made to determine the condition of the housing stock in this effort. About 380 housing units were counted, with the vast majority of units consisting of single family homes. The lesser number of units compared to the 1975 study is probably due to a reduction in the number of mobile homes and deteriorated/ dilapidated homes.

Generally, land and housing values throughout the county (including Yarnell/Glen Ilah) have been rising in recent years. Assessed valuations associated with land and housing values have also been rising. However, homeowners and landowners in the areas near the proposed mine site (e.g., most notably in Glen Ilah) have expressed concern over a potential decrease in property values attributable to the negative aspects of the mine such as visual effects, noise and public safety. The closest residences are within several hundred yards of the MSA (see also the visual resources discussion). Real estate value issues will be discussed in Chapter 4 of this EIS.

3.10.6 PUBLIC SERVICES AND INFRASTRUCTURE

This section summarizes existing public services and infrastructure in the immediate Yarnell area. The unincorporated community of Yarnell, with its rural nature and reliance on Yavapai County, Prescott and Wickenburg for public and commercial services, would be very vulnerable to major additional growth.

On the other hand, service and infrastructure within Prescott (with a metropolitan population of more than 75,000 persons) and Wickenburg (a relatively stable city of 4,800 persons) would not be affected to any significant degree by any potential growth associated with the proposed Yarnell Project given the expected low proportion of inmigrating residents who would work at the mine. Existing residents of the study area hired to work at the mine would have negligible identifiable impact upon public service and infrastructure in their home communities. While it is anticipated that the residency locations of any inmigrators associated with the mine would be spread out into the wide variety of residency areas within reasonable commuting distance, it is important to consider the potential impacts associated with some growth in Yarnell.

3.10.6.1 Utilities

Water is provided to Yarnell residents through the Yarnell Water Improvement Association. There is no centralized sewer system; sewage disposal needs are provided through individual septic tanks. Electric power is provided by Arizona Public Service Company, and propane is available from a variety of local and regional dealers. Telephone service is provided by U.S. West Communications.

3.10.6.2 Education

There is one public elementary school in Yarnell. Students in junior high and high school are bused to Wickenburg, 26 miles south, or to Prescott, 31 miles north. Enrollment (based on 40th day average daily memberships) in the elementary school has been relatively stable in recent years, with 77 students in 1992-93 and 1993-94, 71 students in 1994-95 and 84 students in 1995-96 (Arizona Department of Education 1996).

3.10.6.3 Public Safety and Emergency Services

The Yavapai County Sheriff's Department has stationed a sergeant and four deputies in the Yarnell District. These officers are responsible for patrolling more than 1,000 square miles of county land. There is a substation in Yarnell which can be used as an office facility, but the substation is typically unmanned and calls to the Sheriff from Yarnell would go to the main facility in Prescott. There are no predominant or unusual types of Sheriff's department calls currently in the Yarnell District; rather, calls are typically for "general police services" (Yavapai County Sheriff's Office 1996).

A 911 emergency call from the Yarnell area would be received in Prescott by a dispatcher in the County Sheriff's office. Generally, an emergency call would lead to dispatcher contact with the nearest Sheriff's deputy, who would proceed to the emergency site. A member of the volunteer fire department may also respond to an emergency if available. If an ambulance is needed, the dispatcher would call for an ambulance either from Wickenburg or Prescott. Wickenburg may be the preferred ambulance source in most cases to Yarnell because the ambulance can arrive sooner than an ambulance from Prescott (Yavapai County Sheriff's Office 1996). In recent years, the city of Wickenburg ambulance service has made an average of about 100 ambulance calls per year to the Yarnell/Glen Ilah area (City of Wickenburg Ambulance Service 1997). The frequency of these calls over any shorter time period varies widely.

3.10.6.4 Non-Emergency Medical/Health Care

A private medical office and registered nurse-practitioner are available in Yarnell. Full medical facilities are available in Wickenburg to the south and Prescott to the north via State Highway 89. Many Yarnell area residents need to have regular visits to doctors or health facilities in Wickenburg.

3.10.6.5 Other Services

The library in Yarnell has seen increased use in recent years. The area is served by a local weekly newspaper and has limited financial services including a branch office of Bank One. There are four motels with 20 units, two trailer/RV parks and one public campground available.

3.10.7 FISCAL CONDITIONS

The proposed project would occur in unincorporated Yavapai County. Therefore, the county would be the primary governmental jurisdiction affected by the project. While the county would gain certain tax revenues from project implementation, it could also be responsible for provision of any necessary services and infrastructure, which would be associated either directly or indirectly with project implementation. Consequently, a summary of Yavapai County's existing fiscal conditions is presented below based on information in the 1996 adopted county budget (Yavapai County 1996).

3.10.7.1 County Revenues and Expenditures

As the county has grown, sources of revenue to Yavapai County have also grown. Major 1996-97 sources of General Fund revenue to the county projected to include property taxes (more than $16.6 million in 1996-97), intergovernmental revenues such as distributions of state sales tax ($12.7 million), charges for services and fees (more than $2 million), the Motor Vehicle Division distribution to the county (more than $2.5 million), county sales tax ($1.5 million) and fines and forfeits (slightly less than $1.3 million). Revenues for Special Funds, such as roads, environmental services, solid waste and health, come primarily from user fees.

As with revenues, county expenditures have grown in recent years to serve the needs of the growing populatinn. Major projected budget categories of County General Fund expendhtures include the Sheriff's Office (more than $8.5 million in 1996-97), medical assistance ($7.3 million), facilities/parks ($2.4 million), general services ($2.6 million), superior courts ($2.6 million) and the county assessor, the county attorney, management information systems and the planning and building department (each with an expenditure of about $1.5 to $2 million).

3.10.7.2 Property Taxes

Property taxes would be the major element of additional revenue from the proposed Yarnell Project. In Arizona, a gold mine/processing facility is "centrally valued," which means the state of Arizona Department of Revenue would have primary responsibility to calculate the market value of the project, upon which property taxes would be based. Therefore, the Yavapai County assessor would not play the primary role in valuing the project. The Department of Revenue would calculate the market value of the project using several appraisal perspectives, including the income approach and cost approach. These approaches use information, such as potential income from the proposed project and the value of surface land, supplies, capital equipment and the mineral resource itself, to calculate the overall market value of the property.

Property tax amounts in Arizona are based on assessed valuation, which is less than the market value. Assessed valuation is determined by applying a percentage (as prescribed by state law) to the market value of the property. Once the assessed valuation amount is determined, appropriate government jurisdictions would apply their standard property tax rates to the assessed valuation to calculate actual property tax amounts.

In addition to Yavapai County, government jurisdictions with property tax rates applicable to the Yarnell Project would include the state of Arizona, the Arizona school equalization program, Yarnell Elementary School District, Yavapai Community College and special districts involving the fire department, flood control and the library. Some of these jurisdictions can apply a primary tax rate (on the full assessed valuation amount), while others can apply only a secondary tax rate (on a limited assessed valuation amount).

Assessed valuation in Yavapai County has grown substantially in recent years as industrial, commercial and residential building and development have increased. Total primary assessed valuation in the 1996-97 fiscal year was about $878 million, a five percent increase from 1995-96. Total secondary assessed valuation in 1996-97 was about $901 million, a two percent increase from 1995-96. Assessed valuation for the Yarnell ElementarySchool District, the Yarnell Fire Department and the Yarnell Street Light Improvement District were about $4.8 million, $2.9 million and $1.4 million, respectively. The 1996 total primary property tax rate (primarily consisting of state, county and elementary school tax rates) was 9.9927 mills for the Yarnell tax district, with a total secondary tax rate of 1.6559 mills, including taxes for the county, fire district and street lighting district. Both the primary and secondary tax rates are down slightly from 1995 tax rates.

3.10.8 ENVIRONMENTAL JUSTICE

On February 11, 1994, Executive Order 12898 (Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations) was published in the Federal Register (59 FR 7629). The Order requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority and low-income populations. Environmental justice has been defined by the EPA as the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies. This goal of "fair treatment" is not to shift risks among populations, but to identify potential disproportionately high adverse impacts on minority and low income communities and identify alternatives, if necessary, to mitigate these impacts.

Race information from the 1990 census shows that 97.5 percent of the Yarnell population is "white." This classification includes the 6.8 percent of the area's residents who are of Hispanic origin. The census data indicate that the annual income of 16.3 percent of the white/Hispanic population was below the poverty level. In comparison, 13 percent of the population of Yavapai County and 15 percent of the population of Arizona were below the poverty levels according to the 1990 census data.

CHAPTER 4

CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

4.0 CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

An analysis of the potential environmental and socioeconomic consequences that could result from implementation of YMC's proposed action or the alternatives is provided in this chapter. An environmental impact is defined as a modification of the existing environment or as it is anticipated to be in the future as a result of the proposed action or alternatives. Environmental impacts can occur as a result of the action (direct) or as a secondary result (indirect) and can be long term (greater than 10 years) or short term (less than 10 years) in duration. Impacts can vary in degree or magnitude from no change to substantial change. "Cumulative" effects are considered separately in Chapter 5.

The analyses of impacts address the issues raised during the scoping process and are framed primarily in terms of the existing environment described in Chapter 3. Issues such as cyanide management and reclamation are addressed as they relate to specific elements of the human environment (e.g., wildlife). Reclamation bond amounts have not yet been established.

Information used to analyze impacts may include:

- resource quality, or the present condition of the resource potentially affected;
- resource sensitivity, or the probable response of a particular resource to the proposed action;
- resource quantity, or the amount of the resource potentially affected;
- duration of impact, or the period of time over which the resources would be affected or
- existing standards in regulations or policies.

Quantitative measurements of impacts are discussed where possible. Where numerical measurements are not possible or readily available, qualitative criteria are used, based on agency guidelines and professional evaluations.

Anticipated impacts for three alternatives in addition to the proposed action are addressed in this analysis. The alternatives considered in this EIS include (see Chapter 2 for a discussion of each alternative):

- The Action as Proposed by YMC
- Alternative 1 -- No Action
- Alternative 2 -- Elimination of the South Waste Rock Dump (SWRD) And Consolidation of Waste Rock into the North Waste Rock Dump (NWRD)
- Alternative 3 -- Elimination of the North Waste Rock Dump And Consolidation of Waste Rock into the South Waste Rock Dump

Some mitigation measures, designed to reduce potential impacts, have been incorporated by YMC into the proposed project. When impacts would remain after design measures and Best Management Practices (BMPs) have been applied, additional mitigation measures are identified. These measures are recommended by the BLM and are not part of YMC's MPO. Residual (or unavoidable) impacts projected to occur after all mitigation measures have been applied are then identified.

Final mitigation measures would be identified after public review of the EIS and in consultation with other agencies and YMC. If the mining plan were approved, the BLM would identify the measures as required conditions or stipulations in the record of decision.

4.1 THE PROJECT AS PROPOSED BY YMC

4.1.1 TOPOGRAPHY

4.1.1.1 Direct and Indirect Impacts

The creation of the open pit, waste rock dumps and heap leach pad would alter the existing land surface features if the Yarnell Project proceeds. The open pit would be partially backfilled to facilitate drainage and minimize the possibility of pond creation. The NWRD would cover existing mill tailings at the head of the Yarnell Creek channel cut, but would terminate short of Cottonwood Spring and the wetland stretch of Yarnell Creek. The heap leach pad and the SWRD are to be constructed over existing depressions and would transform the areas to steeply sloping mounds.

In general, land surface features in the project area would become flatter at tops of the WRDs and heap, but steeper on their side slopes and less irregular in shape. With the exception of the pit, most of the disturbed area would blend with the form of the surrounding topography. Impacts to topographic features from the proposed project are summarized in Table 4-1.

4.1.1.2 Impact Mitigation

YMC proposes reclamation and closure measures to lessen effects to topographic features through grading disturbed topography to stable slopes and blending them with existing topography. These efforts would blend project-related effects with the line and form of existing topographic features to some extent, but would not eliminate topographic effects, particularly the removal of a face of Yarnell Hill as part of the open pit. A berm and fence would be constructed around the abandoned pit to restrict access to potential hazards. No additional mitigation measures are practicable with respect to topographic features.

4.1.1.3 Residual Effects

Although access to potential hazards of the abandoned pit would be restricted, it would not be prevented. The construction of project components would introduce unnatural landforms to the area. This would result in a direct long-term alteration to the topography. However, there are no unique or unusual topographic or geomorphic features in the area that would be altered.

TABLE 4-1
Proposed Yarnell Project Operational Features Affecting Topography

Structure/Feature	Acres of New Disturbance	Maximum Height or Depth (ft)	Top or Bottom Surface	Overall Side Slopes (H:V)
NWRD	22	200	Sloped	2:1
SWRD	49	225	Sloped	2:1
Yarnell Pit	38	480	Benched	2:1
Heap Leach Pile	35	200	Sloped	2:1
Roads*	8	NA	Sloped	0

* Road surfaces would be crowned, with cut or fill side slopes.

4.1.2 GEOLOGY, MINERAL RESOURCES AND GEOTECHNICAL CONSIDERATIONS

4.1.2.1 Direct and Indirect Impacts

Underground mining of the highest-grade ore within the proposed project area has taken place in the past. The proposed mining operation would remove approximately 180,000 ounces of additional gold which would significantly deplete the mineral resource. This depletion would be a necessary effect to meet the purpose of and need for the proposed action.

Mineral exploration drilling activities conducted by YMC and previous property holders have been used to determine the limits of the gold orebody within the MSA. The results of this exploration indicate that economic-grade mineral resources do not exist in the areas of the proposed heap pad, waste rock dumps and the process and ancillary facility areas. Therefore, no potentially valuable mineralization would be buried by the placement of these structures and features in their proposed locations.

Facility stability concerns focus on public health and safety issues. Post-reclamation stability of proposed Yarnell Project facilities was evaluated by selecting a two-dimensional cross section through areas of each structure that would be most critical for stability. These areas were selected based on height of structure, outside slope and foundation slope. Slopes of each selected cross section were analyzed at their planned overall slopes of 2h:1v. The results of these analyses are discussed in Chapter 3. Analysis conducted by SMI (Baseline Studies Document, Volume 3, Facilities Design Report, SMI, 1996) concluded that facilities would be stable at these planned slopes. SMI chose criteria for slope stability based on guidelines for embankments. The minimum safety factor criteria set by SMI were 1.3 for static conditions and 1.15 for seismic conditions. In their reclaimed configuration, the open pit, heap and WRDs all exceeded a 1.3 safety factor. Seismic analysis of these structures used a pseudostatic coefficient (0.05g) representing a seismic event with a return frequency between 50 and 250 years. In their reclaimed condition, these structures exceeded a 1.15 safety factor in the stability analyses. An additional stability analysis was conducted by SMI for the NWRD, taking into account the existing tailings beneath the NWRD. The safety factors from this analysis exceeded the minimum criteria. Based on these analyses, the proposed designs of the open pit, heap and WRDs would be stable, and impacts from failures would be unlikely. Relationships between proposed facilities and potential effects to water resources are discussed in sections 4.1.4.2 and 4.1.4.3. In addition to these EIS analyses regarding facility design, the APP process conducted by the ADEQ and the NPDES storm water permitting process administered by the EPA include additional evaluations of the stability and overall design parameters for the proposed facilities.

4.1.2.2 Impact Mitigation

There are no identifiable adverse effects that would require mitigation.

4.1.2.3 Residual Effects

Residual effects are negligible.

4.1.3 SOILS

4.1.3.1 Direct and Indirect Impacts

The proposed Yarnell Project would disturb 182 acres within the MSA, as shown in Figure 4-1, and 18.5 acres for the water supply well field and pipeline, resulting in both long- and short-term impacts as a result of soil removal, storage and re-application. Long-term impacts would include changes in soil structure and texture, destruction of natural soil horizons, increased erosion and creation of unreclaimable areas in the open pit. Short-term impacts would include soil erosion losses, a reduction in soil productivity and an increase in soil compaction.

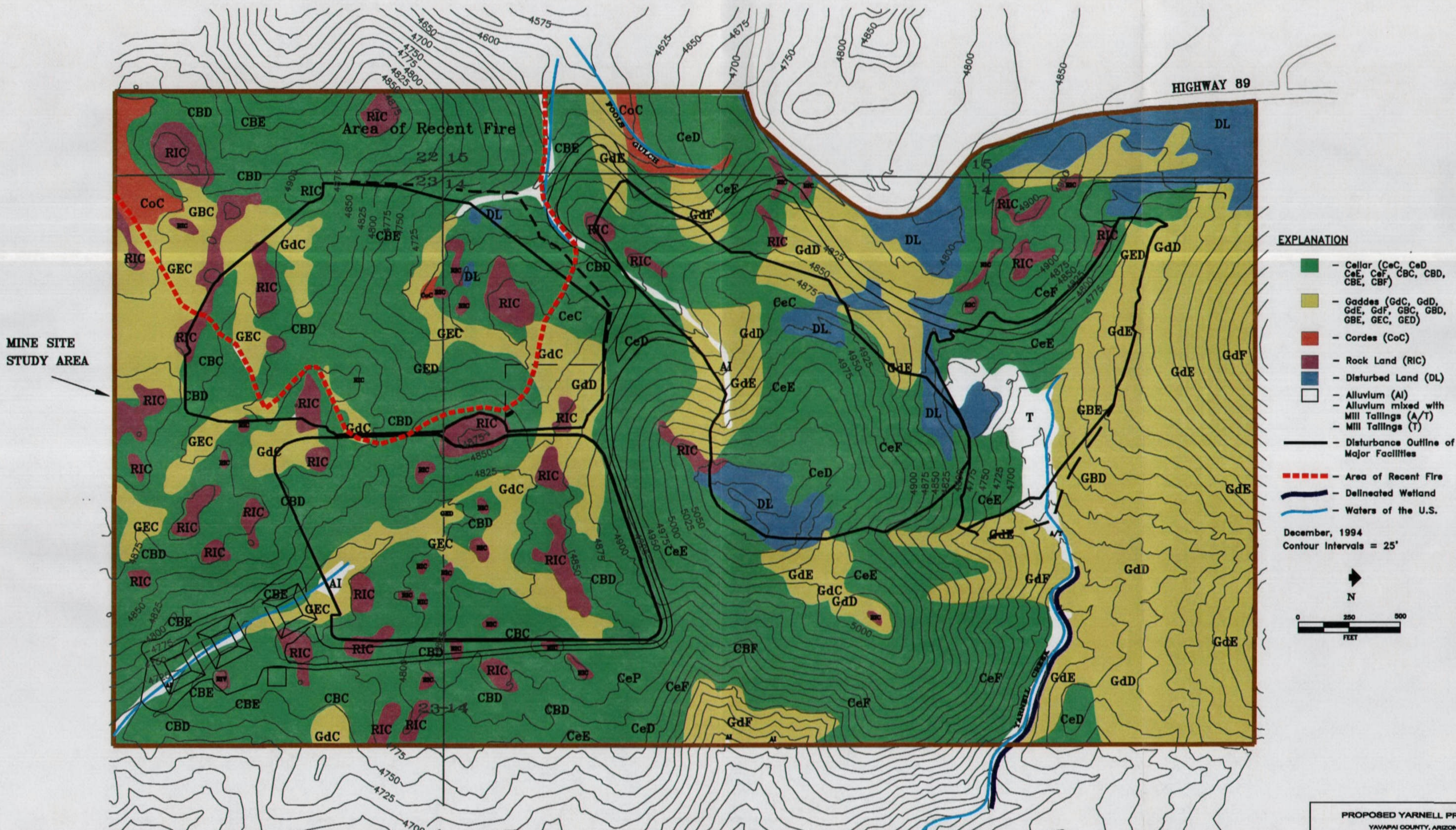
As proposed, during reclamation, topsoil would not be applied to about 28 acres of the open pit or 7.6 acres of roads retained permanently, resulting in a long-term, high adverse impact to the soil resources in this area. In addition, 46 acres would be converted to steep 50 percent slopes, increasing the risk of erosion.

All available suitable soils in areas to be impacted would be salvaged and stockpiled. Recovery of soils is limited by steep slopes and the occurrence of boulders and rocks. Up to one-half of the topsoil resource may not be recoverable and would be lost permanently. Establishment of a suitable growth medium on approximately 147 acres would consist of replacement of topsoil or the incorporation of fertilizers or other soil amendments to the regraded material prior to seeding. This process would alter the natural soil structure, destroy the soil horizons, blend all soil horizons together and permanently change soil texture, and an unknown volume of soil may remain stockpiled. The reclaimed post-mining topography would not resemble the current soil mosaic found at the site, and post-mining soil profiles on reclaimed land would have a more uniform soil texture, structure, chemistry and depth.

The impacts of mining on the soil profile and distribution would have indirect impacts on the vegetation. Vegetation types currently present are, in part, a function of soil type, depth and topography, which regulates runoff and moisture availability. The post-mining topography, with a uniform application of soil or incorporation of fertilizers or other amendments to the regraded material to establish a suitable growth medium, may reduce plant diversity. In addition, increasing the number of bare rock exposures would have secondary impacts on the environment by reducing vegetation cover, increasing runoff and erosion and potentially deteriorating surface water quality.

The disturbance of soil resulting from stripping and the creation of steep (50 percent) slopes of the regraded WRDs and the heap would increase soil losses through erosion. Increased erosion rates, relative to natural erosion rates, would result from soil salvage, storage and re-application operations. Soil erosion would be a short-term impact. Erosion would be controlled during mining and by the completion of the proposed reclamation plan. Secondary impacts of soil erosion may include deterioration of air and surface water quality.

Stockpiling soil for long periods can adversely affect soil chemical and biological properties, productivity and the success of revegetation. Stockpiling for more than two years can significantly decrease the viability of seeds and microbiota (Office of Technology Assessment 1986). Following reclamation, post-mining soil productivity would



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 4-1
PROPOSED PROJECT
MINE SITE STUDY AREA
DISTURBED AREAS
SOIL TYPES MAP

eventually be restored by natural processes. The loss of soil productivity would result in a short-term impact.

Soil compaction would occur at ancillary facilities and on roads from vehicle traffic, beneath buildings and during reclamation operations. Soil compaction can decrease soil aeration, reduce plant germination and seedling emergence and reduce water infiltration, hence increasing surface water runoff and erosion. Soil compaction would be a short-term impact, except on roads retained, if mitigated according to the proposed reclamation plan.

In addition to the effects within the MSA, there would be short-term, negligible impacts to soils along the water pipelines during construction. Vegetation would be selectively removed from the corridor, creating minor localized soil disturbances, and there may also be compaction of soil by machinery used to install the pipeline. Any serious compaction of the soil or any critical erosion problems would be mitigated following termination of operations.

4.1.3.2 Impact Mitigation

YMC has proposed erosion control and reclamation as outlined in the MPO. All disturbed areas accessible by equipment would be stripped of topsoil. Topsoil would be stockpiled on site, out of major drainageways, constructed with 33-percent slopes and seeded with native grass to minimize erosion. Topsoil would be reapplied or fertilizers or other amendments would be incorporated into the regraded material on all disturbed surfaces except the steep slopes of the open pit and permanent roads.

Under the proposed action, about 147 of the 182 acres disturbed within the MSA would have topsoil or soil amendments added prior to seeding. There are roughly 153,000 cubic yards of salvageable topsoil covering the areas to be disturbed. This would provide a topsoil cover of about seven inches thick over the 147 acres. Natural soil development on this rocky substrata of the pit would require thousands of years.

During mining and reclamation, soil erosion would be mitigated by diversion channels, sediment retention structures and regrading to reduce slopes. Disturbed areas would be revegetated and a protective mulch applied to minimize erosion. Erosion would be monitored for up to seven years following reclamation, and areas exhibiting severe erosion during this time would be stabilized.

During storage of topsoil, there would be a temporary decrease in soil productivity. Following successful establishment of vegetation on reclaimed surfaces, the pre-mining soil productivity and biological activity level would eventually be restored. Weed control may be necessary on newly reclaimed areas and topsoil stockpiles.

YMC has proposed reapplying topsoil on disturbed areas or the use of amendments on the regraded area. However, YMC has not indicated that all salvaged topsoil will be reapplied to disturbed areas. Therefore, the following additional mitigation measure is required.

YMC shall use all topsoil salvaged from disturbed areas in reclamation. All salvaged and stockpiled topsoil shall be reapplied to disturbed areas.

Areas experiencing heavy vehicle traffic (and not designated to remain) and areas under buildings and structures would likely be compacted. These areas would be ripped to relieve compaction and provide a more suitable growth medium. Accessible flat benches of the pit may be ripped and/or scarified for the anchoring of any soil materials. Some small depressions would be left on surfaces to aid moisture retention. These areas would be used to seed native species and transplant selected native shrubs.

The alteration of soil structure and texture and the destruction of natural soil horizons cannot be mitigated. However, once vegetation is successfully established, natural soil-forming processes would slowly re-establish soil profiles.

4.1.3.3 Residual Effects

The proposed project would result in long-term impacts to soils. The soil profiles in areas altered by mining activities can never be returned to their original condition. In addition, approximately 28 acres of rocky disturbed land having steep slopes and seven acres of permanent roads would not receive topsoil. This would be a permanent loss of soil resources. Topsoil resources that are unrecoverable due to steep slopes and boulders would be permanently lost. However, since the soils are not rare in this part of Arizona, the impact to the integrity of the local ecosystem is limited.

4.1.4 WATER RESOURCES

This analysis of consequences to water resources is divided into quantity and quality for both surface water and groundwater. Attention was focused on issues that were raised during the NEPA scoping process. These issues are summarized below.

- Impacts from mine water supply pumping and the mine pit on groundwater level and yield of wells in the area.
- Impacts of groundwater withdrawal on surface water flow.
- Adequacy of the proposed water supply.
- Water ponding and groundwater inflow to the mine pit.
- Impacts of the proposal on the quality of both surface and groundwater.
- Impacts to waters of the U.S., including wetlands.

The geographic area evaluated is the entire Water Resources Study Area (WRSA).

Surface water quality would be significantly impacted if the water quality of any surface water no longer meets applicable Arizona Surface Water Quality Standards. Groundwater quality degradation would be significant if the Arizona State Aquifer Water Quality Standards or the Federal Maximum Contaminant Levels (MCLs) are exceeded.

4.1.4.1 Surface Water Effects - Occurrence, Flow and Quantity

Heap Leach Facility. The heap leach facility would have the following impacts to surface water quantity and drainage patterns in the MSA.

- Approximately 45 acres covered by the heap leach pad and solution ponds would no longer contribute to surface runoff to Yarnell Creek during the life of the project. Surface water originating upgradient of the heap leach facility would be diverted around the facility and discharged at outfall SWO-01. Diversion channels are designed to accommodate runoff from the 100-year, 24-hour storm event (4.8 inches). Precipitation falling on the leach site from a 100-year, 24-hour storm event, the volume of operating solution and a volume equal to the 24-hour draindown of the heap would be contained within the heap leach facility; this is described in Section 2.1.4.4 of this document. After closure/reclamation, the 45 acres of drainage would be returned to the Yarnell Creek drainage.

- During the initial construction of the heap leach facility, two temporary diversions (designed for the 100-year, 24-hour event) would divert flow around the leach pad area to outfalls SWO-03 and 04. Drainage from a waste rock fill area would be discharged at SWO-03, while an undisturbed future phase of the leach pad area would be discharged at SWO-04. These diversions and discharge points would be temporary and would be covered by the leach pad as it is expanded during operations.
- Tom Cat Tank, a range improvement, would be covered by the leach facility and permanently lost.

Waste Rock Dumps. The two waste rock dumps would have the following minor impacts to surface water quantity and drainage patterns within the MSA.

- Current drainage patterns would be permanently altered. Runoff from the top surface of the SWRD that previously drained to Fools Gulch would be diverted to Yarnell Creek and discharged at outfall SWO-01. The sloped surface of the SWRD would drain to a sediment retention structure at outfall SWO-09. Runoff from the NWRD would drain to a sediment retention structure at outfall SWO-06. During operations, discharge from the sediment retention structures should not occur from storm events smaller than a 10-year, 24-hour storm. The sediment retention structures would have the capacity to contain a 25-year, 24-hour event. Therefore, the structures should be able to contain runoff from a 10-year, 24-hour storm plus two to three years of accumulated sediment under average conditions. Upon reclamation, these retention basins would be filled with coarse waste rock.
- Upon completion of the SWRD, 37 acres that previously drained to Fools Gulch would be permanently diverted to the Yarnell Creek drainage by diversions along the west side of the heap leach facility and discharged at outfall SWO-01 (see Figure 2-4). Upon backfilling and reclamation of the pit, about 15.4 acres that previously drained to Yarnell Creek would be diverted to Fools Gulch by the pit. Therefore, the net increase in drainage to Yarnell Creek would be approximately 22 acres. This acreage comprises about 2.5 percent of the Yarnell Creek drainage area upstream of its confluence with the catchment containing the heap leach facility and outfall SW-01. Figure 3-6 shows the drainage pattern and catchment areas. The permanent diversion channel would be more than 3,000 feet long and would be near the head of the drainage near the drainage divide. Flow from the diversion would contribute to total flow in the lower Yarnell Creek drainage. Peak flow from the diversion may be slightly attenuated compared to peak flow under natural conditions. There would be little effect on the peak flow in Yarnell Creek. The area diverted from Fools Gulch would be the relatively flat

top surface of the SWRD. Infiltration of precipitation would likely be much higher than natural soils and bedrock, resulting in reduced runoff. Any seepage from infiltration into the SWRD would return to Fools Gulch. Therefore, any increase in flow rate or volume would likely be less than the 2.5 percent increase in the drainage area.

- Precipitation infiltrating the dumps could appear as seeps near the toe of the dump.
- Seepage of water from the upper tailings bench may increase as consolidation occurs resulting from placement of the NWRD over them. Seepage may then decrease to about half of the current rate due to decreased permeability (SMI, July 1997).

Mine Pit. The mine pit would have the following minor impacts to surface water quantity and drainage patterns in the MSA during mining and post-closure.

- Storm runoff would enter the mine pit. This runoff would either evaporate, seep into the bedrock or flow into Fools Gulch. Water that accumulates in the pit during mining would be pumped out of the pit and used for dust suppression.
- The pit would be partially backfilled to establish drainage toward the southwest end of the pit bottom (see Figure 2-11) at a one-half to two percent grade. The mine pit would function as an extension of Fools Gulch catchment.
- The decline in groundwater levels surrounding the pit could affect Cottonwood Spring; this is described in Section 4.1.4.3.

Roads and Other Disturbance. Runoff from roads, waste rock fill area and other disturbance would be collected in diversions and discharged. These diversions would be designed for the 100-year, 24-hour precipitation event. The following permanent diversions of surface water would occur.

- The undisturbed area and soil stockpile south of the heap leach facility would be diverted and discharged at outfall SWO-02. Discharge from SWO-01 draining the surface of the SWRD would drain to the diversion for SWO-02 and runoff from the two areas would be combined and discharged to Yarnell Creek.
- The service road east of the heap leach facility would be constructed with waste rock and runoff would be captured and discharged at outfall SWO-05 to Yarnell Creek.
- Runoff from an undisturbed area, the office and a soil stockpile area would be permanently diverted around the NWRD and discharged to Yarnell Creek at outfall SWO-07 below the sediment retention structure.
- Runoff from the shop and haul road constructed of waste rock would be collected and discharged at outfall SWO-08 to Fools Gulch west of the mine pit.

The diversion of storm water runoff should have little impact on water quantity because the diversion of flows would be near the head of drainage areas. Peak flows from these areas may be different because the length and slope of the diversion channels differ from the undisturbed channels.

Water Supply Wells. The withdrawal of groundwater from Well YMC-04 may have an effect on surface water sources within the MSA such as Cottonwood Spring, but would not have an effect on surface water sources outside of the MSA. The withdrawal of groundwater from wells TW-01, 2BCD, and the Section 28 well field should not affect surface water sources in the WRSA. These conclusions are based on groundwater level declines surrounding each water supply well as predicted from standard pump test analysis and groundwater modeling; this is discussed in detail in Section 4.1.4.3 and is not repeated here.

The flow of the two-mile perennial stretch of Antelope Creek should not be affected by water supply wells YMC-04 and TW-01. This conclusion is based on two reasons.

- The perennial stretch of the creek derives its water from the TSV aquifer unit, while the source aquifer for water supply wells YMC-04 and TW-01 is the Bedrock Complex Aquifer System (BCAS).
- The pumping of groundwater from wells YMC-04 and TW-01 did not reduce the flow at two monitoring locations on the perennial stretch of Antelope Creek. The pump tests on wells YMC-04 and TW-01 are described in Section 4.1.4.3.

Surface Water Rights. The BLM grazing permittee, William Grantham, holds Stockpond Claim 38-62572 for livestock watering at Tom Cat Tank. This stockpond would be covered by the proposed heap leach facility, and the stockpond and associated water right would be lost.

4.1.4.2 Surface Water Effects - Quality

Heap Leach Facility. In the absence of a catastrophic event or failure (such events and their impacts are described later in this section), the heap leach facility should have minimal impact to surface water quality. This conclusion is based on the following.

- Storm water runoff originating upgradient of the heap leach facilities would not come in contact with the leaching facility; this water would be captured before it reaches the facility and diverted downgradient. Diversion channels are designed to accommodate runoff from the 100-year, 24-hour storm (4.8 inches).
- A topographic divide exists between the MSA and towns of Glen Ilah/Yarnell, as described in Section 3.2.5.1. If runoff occurred from the heap leach facility, it would flow south/ southeast, away from Glen Ilah and Yarnell and would not impact surface waters in those areas.
- During operations, precipitation falling on the leach pad would not leave the site as surface runoff. Runoff from the heap leach pad area and process ponds would be collected and retained in the process ponds. During the Phase I construction of the heap leach pad, outfalls SWO-03 and 04 would discharge from two temporary drainage basin areas. Outfall SWO-03, which would discharge waters contacting waste rock, would be subject to EPA effluent limitation guidelines and would be combined with discharge from SWO-04 (subject to visual inspection standards) by means of a temporary diversion. The drainage areas for both SWO-03 and 04 would be occupied by the Phase II heap leach pad. The process ponds have been designed to contain the combined volume of normal operating solution, a 24-hour heap solution draindown and the 100-year, 24-hour precipitation event. The diversion channels have been designed to handle runoff from the 100-year, 24-hour precipitation event.
- Sediment in discharges from SWO-03 and 04 would be controlled by using straw bales, silt fences and other best management practices

along the diversion channels. These types of control would be adequate for normal precipitation, but would likely not be able to handle peak flow from larger events. Therefore, increased sedimentation would be expected during large precipitation events.

- The leached ore would be rinsed with water until the water quality standards specified in the APP are met, which may take up to three years. The detoxification/neutralization process would include reducing the weak acid dissociable (WAD) cyanide to 0.2 mg/l and stabilizing the pH between 6.0 and 9.0.

Surface water quality would likely not be significantly degraded downstream of the heap leach facility under the following catastrophic scenarios.

- *A rainfall event greater than the 100-year, 24-hour storm (4.8 inches).* The heap leach ponds are designed to have two feet of freeboard. This freeboard represents more than 30 percent of the volume of a 100-year, 24-hour storm. If the ponds were likely to spill, YMC would be required by the conditions of the APP to detoxify the solution in the storm water pond, which would be where discharge would take place. If the ponds did spill without implementation of detoxifying procedures, the water that would spill from the storm water pond would be diluted by the volume of precipitation collected within the heap leach facility. The water that would spill from the storm water pond would be diluted by about a 2:1 ratio by the precipitation collected within the heap leach facility. Spilled solution would then be diluted by runoff outside the heap leach facility. Dilution would roughly be proportional to the surface area of runoff. Upon reaching Yarnell Creek, dilution would be about 20:1. At the confluence of Yarnell Creek with Antelope Creek, dilution would be about 35:1. Assuming a process solution with a concentration of about 100 mg/l of free cyanide, the concentration in the storm water pond would be 50 mg/l. Concentrations of free cyanide would be diluted to about 2.5 mg/l at the confluence with Yarnell Creek and about 1.4 mg/l at the confluence with Antelope Creek. These calculations do not consider oxidation or other natural degradation that would take place when the process solution is mixed with precipitation runoff or is exposed to ultraviolet light. Therefore, the impact from such a spill would not significantly impact surface or groundwater quality. The likelihood of a storm event exceeding 4.8 inches in 24 hours occurring during the 10-year period through reclamation of the site is about 10 percent.
- *An earthquake greater than a 250-year return frequency.* The heap leach pad and solution ponds would be stable for seismic events exceeding the 250-year recurrence interval earthquake. Should a seismic event occur that could cause failures in the heap leach facility, there would likely not be a total failure of the system. Slumping and movement of ore outside the perimeter of the leach pad could occur. Any movement of the pond embankments would not likely result in total release of solution from the ponds. Some dilution of the CN solution would occur from the storm water pond. In addition, any CN solution released would likely be attenuated or broken down upon contact with other minerals and ultraviolet light. Therefore, the impacts from such a spill would not

significantly impact surface or groundwater quality. The likelihood of an earthquake of this magnitude occurring during the 10-year period through reclamation of the site is about four percent.

- *Loss of solution from the heap leach pad from washouts in the compacted fill of the foundation.* The surface water diversions would protect the heap leach facility and would be designed to handle the 100-year, 24-hour rainfall event. Drainage on the leach pad for all but the southeast corner would be toward the center of the pad. In these areas, erosion of the compacted fill of the heap leach pad foundation would not be possible. The only area where erosion of the heap leach pad foundation would be possible is the east end of the south side of the leach pad. This area would have a three-foot high perimeter berm. If the perimeter berm were breached by an extreme event, the result would be escape of solution; the consequences of this have been described earlier in this section.

Waste Rock Dumps. The North and South waste rock dumps should have minimal impact to surface water quality for the following reasons.

- Storm water runoff originating above the WRDs would be captured and diverted around the WRDs to outfalls SWO-02 and 07. Runoff in contact with the WRDs would be collected and discharged from outfalls SWO-01, 06 and 09. Sediment retention structures would be constructed at SWO-06 and 09. Straw bales, silt fences and other best management practices would be used along the diversion channels to control sediment. The diversion channels would be designed to accommodate runoff from the 100-year, 24-hour storm event (4.8 inches). These diversions would be permanent structures and would be retained after the site is reclaimed.
- Sediment retention structures below the NWRD and SWRD would greatly reduce the amount of sediment reaching Yarnell Creek and Fools Gulch. These structures are designed to contain the 25-year, 24-hour event (3.8 inches) with one foot of freeboard. This capacity would allow containment of the 10-year, 24-hour event and two to three years of accumulated sediment under average conditions. Flows exceeding the capacity of the structure would be discharged through an emergency spillway designed to safely pass the peak flow of the 100-year, 24-hour event. The sediment structures would be inspected annually and sediment removed as needed and placed in the WRDs. Since the sediment would be derived from the waste rock (which would be sampled for acid-forming materials), the sediment would not require sampling before disposal.
- The embankment of the sediment retention structures would be constructed of coarse, compacted waste rock and be designed as flow-through structures. It is anticipated that water contained in the structure would seep into the embankment and infiltrate the materials below the embankment, but that no water would seep through the embankment. No dewatering of the structures is planned. However, stored water may be used for dust suppression. Discharge from these structures would be monitored and subject to EPA effluent limitation.
- The sediment retention structures would be reclaimed by filling with waste rock.
- Precipitation that falls on the WRDs should not emerge as acidic seepage. Batch leach test

results met ADEQ water quality standards except for antimony in two samples. Secondary standards were exceeded for iron in two samples and manganese in one sample. The results of geochemical characterization (SMI, July 1997) are described in detail in Appendix D. The geochemical characterization suggests that the waste rock is fairly inert; this means that its ability to generate acid is low compared to its acid-neutralizing potential. A confirmational waste rock geochemical testing program and contingency plan would be required under the APP during the life of the mine. Waste rock not tested as "inert" would be segregated and handled differently to prevent acid generation from the waste rock placed in the NWRD and SWRD.

- Seepage from the historic tailings may result from consolidation after placement of the waste rock in the NWRD. Based on geochemical test results, the seepage should not be acid forming, as there is little evidence of acid generation currently, and the tailings have been in place for 55 years. Batch leach test extract from the tailings met state groundwater quality standards except for manganese and cadmium in one sample and total cyanide in two samples and exceeded secondary standards for sulfate, copper, manganese and zinc in the two samples from the leached ore area upgradient from a portion of the upper tailings. The results of the batch leach tests are provided in Appendix D.
- Erosion and sedimentation should be reduced by a number of structural control features and best management practices that would be required by the project's Storm Water-NPDES permit, storm water pollution prevention plan (SWPPP) and spill prevention control and countermeasures (SPCC) plan. The failure of sediment control structures is unlikely. However, large events could exceed the capacity of berms, silt fences, hay bales and other surface water control structures, resulting in increased sedimentation. Storms greater than a 10-year, 24-hour event could result in flow through the emergency spillway of the sediment retention structures, depending on the amount of sediment accumulated in the ponds. Storms greater than a 100-year, 24-hour event could cause erosion of the spillway and breaching of the embankment. This would result in increased sediment loading. However, during such an extreme event, background sediment levels would be very high, and overall impacts would not be significant.
- The WRDs would be regraded, compacted areas scarified, topsoil replaced or a suitable growth medium established and revegetated.

Mine Pit. The geochemical characterization of the type of rock found in the pit, as described in Appendix D, has predicted that acid rock drainage is not likely and that any seepage from the pit walls should not degrade surface water quality. Therefore, any surface water draining from the mine pit should not degrade the water quality of Fool's Gulch.

Runoff from the pit could increase sediment loads to Fools Gulch. However, the need for sediment, erosion and other surface water control measures would be evaluated by YMC at the end of mining. Sediment control measures, including a sediment retention structure, would be implemented at that time, if needed.

Roads and Other Disturbances. Based on the results of the geochemical characterization, storm water runoff from roads and other disturbance should not degrade the quality of surface water. Storm water outfalls SWO-05 and 08 would discharge runoff collected from roads and other disturbance and would be subject to monitoring and EPA effluent limitation guidelines. Runoff would be collected via a ditch or swale cut along the edge of the roads. Straw bales, silt fences and other best management practices would be used along the diversion channels, ditches and swales to drain roads and areas filled with waste rock to control sediment, if required. These areas would be compacted and, therefore, would not be expected to generate substantial quantities of sediment. Outfalls SWO-02, 04 and 07 would be visually monitored, but would not discharge waters that had contacted waste rock. Increased sedimentation could occur from large storm events resulting in peak flows that exceed the capacity of the sediment control structures.

Water Supply Wells. The withdrawal of groundwater from the water supply wells would not affect the quality of surface water.

4.1.4.3 Groundwater Effects - Occurrence, Flow and Yield

Heap Leach Facility. The proposed heap leach facility should have minimal impact to groundwater flow or depth to groundwater underneath and down-gradient of the leach facility for the following reasons.

- The heap leach facility would be constructed on top of the existing land surface; the underlying geology and aquifer system would be unchanged.
- There is little groundwater recharge area up-gradient of the heap leach facility because the facility is near the top of the watershed. The groundwater divide that separates the MSA from Glen Ilah/Yarnell is discussed in Section 3.2.5.1.

The potential for shallow perched groundwater beneath the heap leach facility would pose two main concerns. First, the development of hydraulic pressures could affect the stability of the heap leach pad and solution ponds. Second, the potential connection with the groundwater system could inhibit detection of releases of leach solution until after groundwater had been impacted. These conditions are not expected to occur for the following reasons.

- Subsurface drains would be installed following natural drainage patterns under the heap leach pad, pond and ADR plant site. This system would drain any near surface groundwater beneath the heap leach facility.
- The occurrence of perched groundwater in soils above low permeability bedrock layers would be due to direct precipitation and would be temporary. Infiltration would be reduced by construction of the heap leach facility.
- The heap leach facility would be near the top of the drainage and near the top of Yarnell Hill. The only source of groundwater at the site would be infiltrating precipitation.
- As discussed in Chapter 3, infiltration rates in the MSA are several orders of magnitude less than the hydraulic conductivity. The limiting condition for groundwater migration in the granodiorite system is the supply of water from infiltration. Therefore, except for local areas of temporary perched groundwater, infiltrating precipitation would be conducted into the fracture flow aquifer system and would not affect the stability of the heap leach facility.

Waste Rock Dumps. The WRDs would have negligible impact on groundwater occurrence, flow and yield because:

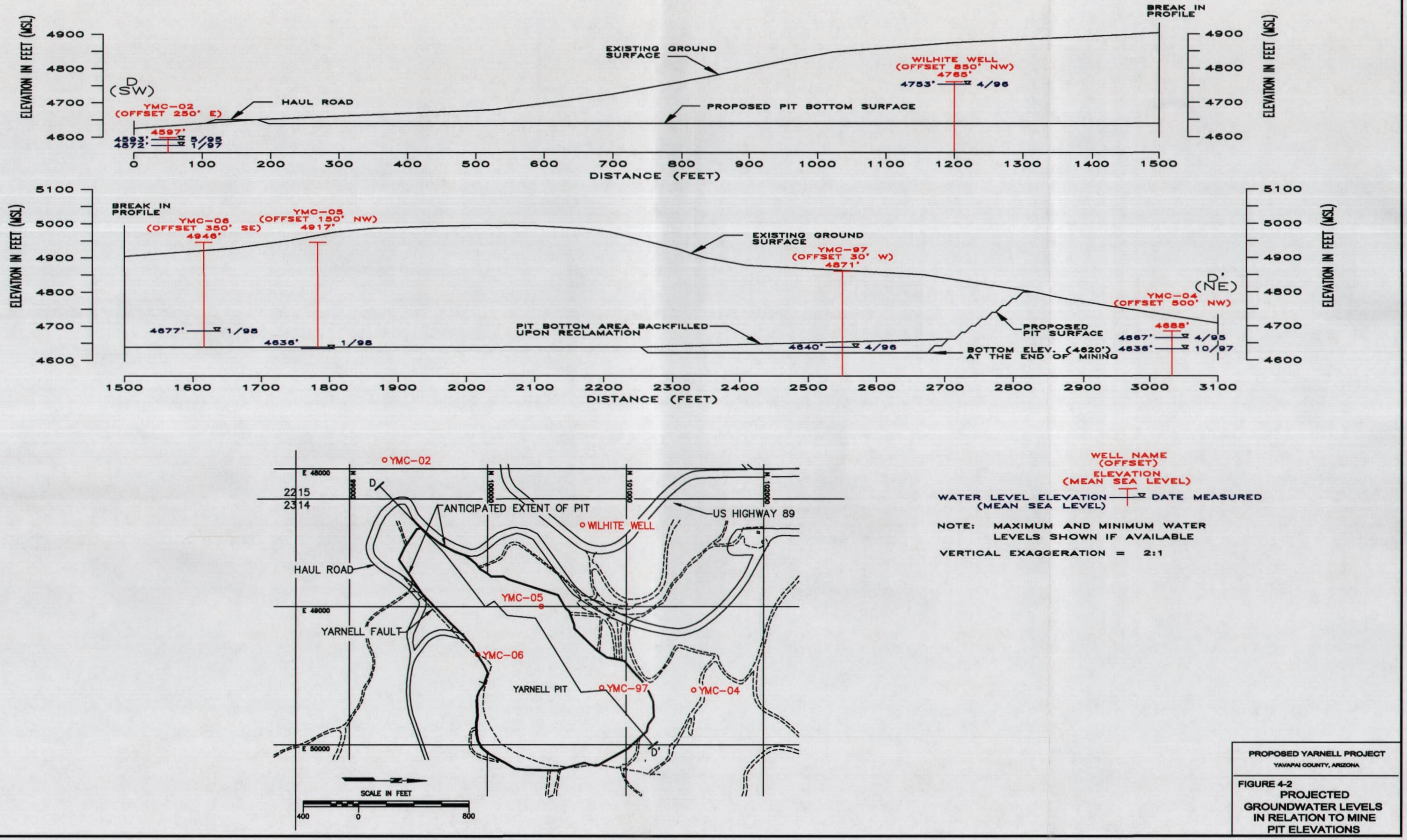
- ♦ The WRDs would be constructed on top of the existing land surface; the underlying geology would be unchanged.
- ♦ There is little groundwater recharge area upgradient of the WRDs because they would be located near the head of the watershed.
- ♦ The design of the WRDs would not prevent precipitation from infiltrating the waste rock or prevent such precipitation from infiltrating the ground under the waste rock.
- ♦ Settlement of the historic tailings from placement of the NWRD was calculated using traditional consolidation theory and the effect of seepage from the tailings estimated (SMI, July 1997). Results indicate seepage from the historic tailings to bedrock may increase slightly after placement of the NWRD, but should decrease to approximately one-half the current rate within about three years. Seepage volume from the tailings is minor.

Mine Pit. The mine pit may result in a permanent decline in groundwater levels in at least part of the MSA, but there should be no impact to groundwater outside of the MSA. This conclusion is based on the computer model MODFLOW-96, run by Groundwater Resources Consultants, Inc. (GWRC) in January and February, 1998. This theoretical model, developed by the U.S. Geological Survey (Harbrecht and McDonald 1996), is commonly used to simulate groundwater flow in fractured bedrock systems such as found at the Yarnell Mine. Wells YMC-02, 04, 05 and 06 and exploration hole YM-97 provide the water level data for use in the modeling (see Figure 4-2).

Using the available groundwater data, MODFLOW-96 predicted that the mine pit, excluding pumping from Well YMC-04, would result in the impacts listed below seven years after the start of mining operations.

- ♦ Groundwater levels would decline in all directions surrounding the pit. As shown in Figure H-1 of Appendix H, the area of groundwater drawdown (cone of depression) would approximate a 3200 foot long, 2500 foot wide ellipse. This may have some impact on the groundwater divide within the MSA, but no impact on the groundwater divide that exists between the MSA and the towns of Glen Ilah and Yarnell.
- ♦ On the northeast side of the pit, groundwater drawdown was predicted to be zero at a distance of 300 feet from the edge of the pit. On the southwest side of the pit, groundwater drawdown would be zero at a distance of 1200 feet from the edge of the pit.
- ♦ Groundwater drawdown would be over 30 feet in the southwestern part of the pit, five feet at the Wilhite well, and less than 0.5 feet at both Fools Gulch and Cottonwood Spring. With the exception of the Wilhite Well, springs and wells outside of the MSA would not be affected by the pit.

The results from MODFLOW-96 assumed 16 inches of annual precipitation and a recharge rate of 5% (the amount of rainfall and snowmelt that infiltrates the ground). The accuracy of MODFLOW-96 with respect to its ability to predict groundwater flow and levels in the MSA is discussed in the next subsection "Water Supply Wells". Should pit dewatering adversely affect the Wilhite well, mitigation has been proposed and is described later in this chapter.



PROPOSED YARNELL PROJECT
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FIGURE 4-2
PROJECTED GROUNDWATER LEVELS IN RELATION TO MINE PIT ELEVATIONS

The ponding of groundwater in the mine pit during and after the life of the mine should be minor for the reasons discussed below.

- The quantity of groundwater available in the fractured granodiorite of the MSA is limited, and the groundwater that does exist will not easily or quickly flow into the pit. This is discussed in detail in Section 3.2.5, and confirmed by exploration drilling in the proposed open pit area. Only 10 of the 96 exploration drill holes in the pit area encountered groundwater above or near to the final backfilled pit elevation of 4,640 to 4,660 feet. In fact, only 19 of the 96 exploration holes drilled between elevations 4,550 and 4,825 feet encountered any groundwater.
- After the completion of mining activities, surface drainage out of the pit and into Fools Gulch would be facilitated through two methods: a) the pit would be partially backfilled to an elevation of 4,640 to 4,660 feet, and b) a drainage channel of slope 0.5-2 percent would be established along the pit bottom.

Water Supply Wells. The withdrawal of groundwater from Well YMC-04 may impact springs and wells in the MSA, but would not impact water sources outside of the MSA. The withdrawal of groundwater from wells TW-01, 2BCD, and the Section 28 well field should not impact water sources in the WRSA. Well YMC-04, located in the MSA, will be discussed first. Two methods were used to predict the effect of the pumping of this well on nearby water sources. First, a pump test was conducted on Well YMC-04. Groundwater was pumped from Well YMC-04 for 10 days; this did not reduce the flow or water levels of streams, springs, and wells in the WRSA. The two closest water sources to Well YMC-04 are wells YMC-01 and the Wilhite well, located 1,100 feet to the east and 1,600 feet to the southwest, respectively. Second, groundwater levels in the MSA were simulated using the theoretical model MODFLOW-96. Assuming a constant 15 gpm pumping rate for Well YMC-04, the model predicted the following impacts seven years after the start of pumping.

- The cone of depression (area influenced by pumping up to the two-foot drawdown contour) would extend from Well YMC-04 approximately 3,800 feet to the southeast along Yarnell Creek, 3000 ft. to the southwest towards Fools Gulch, and 3,000 feet to the northwest (Figure H-2 of Appendix H).
- Groundwater levels are predicted to decline 30-50 feet in the southern part of the mine pit, 20 feet at Well YMC-04, 15 feet at Cottonwood Spring, 5 feet at the Wilhite Well, and less than 2 feet at Fools Gulch Spring.
- Within two years after the end of pumping of Well YMC-04, groundwater levels would return to within 0.5 feet of original levels.

The above results from MODFLOW-96, which included drawdown from the mine pit, assumed 16 inches of annual precipitation and a recharge rate of 5%. The accuracy of the predictions from MODFLOW-96 depends on two factors: 1) how well actual precipitation and recharge during the life of the mine matches the input used in the model, and 2) the ability of the model to simulate the movement of groundwater in the fractured granodiorite of the MSA. The results of the pump test and modeling by MODFLOW-96 do not agree concerning the impacts of pumping groundwater from Well YMC-04. The pump test suggests no impacts to nearby water sources, while MODFLOW-96 does predict impacts to nearby water sources. For the following reasons, the results of the model with respect to the pumping of Well YMC-04 and pit dewatering are considered to represent a "worse case" prediction of actual groundwater drawdown in the MSA:

- ♦ One of the basic assumptions of MODFLOW-96 is probably not valid in the geology of the MSA. MODFLOW-96 assumes that the movement of groundwater approximates the flow of water through porous media, such as sand and gravel. The pump test on Well YMC-04 suggests that the movement of groundwater in the fractured granodiorite of the MSA is not the same as through porous media. The 10-day pumping of groundwater from Well YMC-04 did not cause a decline in the water level in nearby observation wells and surface waters; this is an indication that the fractures in the granodiorite of the MSA are not well-connected and groundwater does not move freely through them.
- ♦ The actual recharge rate may be greater than the value of 5% used in the model. Studies in fractured granite near Payson, Arizona showed a recharge rate of 15% (Southwest Ground-Water Consultants, Inc., 1997). If the actual recharge rate in the fractured granodiorite of the MSA is 10% or greater, predicted drawdown from MODFLOW-96 would be much less than previously described.
- ♦ Groundwater levels from only five wells were available as input into the model; as a result, calibration of the model to actual groundwater levels in the MSA was not done.

The conclusion that the pumping of groundwater from Well TW-01 should not affect nearby water sources is based on two reasons.

- ♦ The two observation wells, TW-02 and YMC-03, showed no decline in groundwater levels as a result of the pump test on well TW-01. Wells TW-02 and YMC-03 are located 2,000 feet east and 2,200 feet southeast of well TW-01, respectively. This suggests that groundwater drawdown would not extend more than 2,000 feet from Well TW-01, and there are no perennial surface water sources or active wells within 2,000 feet of Well TW-01.
- ♦ There is some question whether Well TW-01 would produce enough water to be a useful water supply source during the life of the mine. The estimated sustainable yield from the well is only 10-15 gpm., based on a 3.5 day pump test in which yield from the well declined from 73 gpm to less than 30 gpm. The pump test was terminated after 3.5 days because the water level in TW-01 dropped to near the pump intake and the bottom of the water-producing fractures.

The conclusion that the pumping of groundwater from Well 2BCD and the Section 28 well field should not affect nearby water sources is based on a number of reasons, discussed below.

- ♦ Most of the perennial surface water sources in the WRSA are over 1,000 feet higher in elevation than the groundwater levels in Well 2BCD and the Section 28 well field.
- ♦ Most of the perennial surface water sources in the WRSA are located over two miles from Well 2BCD and the Section 28 well field.
- ♦ Pump test analysis using the Theis equation predicted that the decline in groundwater levels (i.e. drawdown) surrounding each well would not interfere with known water sources, with the possible exception of the well at the Arrowhead Café. Projected theoretical drawdown was up to

2.0 miles from Well 2BCD and 3.0 miles from the Section 28 well field; at those distances, the drawdown would be less than one foot. These results assume that a) Well 2BCD is pumped at 50 gpm, and the five wells in the Section 28 well field are pumped at a combined total of 50 gpm b) there is no groundwater recharge. There are no active wells within 3.0 miles of Well 2BCD; the closest active well to the Section 28 well field, the Arrowhead Café, is 2.5 miles west. Well 2BCD was pumped for 34 days in June-July of 1996, and the Section 28 well field was pumped for 10 days in August/September 1996. None of the observations wells, 1.00 to 3.33 miles away, showed a response as a result of the pump tests. Predicted water level declines surrounding Well 2BCD and the Section 28 well field are shown in Appendix H (Figures H-3 and H-4).

It is impossible, however, to be certain that no wells in the WRSA would be affected by the YMC water supply wells. This is because pumping all of the water supply wells for eight to nine years could result in more area wide water level decline than can be predicted by short-term individual pump tests. Therefore, mitigation measures have been recommended on Table 4-3 for the following two wells most vulnerable to a drop in water level as a result of pumping from the water supply wells.

- The Wilhite Well, approximately 1,600 feet southwest of Well YMC-04.
- The well that supplies the Arrowhead Cafe, approximately 2.5 miles west of the Section 28 well field.

4.1.4.4 Groundwater Effects - Quality

Heap Leach Facility. YMC would be required to obtain an APP from the ADEQ for the heap leach facility. An APP requires a project-specific design intended to protect groundwater at a particular mining site.

A Discharge Impact Area (DIA) analysis was completed to meet APP requirements. The analysis assumes leakage from the heap leach and solution ponds and estimates the time and distance for pollutant concentrations to be diluted to levels indistinguishable from background concentrations.

Assuming that YMC meets the requirements of the APP and that there are no catastrophic events as described in Section 4.1.4.3, the heap leach facility should have minimal impact on groundwater quality. This conclusion is based on several major factors, discussed below.

The engineering design of the heap leach facility, as described in detail in the MPO and APP application (Facility Design Report), greatly reduces the potential for groundwater contamination.

- The heap leach facility is designed to be a zero-discharge facility; this means it is designed to contain all fluids within the facility, including rainfall from the 100-year, 24-hour storm event. The leach pad would be fully lined with a high-density polyethelene (HDPE) liner and would contain a subsurface drain system and a leak detection system. The pregnant and barren solution ponds would have two synthetic liners with a leak detection system between them. Sections 2.1.4.2 and 2.1.4.4 of Chapter 2 describe the containment design features of the heap leach facility in detail, and the APP would contain provisions for leak detection and contingency planning.

- Groundwater quality at Well YMC-03, which is downgradient of the heap leach facility, would be monitored quarterly during the life of the mine and annually for five years after mine closure. Monitoring after five years following mine closure may or may not be required by ADEQ; this depends largely on the water quality results during the required monitoring period.

The local geology, summarized in Section 3.2.5 of this document and described in detail in the Hydrogeologic Baseline Report by GWRC should minimize impacts to groundwater. The low hydraulic conductivity and transmissivity of the rock units in the MSA means groundwater migrates slowly downgradient of the leach facility. As described in Section 3.2.5.1, most of the MSA consists of the BCAS. The BCAS contains relatively small amounts of groundwater in joints, fractures and faults; the hydraulic connections between these spaces in the rocks are poor, and the movement of groundwater is slow.

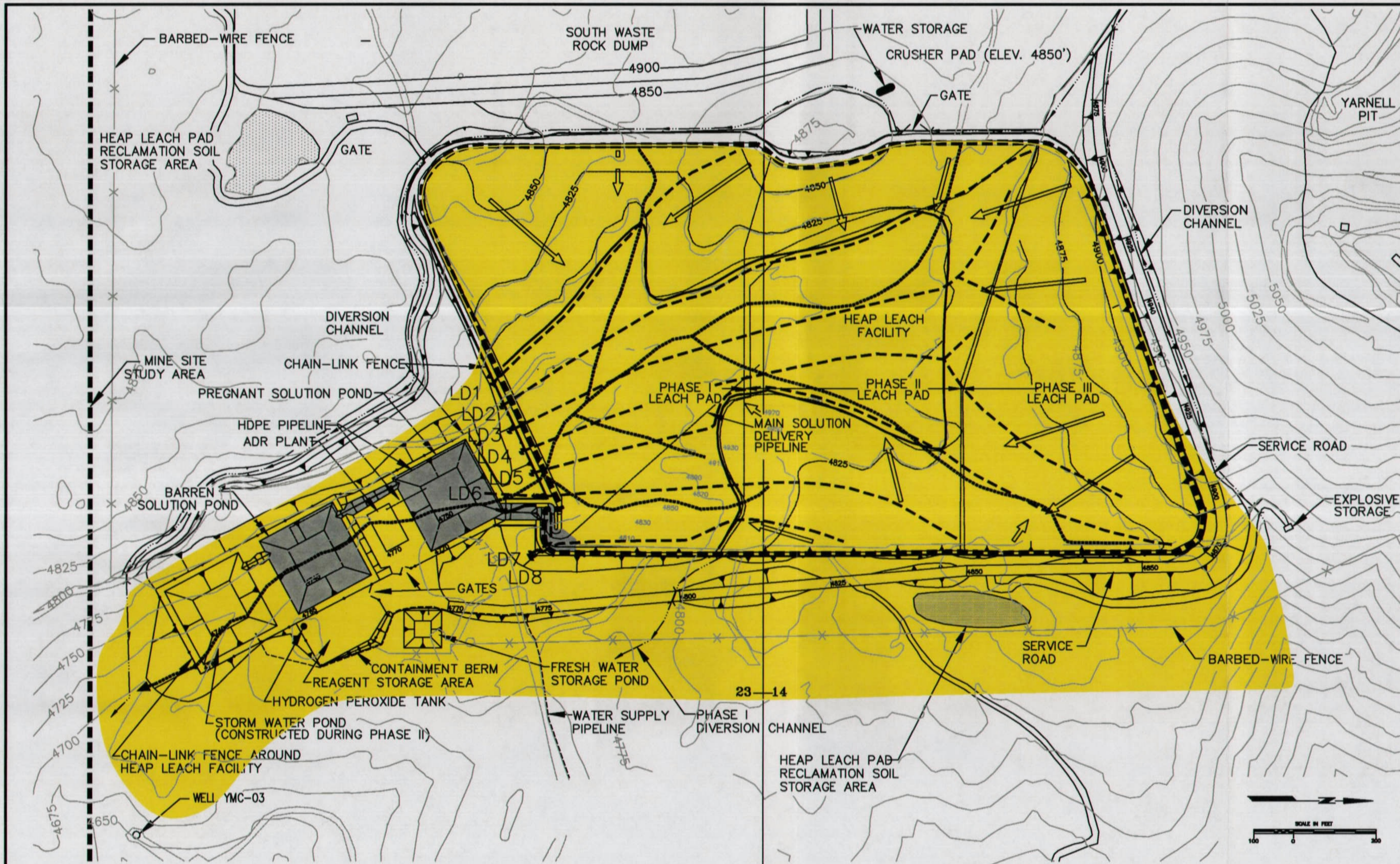
A characterization of groundwater quality downgradient of the heap leach facility was completed as part of the APP process. The DIA analysis estimated the impact on groundwater quality using dilution and mass balance calculations. The major assumptions used were:

- There is leakage of process solutions through the synthetic liner through 0.448 inch (11 mm) diameter holes; there is one hole per acre of liner.
- The average saturated constant head above the synthetic liner is one foot for the leach pad and 10 feet for the solution ponds.
- The bedding layer directly under the synthetic liners is one foot thick and has a saturated hydraulic conductivity of 10^{-6} cm/sec.
- The hydraulic conductivity of the underlying granodiorite is 5×10^{-4} to 3×10^{-6} cm/sec (0.009 to 1.5 ft/day), and the effective porosity is 0.04.
- Total dissolved solids (TDS) was modeled, and the initial process solution had a TDS of 5,000 mg/l.
- There is no geochemical attenuation of the process solution after leakage through the liners.
- Monitoring well YMC-03 has a mean background TDS concentration of 616 mg/l.
- The drainage area upgradient from Well YMC-03 is 75 acres, of which 36 acres is the heap leach facility and 39 acres is above the leach facility.
- The annual precipitation is 20 inches, and one inch infiltrates into the ground.
- The topography downgradient of the leach facility is five to 40 percent.

Using the above-listed assumptions, the DIA analysis results are:

- TDS would exceed background levels under the entire footprint of the heap leach pad and solution ponds.
- TDS would exceed background levels for approximately 350 feet east of the heap leach pad.
- The travel rate for pollutants would be five to 40 feet per year, which translates to 40 to 320 feet during the eight-year life of the mine.

The following should be noted concerning the DIA analysis described above and illustrated in Figure 4-3:



SUBSURFACE DRAIN (BENEATH LEACH PAD FILL)

LEAK DETECTION SYSTEM (BENEATH SYNTHETIC LINER IN LEACH PAD LINER SYSTEM)

DIRECTION OF FLOW ABOVE SYNTHETIC LINER

ESTIMATED DISCHARGE IMPACT AREA

EDGE OF LEACH PAD LINER SYSTEM

LD5 POINT AT WHICH LEAK DETECTION SYSTEM DRAINS REACH SURFACE

SHADED AREAS INDICATE COVERAGE WITH BIRD NETTING OR OTHER APPROVED PROTECTION

NOTE: Based on SMI – 1997a.

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FIGURE 4-3
HEAP LEACH AND POND SYSTEM DISCHARGE IMPACT AREA

- The DIA could be larger or smaller, depending upon how well the assumptions used in the dilution and mass balance equations are met. Additional information on the DIA is contained in the Facility Design Report (SMI, 1997a).
- The area of groundwater pollution does not represent an area of equal pollutant concentration or the limit of pollutant migration. It only represents the area in which TDS might exceed the natural background level. Standard dilution and dispersion methods for flow through porous media are not applicable to the fractured bedrock of the proposed heap leach site. As a result, simple dilution and mass balance calculations were used.

Groundwater quality, as well as surface water quality, would likely not be significantly degraded downstream of the heap leach facility under the following catastrophic scenarios.

- A rainfall event greater than the 100-year, 24-hour storm (4.8 inches).
- An earthquake greater than a 250-year return frequency, which could cause failures in the heap leach pad and solution containment ponds.
- Loss of solution from the heap leach pad from washouts in the compacted fill of the foundation.

The likelihood of occurrence and the impacts from these catastrophic events was discussed in Section 4.1.4.2.

Waste Rock Dump. The impact to groundwater quality downgradient of the two WRDs should be minimal for the following reasons.

- Storm water runoff upgradient of the WRDs would be captured and diverted around them. Seepage through the waste rock would be limited to precipitation that falls on the waste rock.
- Geochemical characterization of waste rock suggests that it would not generate acidic water. Batch leach test results met ADEQ water quality standards except for antimony in two samples. Secondary standards were exceeded for iron in two samples and manganese in one. Details of the geochemical characterization of the waste rock is provided in Appendix D.
- The water quality of Well YMC-04, at the proposed site of the NWRD, is fairly good as described in Section 3.2.6. The water quality in this well appears to represent actual field conditions that result from percolation of groundwater through the same type of rock that would be stored in the waste rock dumps.
- Groundwater quality downgradient of the SWRD would be monitored at Well YMC-02. Groundwater quality downgradient of the NWRD would be monitored at Well YMC-01. These wells will be monitored quarterly during the life of the mine and annually for five years after mine closure. Monitoring after five years following mine closure may or may not be required by ADEQ; this depends largely on the water quality results during the required monitoring period.
- An ongoing waste rock geochemical characterization program would be required under the APP during the life of the mine. Waste rock within 20 feet of either side of the ore zone would be sampled and analyzed quarterly. A composite sample of blast hole cuttings collected during the quarter would be

analyzed. If an alert level was exceeded, YMC would identify where the waste rock was placed and isolate it by surrounding it with 20 feet of inert material on all sides, if possible.

- In the NWRD area, seepage from the historic tailings may temporarily increase. However, there is little evidence of acid generation, and the tailings have been in place for 55 years. Batch leach extract tests have met ADEQ groundwater standards for all parameters except manganese and cadmium in one sample and total cyanide in two samples. Secondary aquifer standards were exceeded for TDS, sulfate, manganese and zinc in the two samples from the crushed ore area.

The waste rock geochemical characterization in the APP is a reactive rather than a preventative plan and is somewhat difficult to implement considering the proposed operating methods. Waste rock would be dumped in a single lift which will reach heights up to 225 feet. As such, it would be very difficult to isolate any non-inert waste rock by surrounding it with 20 feet of inert material. Therefore, additional geochemical monitoring of a predictive nature is recommended as a mitigation measure in Section 4.1.4.7.

Mine Pit. No significant impacts to groundwater quality are expected from the mine pit for two reasons.

- Little ponding of groundwater is expected to occur in the mine pit, as described in Section 4.1.4.4.
- Geochemical characterization of waste rock suggests that it will not generate acidic water. This is described in Appendix D.

Water Supply Wells. The withdrawal of groundwater from these wells would not affect groundwater quality. The effect on groundwater quantity is discussed in Section 4.1.4.3.

4.1.4.5 Waters of the United States

The proposed action would not affect the delineated wetlands along Fools Gulch. Theoretical drawdown modeling using MODFLOW-96 indicates pumping from Well YMC-04 and pit dewatering could lower water levels at Cottonwood Spring by about 15 feet. This could reduce or eliminate the flow of Cottonwood Spring, or the spring could reappear further downstream. Any of these scenarios could adversely affect the Yarnell Creek delineated wetland. Groundwater modeling, described in Section 4.1.4.3, predicts that water levels would return to within 0.5 feet of pre-mining levels two years after pumping ceased. Therefore, any impacts to Cottonwood Spring and the Yarnell Creek wetland would be temporary and would not require permanent mitigation. Therefore, monitoring and a contingency plan have been recommended as mitigation.

Table 4-2 summarizes effects to Waters of the U.S. from the proposed pipelines and mine facilities in the MSA. These effects are discussed below.

The west water supply pipeline corridor would cross and sometimes follow short segments of 33 dry, sandy desert washes. About 536 feet of waters of the U.S. would be affected by the west pipeline. The east pipeline would cross an eight-foot segment of one desert wash. Where the water supply pipelines would cross desert washes (waters of the U.S.), the pipeline outer diameter would be 3.5 or 4.5 inches. Where the pipelines cross shallow, wide desert washes with

Table 4-2
Impacts to Waters of the U.S.

Affected Area	Mine Facility	Summary of Impact
Desert Washes	West Pipeline Corridor	The pipeline would cross 33 desert washes totaling about 537 feet of crossings, but no adverse impact would be expected.
Desert Washes	East Pipeline Corridor	The pipeline would cross an eight-foot segment of one desert wash, but no adverse impact would be expected.
Unnamed drainage to Yarnell Creek	Heap leach and solution ponds	About 1,200 feet of Waters of the U.S. would be disturbed; 1,000 feet could be reclaimed after mining, leaving 200 feet permanently affected.
Yarnell Creek	NWRD and sediment retention structure	About 900 feet of stream classified as Waters of the U.S. would be permanently buried.
Fools Gulch	SWRD and haulroad	Approximately 450 feet of Waters of the U.S. would be permanently filled.

gradual sloping banks, HDPE flexible pipe would be used to conform to the wash configuration. The 3.5- or 4.5-inch outer diameter pipe would lay in the channel bottom and would not impede flow or cause ponding of water. Where the pipelines would cross deeper washes with steeper banks, rigid sections of pipe would be used to span the bed and bank of the channel. These rigid sections would be sufficient in length to ensure that the pipeline would not fall into the channel if movement of the pipeline were to occur. The pipeline would cross washes approximately perpendicular to the channel's lengthwise axis. Concrete thrust blocks would be used as necessary when adapting pipe to different piping systems and at critical points to be determined during construction. Large boulders along the pipeline corridors would also be used to stabilize pipe segments. No adverse impact to waters of the U.S. would be expected from pipeline construction and operation.

Within the MSA, the proposed facilities would affect an estimated 2,550 feet of streambed classified as waters of the U.S. Therefore, the COE would require a Clean Water Act Section 404 permit. Projected disturbances to waters of the U.S. within the MSA are as follows:

- The heap leach and solution ponds would disturb approximately 1,200 feet of waters of the U.S. in an unnamed drainage to Yarnell Creek,
- the NWRD and sediment retention structure would permanently fill approximately 900 feet of stream delineated as waters of the U.S. in Yarnell Creek, and
- the sediment retention structure for the SWRD and the haul road would permanently fill approximately 450 feet of waters of the U.S. in Fools Gulch.

Upon reclamation of the solution ponds, approximately 1,000 feet of waters of the U.S. in the unnamed drainage to Yarnell Creek would be re-established, leaving a total of 1,550 feet permanently affected within the MSA.

Sections of the permanent diversions could be enhanced with pools and vegetation to mitigate the impacts to waters of the U.S. The Section 404 permit would require a mitigation plan; hence, no additional mitigation is recommended at this time.

4.1.4.6 Impact Mitigation

Well YMC-04 has not been proposed as a groundwater monitoring compliance point because of the lack of its completion record. However, because of its location, YMC-04 should be included as an observation well. Its location beneath the proposed NWRD is ideal for the early detection of any potential groundwater quality impacts. In addition, it would be pumped extensively for water supply to the mine. Groundwater potentially impacted by precipitation infiltrating the overlying waste rock would be induced to flow into the well. Monitoring YMC-04 would provide a record of changes in water quality beneath the NWRD. However, since it is unknown how the well was completed, it should not be considered a compliance monitoring point.

The project design includes no specific mitigation at this time for the potential impacts to Cottonwood Spring and the associated wetland, the Wilhite Well and the Arrowhead Café Well that could result from the pumping of groundwater from water supply wells and pit dewatering. It is recommended that automatic recording devices be placed on the Wilhite Well, Arrowhead Café Well, Well YMC-04, Well YMC-01 and Cottonwood Spring to monitor water levels in the wells and flow at the spring. YMC would be required to submit for approval by BLM a monitoring plan and contingency mitigation plan for these water sources. If monitoring indicates that pumping and dewatering are adversely affecting the Wilhite and Arrowhead Café wells, mitigation could include replacing or deepening the existing wells, trucking water to a storage tank, connecting to another water supply or other measures that replace or supplement the water supply. However, replacement of water supplies for private wells is a potential mitigation measure that BLM would not have the authority to require; any effort to mitigate or replace private water supplies would be voluntary and not enforceable by the BLM. Mitigation for Cottonwood Spring and the associated wetland could include temporary augmentation of water from other sources, development of another water source, replacement of the wetland or a shut-down of Well YMC-04.

There has been no proposed mitigation for the loss of the water right on Tom Cat Tank. The holder of the stockpond claim would need to contact the Arizona Department of Water Resources to withdraw the "38" filing. Following mine reclamation, the use of water supply well TW-01, drilled by YMC on public land, could provide a water source for livestock and wildlife.

YMC would develop and submit to BLM for approval a preventative geochemical monitoring plan that would identify non-inert waste rock prior to placement in the waste rock dumps. The plan should include identification of areas with the highest potential to exceed the alert levels identified in the APP, a sampling plan for these areas as well as routine sampling of other waste rock. The plan may take into account dilution of non-inert waste rock with inert waste rock based on mining methods and pit and dump geometry. The plan may propose a minimum concentration and volume for each constituent monitored, and any values about these minimum thresholds would require special handling. The plan would include special handling and isolation of non-inert materials in order to prevent adverse impacts to surface or groundwater.

Mining and ore processing plans and environmental permitting programs for the proposed project have been designed by YMC with consideration of the existing hydrological environment and potential effects to water resources. These elements, which would serve to mitigate potential adverse effects of the proposed project, are summarized in Table 4-3. However, many elements could contribute to effects which cannot currently be projected. These consist of design and construction elements and natural processes, such as precipitation and erosion. To account for this uncertainty, additional mitigation measures could be incorporated into the project. Additional mitigation measures for water resources, as they relate to design features, are summarized in Table 4-4.

4.1.4.7 Residual Effects

Drainage patterns would be permanently affected by the presence of the heap leach facility, WRDs and other proposed facilities. The proposed Yarnell pit would be partially backfilled to establish drainage. The pit could continue to collect water from storm water and groundwater seepage. A small sediment settling structure may be constructed if necessary. The steep reclaimed slopes of the waste rock dumps and the heap leach may contribute increased sediment to surface water after reclamation. Waters of the U.S. would be filled by the WRDs and altered by construction and reclamation of the solution ponds. Tom Cat Tank would be permanently lost.

4.1.5 VEGETATION

4.1.5.1 Direct and Indirect Impacts

The proposed action would disturb about 182 acres within the MSA as shown in Figure 4-4. Mining activities would result in effects to chaparral and desert vegetation types, COE-designated Waters of the U.S. and plants protected by the Arizona Native Plant Law. As proposed, the project would not impact any federally-listed threatened or endangered plants, plants designated by the BLM as sensitive or wetland vegetation. Wetlands and Waters of the U.S. are discussed in Section 4.1.4.6.

The largest impact would remove 69.2 acres of oak shrubland. Other vegetation types disturbed include oak shrubland-burned (32.9 acres), oak shrubland-north slope (32.7 acres), turpentine bush/wait-a-minute bush shrubland (25.4 acres) and mountain mahogany shrubland (16.3 acres). Vegetation along the water pipeline corridors would only be trimmed or selectively removed to facilitate installation and operation of the four-inch water pipeline. A few cottonwood and Goodding willows around the old pond (Tom Cat Tank) would be covered by the heap pad. There are no plans to salvage these trees, and they would be lost.

Sixteen species of plants (see Appendix G, Table G-1) protected by the Arizona Native Plant Law occur on the mine site and along the water pipeline corridors. These cacti, nolinas, yuccas, agaves and shrubs would be salvaged according to Arizona statutes.

4.1.5.2 Impact Mitigation

Approximately 147 acres of MSA disturbance would be reclaimed with the seed mix shown in Table

TABLE 4-3
Mitigation Features Incorporated into Proposed Project Plans

Potential Issue	Mitigation Feature
Leakage or failure of the Heap Leach Facility to contain leaching solutions	• Designed to be a closed-circuit, zero-release facility meeting BADCT. • Incorporates leak detection. • Notification of the BLM and ADEQ, stopping process solution application above the affected leak detection drain, assessment of water source, comparing pumping rate from the leak detection sump with stoppage of solution application and a decision among BLM, ADEQ and YMC on continued solution application on other parts of the heap. • Groundwater monitoring performed under APP requirements. • Contingency plans to handle potential emergency situations. • Identify borrow source and quantity for composite liner system and estimate potential seepage through composite liner system. • Document settlement estimates of fill under full heap load and make revisions as necessary. • The heap leach facility is designed to meet prescriptive design criteria outlined in the ADEQ BADCT manual (1996). • QA/QC testing and inspection during construction per APP. • Underdrain system would be constructed beneath facility. • Detailed contingency plans if leakage is detected per APP.
Releases of leaching solutions or storm water runoff to surface water	• Adequate storage capacity to contain storm water runoff and draindown of solution in the event of a power failure. • Diversion of upgradient drainage around the facility. • Neutralization of the heap leach pile during closure and reclamation. • NPDES storm water discharge permit requirements. • Backup power source to maintain solution levels in ponds. • Freeboard included in solution pond design. • Non-discharging facility designed to meet or exceed ADEQ requirements and BADCT design standards. • Reclaim NWRD after site is filled with waste rock, prior to closure/reclamation of project. • Construct sediment retention structures at toe of WRDs. • Monitor Fools Gulch and Cottonwood Springs per APP. • Design channels for minimum grade necessary to prevent erosion. • Design armor for erosion control in susceptible areas.
Spills of hazardous materials	• An SPCC Plan will be implemented. • Reactive substances are segregated. • Groundwater monitoring performed under APP.
Ponding of water in the mine pit	• Excess water collected during operations and used for dust suppression. • Partial backfilling and final grading to facilitate drainage out of the pit and construction of a settling pond, if needed.
Adequacy of water supply and its impact on nearby ground-water users or the magnitude and duration of flows to springs and streams	• Adequate water storage for high-demand summer months. • Groundwater supply derived from multiple sources, thus providing a secure and sustainable water supply. • Well permits have been acquired with the exception of YMC-04 where water leases are pending. • Aquifer testing demonstrated that nearby groundwater wells and surface water flows will not be significantly impacted. • The groundwater storage will rebound to pre-pumping conditions after the cessation of operations and reclamation. • Pipeline crossings of desert washes would conform to wash or span wash using rigid pipe.

Source: MPO (YMC 1995 and 1996) and Facility Design Report (SMI, 1996 and 1997a)

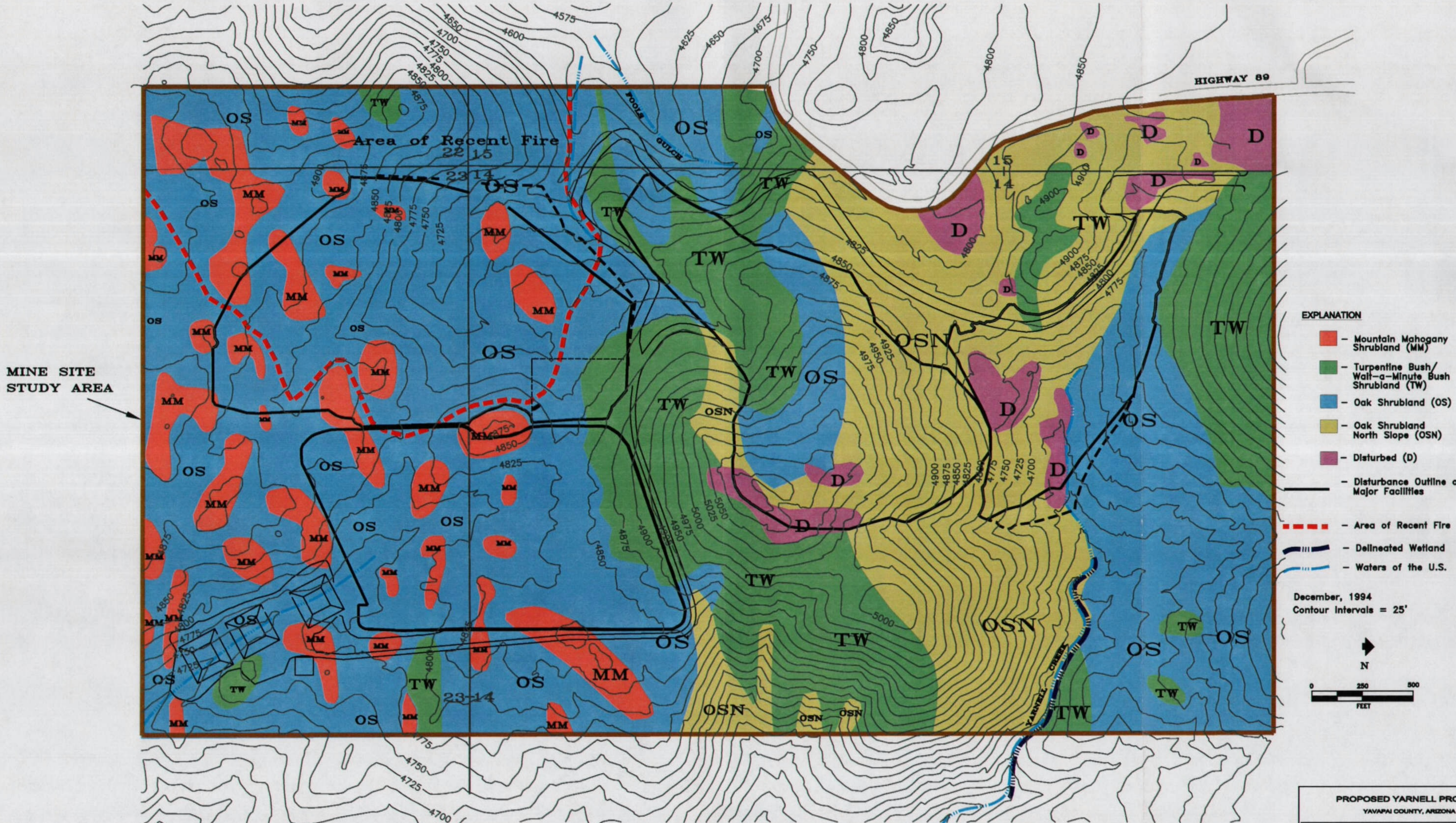

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FIGURE 4-4
PROPOSED PROJECT
MINE SITE STUDY AREA
DISTURBED AREAS
VEGETATION TYPES MAP

TABLE 4-4
Additional Recommended Mitigation Measures

Design Feature	Potential Impact	Mitigation
Heap Leach System	Leakage due to liner tear; blocking of solution flow channel from heap to ponds, from instability of initial heap lift.	♦ Confirm stability of the initial lift of ore placed on pad; modify loading plan or pad grading if stability is an issue.
	Potential leakage to groundwater from the concrete sump.	♦ Review current design of concrete sump for addition of leak detection system.
Layout of the Leach Pad and Heap Loading Sequence	Increased surface area disturbance.	♦ Determine haul routes and loading patterns and final design of runoff controls from roads and disturbed areas outside of pad limits;
Waste Rock Dumps	Acid rock drainage or metals leaching from the infiltration of precipitation through the waste rock materials.	♦ Develop an operational monitoring plan for continued geochemical characterization of waste rock at a frequency that will enable early identification of non-inert material; ♦ Develop contingency plans to special handle identified non-inert material.
Groundwater Monitoring Plan	No monitoring of distinctive water type near mineralization and within NWRD.	♦ Add Well YMC-04 to the groundwater monitoring program as an observation point.
Mine Pit and Water Supply	Impact to water quantity in Wilhite or Arrowhead Cafe wells or Cottonwood Springs.	♦ Automatic recording of the Wilhite Well, Arrowhead Cafe Well, Wells YMC-04 and YMC-01 and Cottonwood Spring to monitor water levels in the wells and flow at Cottonwood Spring. ♦ Mitigation to replace water supply if adversely affected.

2-6. This seed mix includes shrubs, yuccas, nolinas, grasses and forbs common to the five chaparral vegetation types disturbed.

Approximately 9.3 acres of the 37.7 acres of the Yarnell pit would be reclaimed under the proposed action. The remaining 28.4 acres of the pit and seven acres of permanent roads would not be reclaimed. The reclaimed areas of the heap leach facility and north and south waste rock dumps would include 60.3 acres of the relatively flat top surfaces and 46.1 acres of the 50-percent side slopes. Additionally, approximately 31.2 acres of roads, building sites, sediment control facility and other miscellaneous areas with relatively gentle slopes would be reclaimed.

The proposed seed mix in the reclamation plan has the potential to return the relatively flat top landscape of the heap leach facility, NWRD and SWRD and other miscellaneous areas to a chaparral vegetation type. However, the process would be slow and would require hundreds of years to return to present levels of density and diversity. Reclamation of the steep 50-percent side slopes would be more difficult and it may not be possible to create a chaparral vegetation type similar to those in the flatter areas. Plant species diversity and total vegetation cover would be limited by the steep and unstable slopes. Accessible pit benches (described in Section 4.1.3.3) would be used to seed with native species and selected native shrubs would be transplanted. Plants with the greatest potential to colonize these steep slopes would be the annual and biennial forbs of the project site as listed in Appendix

G. These native and introduced forbs have the greatest potential to colonize disturbed habitats and, over long periods of time, could create favorable conditions for the perennial species.

Impacts to plants protected by the Arizona Native Plant Law would be mitigated by salvaging all protected plants from areas to be disturbed. An area near the topsoil stockpile would be dedicated and maintained as a plant nursery. When the mine would begin reclamation, the salvaged plants would be re-planted.

4.1.5.3 Residual Effects

The proposed action would result in long-term residual effects through loss of vegetative resources. Affected areas cannot be fully returned to their pre-disturbance condition, although proposed reclamation activities would lessen effects through revegetation and would return portions of the disturbed areas to a mature chaparral vegetation type over hundreds of years. About 35 acres of vegetation would be permanently lost due to the inability to reclaim most of the pit and permanent roads. Overall, residual effects would not be significant. None of the affected plant communities have a limited acreage and distribution in this region.

4.1.6 WILDLIFE

Issues include impacts on wildlife, wildlife habitats, threatened and endangered species and potential wildlife mortality from exposure to hazardous substances.

4.1.6.1 Direct and Indirect Impacts

Principal wildlife impacts of the proposed Yarnell Project would be the long-term to permanent loss of habitat value on disturbed areas, direct mortality from mine and ancillary facility development and operations, short-term wildlife displacement from disturbance areas and secondary mining effects. The impact on wildlife would be severe within the proposed area, but minor when considered in a larger landscape area. Although the Yarnell Project would permanently alter about 182 acres of habitat, the affected habitats are not unique and species affected are generally common with widespread distributions. The only anticipated impact to 13 threatened, endangered and sensitive species potentially present on the MSA would be habitat loss and potential desert tortoise and chuckwalla mortality along a portion of the pipeline corridor from Well 2BCD to the MSA. Mature tortoises are unlikely to be present inside the mine perimeter fence. Such mortality would be limited to occasional individuals inadvertently killed over the life of the mine and should not adversely affect local population viability.

Habitat Loss. The mining operation would directly destroy 182 acres of wildlife habitat within the MSA, 80 percent of which is either oak shrubland or mountain mahogany habitat. These two habitat types support the greatest diversity and abundance of wildlife on site. It could take centuries for these areas to re-establish and develop the successional maturity, diversity and density that is now present. Even then there would likely be a net loss in the acreage of these shrub types on the post-mining landscape as some remaining landforms, aspects, slopes and soil types (e.g., the open pit) would provide unsuitable growing conditions. Although only about four percent of the project area has been previously disturbed by mining, some of these habitats are of high value to the wildlife community. The historic mine adits provide habitat for a low number of species (mostly bats) that might not otherwise occur on site. These tunnels and other natural topographic features would be permanently lost.

Many acres of habitat similar to the MSA exist in the Weaver Mountains and most displaced wildlife would likely be accommodated in undeveloped adjacent areas. The project would permanently reduce habitat values at the proposed mine site due to the 28-acre open pit, seven acres of permanent roads, the loss of historic mine adits and natural topographic features. Undisturbed habitats within the MSA would remain viable for many species. Nevertheless, it could take hundreds of years to restore the vegetative diversity and complexity of disturbed areas to pre-disturbance levels.

In addition to the direct mining-related loss of wildlife habitat, physically undisturbed habitats (roughly 100 acres) on and adjacent to the site would be fragmented, fenced and/or disturbed by various mining activities to the extent that various wildlife species would be displaced for at least the duration of mining. The degree of displacement, or the width of the buffer zone that is established, would depend upon the seasonal sensitivity of wildlife and the tolerance and ability of individual species to adapt to this type of disturbance. For example, most reptiles, small mammals and many birds would use suitable habitat immediately adjacent to, and even inside, mining areas. Species with larger home ranges, low tolerance for disturbance or human proximity and high mobility, such as mule deer, javelina and most mammalian predators, would be displaced the furthest from mining areas, although the effects of that displacement would likely be minor as the MSA comprises only a small portion of their overall home ranges. Nevertheless, habitats in the surrounding area are already occupied with their own wildlife communities and not all wildlife displaced from the project site would be accommodated without effect. Reproduction, territorial defense, foraging and other life functions of displaced and surrounding wildlife could be adversely affected through increased competition for the resources required for survival.

Direct Mortality. Development of the proposed Yarnell Project would result in the direct mortality of some less mobile species. Herpetofauna and burrow-dwelling small mammals would be most susceptible to direct mortality. Mine-roosting bats would potentially be killed unless the historic mine adits were cleared of bats and sealed prior to development. Additional direct impacts to wildlife would occur during the operating life of the mine as some wildlife are unavoidably struck on haul roads and pipeline corridors or achieve access to cyanide solutions. Off-site impacts would be limited to wildlife mortality on State Highway 89. Mortality would be severe on impact areas, but insignificant on wildlife community function in the context of the surrounding landscape.

Cyanide-related animal mortality is a significant issue at heap leach-mining operations. Open water is highly attractive to desert wildlife. This attraction can be fatal unless wildlife is restricted from cyanide-laden ponds, ditches and pools. The vast majority of wildlife mortality associated with heap leach facilities at other mines consists of birds, with reptiles and small mammals comprising the remainder. However, bats are probably under-represented in these totals as they may drink cyanide leach solutions, fly away and die undetected. At other heap leach operations in the western U.S., almost one-half of the total wildlife mortality is associated with solution ditches, less than one-quarter at ponds and less than one-third atop the heap (BLM 1994a).

YMC's proposal to use drip, rather than sprinkler, emitters for the distribution of leach solutions has been effective at other heap leach operations in reducing wildlife mortality (primarily avian) resulting from cyanide solutions which pool in small depressions atop the heap (BLM 1994a). The sides of the leach pad would also be sloped inward to limit solution exposure. Nylon netting is the standard method used to preclude wildlife exposure to cyanide solutions in the ponds. The effectiveness of netting varies with mesh size, pond and ditch configurations, access requirements, securement, wind, maintenance frequency, availability of alternate potable water sources, etc. While netting can be highly effective in reducing wildlife mortality, its effectiveness varies with the above factors and nowhere is it 100 percent effective. Other exclusion methods, including floating covers and floating plastic balls on ponds, enclosing solutions in pipes rather than open ditches and the use of sonic guns to scare away wildlife, have increased effectiveness, but at much higher operational costs.

A six-foot-tall chain-link fence topped with three strands of barbed wire is also proposed around the heap and solution ponds and ditches to effectively block access by medium and large terrestrial wildlife.

It is anticipated that the present proposal, employing properly monitored and maintained drip emitters, one-inch mesh nylon netting and a chain-link/barbed-wire fence, would be effective in minimizing wildlife exposure to cyanide, but it would not be 100 percent effective. Low numbers (≤ several dozen) of small lizards, passerine birds and bats may still access cyanide solutions through the nylon mesh (lizards) or through small gaps in netting. The success of mitigation measures (see Section 4.1.6.2) can only be documented over time. If measures are not effective at minimizing wildlife exposure to toxic solutions, YMC would be required to take further steps to eliminate wildlife mortality.

Lighting. Outdoor lighting of some project facilities may only have discernible effects on bat use of the area, since most wildlife will be displaced from project facilities by unsuitable habitat and chronic mining activities. Those nocturnal species persisting on the partly illuminated margins of mining operations should not experience significant changes in foraging success or predation rates because such species primarily rely on olfactory and auditory senses to meet life requirements. Some species of bats would be attracted to mining areas by insect concentrations (e.g., moths) attracted to the lights. This may provide an insignificant beneficial effect. Increased bat foraging on the MSA is not anticipated to result in an increase in mine-related bat mortality.

Threatened, Endangered and Sensitive Species. With the exception of lowland leopord frogs at Cottonwood Spring, none of the 13 threatened, endangered and sensitive species of concern potentially present in the area were detected within the MSA.

Lowland leopard frogs have been observed at Cottonwood Spring in the MSA and in Antelope Creek several miles downstream from the mine. Small areas of seasonally suitable habitat are sometimes present along upper Yarnell Creek and Fools Gulch. All mining areas are above occupied and potential leopard frog habitat. If a water table drawdown of up to 15 feet were to occur, the amount of available water and the suitability of the area as leopard frog habitat would be reduced. Mitigation measures involving Cottonwood Spring are summarized in Table 4-4.

Desert tortoises have been observed just south of the MSA. While the project area is considered to be outside of tortoise habitat, individuals may occasionally occur in the marginal habitat on site. Such individuals could be killed by mining activities or maintenance and monitoring along the pipeline. Such potential mortality would be greatest during the six-year operating life of the mine and decline in the reclamation phase. Occupied category II and III desert tortoise habitat occurs on private and state land in the central portion of the western water supply corridor. Of the 3.19 acres of Category II habitat, 1.89 and 1.29 acres occur as state and private land, respectively. Of the 6.13 acres of Category III habitat, 0.63 and 5.5 acres occur as state and private land, respectively.

Potential impacts to the tortoise and its habitat resulting from development, maintenance and decommissioning of the water supply pipeline include direct mortality, temporary habitat loss and minor habitat fragmentation (young tortoises only). With the implementation of required and recommended mitigation/compensation measures (see below), the proposal's net effect on the desert tortoise should be neutral, although there would be a small net loss of habitat. Anticipated mortality effects should have no discernible effect on local or regional population viability. Mitigation measures include, but are not limited to:

- pipeline installation during seasons when tortoises are less active,
- a biologist monitoring pipeline installation,
- excluding tortoises from potentially hazardous areas,
- providing earthen ramps to facilitate tortoise movements over pipelines,
- educating mine employees and
- compensating for residual project impacts on the desert tortoise and its habitat on affected BLM and other land remaining after the implementation of mitigation measures.

Marginally suitable but potential habitat for the Arizona Southwestern toad occurs in Antelope Creek several miles downstream from the MSA. This habitat, whether occupied or not, would likely remain viable unless some catastrophic solution pond failure occurred or if groundwater pumping reduced surface water flows through these sections of the creek. Neither event is likely, and mining activities should not affect the Arizona Southwestern toad or its habitat.

Possible chuckwalla scat was located in apparently suitable habitat on private land in Section 21 of the main pipeline corridor. If this species is present, individual chuckwallas could be killed by pipeline corridor blading maintenance or monitoring activities in those presently undisturbed portions of the corridor.

It is unlikely that any of the remaining threatened, endangered and sensitive species (listed in Table 3-12 and discussed in Section 3.3.2.2) are present on site or within the project's zone of influence because of (1) unsuitable habitat, (2) the site location is above the species' known elevational range and/or (3) the site does not represent particularly attractive habitat (i.e., for peregrine falcon). The proposed action would result in "no effect" to listed and proposed species and would meet provisions of the Endangered Species Act, as amended.

Other Wildlife. Impacts to deer and javelina should be limited to displacement from areas within and adjacent to mining areas. Some smaller animals might nocturnally use habitats within the mine's barbed wire perimeter fence. Potential hunting opportunities surrounding the project area should not change as a result of the proposed operation. Following mining, wildlife would recolonize disturbed areas as habitats develop and species' habitat affinities allow.

Reptiles and small mammals are discussed together because of similar habitat utilization and susceptibility to impacts. Members of these groups are terrestrial and spend a significant part of their lives in burrows (where they could be caught underground in attempts to escape mining activities), making them susceptible to direct mortality during mine development and some mine operations. While many of the individuals present in disturbance areas would be unavoidably killed, principally during the development phase of the mining process, they are species that are common and widespread. Reptiles and small mammals outside of mining areas and a narrow buffer zone would be largely unaffected by mining.

The low number of bats on site would be affected by the destruction of roosts and, for those that survive mine development, by reduced foraging habitat and possible exposure to cyanide solutions. Although most historic mine structures in the MSA would be eliminated, there are abundant historical mine workings in the general area.

Birds seasonally present on the MSA would be precluded from impact areas and narrow surrounding habitats for the life of the operation. They would return as habitat affinities and reclamation progression allows. If mine development occurs outside the spring period, when eggs and nestlings are present, there should be no direct avian mortality associated with the project, other than the occasional bird hit by vehicles of commuting mine personnel on regional, high-speed roads or those birds which circumvent measures restricting wildlife access to cyanide solutions. If mine development occurred during the nesting season and if impact areas were not stripped of vegetation before the nesting season began, mining activity could result in the loss of recruitment for those birds nesting on-site.

Local avian and terrestrial predators whose home ranges overlap the MSA would be affected by the proposed action due to a reduced or eliminated prey base within habitats disturbed, eliminated or excluded by mining. The reduced prey base would be total within impact areas and take a century or more for diversity and abundance values to approach former levels. However, impacts to most of the larger predators should be minor since the disturbance area represents only a small portion of their overall home range. The MSA supports a relatively high prey base that is similar to much of the identical surrounding terrain in the Weaver Mountains. As a result, loss of prey may require the expansion of predator home ranges which overlap the impact area. However, proposed mining should not significantly affect the local predator population.

4.1.6.2 Impact Mitigation

To lessen impacts, the following mitigation measures would be required as a condition of permitting the proposed operation.

Mitigation measures to reduce cyanide exposure to wildlife include:

- YMC would use one-inch mesh nylon netting to completely cover all wildlife access to open cyanide solutions. Netting of similar mesh has proven very effective at excluding wildlife at other mine sites (Hallock 1992). Solutions in collection ditches should be placed in collection pipes or the ditches either filled with rock or concrete with netting. Use of drip emitters and maintenance of the heap leach is expected to minimize or eliminate the small pools and puddles atop the heap that are often associated with sprinkler emitters and which may also be exposure pathways to wildlife mortality.
- YMC would install, around the base of the heap leach security fence, a 24-inch wide, 1/2-inch hardware cloth skirt buried six inches below the ground surface, or to bedrock, with the remaining 18 inches extending up the bottom of the security fence. The purpose of this skirt is to block or restrict non-flying, small wildlife access to the cyanide solution ditches and ponds. The functional integrity of the hardware cloth fence would be maintained across the bottom of all gates in the security fence. The integrity of this skirt would be maintained by YMC for the life of the project and checked monthly.
- YMC would regularly survey the condition of the heap leach, ditches, ponds and equipment installed to minimize wildlife mortality for optimal functioning. Deficiencies will be corrected immediately.
- YMC would survey the perimeter of all open cyanide solution ditches and ponds once per week to quantify and remove any dead animals. The survey would be conducted using standard procedures, on the last business day of each week, such that the survey will represent wildlife mortality for that week. Any wildlife mortalities would be categorized as follows: lizard, snake, bird, bat, mammal and total. If possible, animals would be identified as to species. Results would be reported to the BLM quarterly, or immediately in the event of unusual incidents, to determine if this level of mortality is acceptable or if additional preventative measures are required.

Mitigation measures to avoid and reduce impacts to desert tortoise in the western pipeline corridor and compensation for residual impacts are listed below. Measures applicable to private and state land are recommended, based on those required on BLM land.

- Blading from the Section 28 well field pipeline platform for pipeline installation and/or all-terrain vehicle (ATV) maintenance access should occur between November 1 and February 28 when tortoises are less active and when tortoise/construction encounters would be lower.
- In private and state Category II habitat, where new surface disturbance is required to blade a platform for the pipeline and/or ATV access, it is recommended that a qualified biologist would be on site monitoring clearance to avoid potential site-specific impacts to desert tortoises and their habitat. Such avoidance might include moving a tortoise out of harm's way using procedures defined by the AGFD, making minor adjustments in the pipeline route to avoid tortoise den or shelter sites, etc.
- Security fences around wells/well fields, water storage tanks, pumping stations and other ancillary water supply facilities in category II and III tortoise habitats should enclose as small an area as practical to reduce habitat loss. Such

fences should be fitted with 24-inch wide, 1/2-inch hardware cloth, attached to the fence such that the hardware cloth is buried six inches below the ground surface, or to bedrock, with the remaining 18 inches extending up the bottom of the security fence. The purpose of the hardware cloth is to prevent tortoise access to potentially hazardous areas and where they could become trapped inside the fence. The functional integrity of the hardware cloth fence should be maintained across the bottom of all gates in security fences. The integrity of all tortoise fencing should be maintained by YMC for the life of the project and checked monthly.

- Within category II and III tortoise habitats, earthen ramps high enough to cover the water pipeline from the Section 28 well field and provide tortoise crossing points over the pipeline should be spaced approximately every 100 yards along the pipeline. Each ramp would be 10 feet wide. It is envisioned that ramps be developed using hand-held shovels. Furthermore, ramp material should come from previously disturbed portions of the pipeline route to avoid additional habitat disturbance. Locally buried sections of the pipeline would provide the same crossing function and could be used in lieu of ramps.
- YMC employees (including contractors and subcontractors) who, as part of their job description or duties, may encounter desert tortoises (particularly maintenance personnel along the pipeline from the Section 28 well field) would receive desert tortoise awareness training annually to educate them on desert tortoise issues. Such employees would receive such training within two weeks of employment at the mine. The awareness program would be provided by the BLM or a private contractor acceptable to the BLM. At a minimum, the program would include the following topics.
    - Occurrence and identification of desert tortoise and general ecology
    - Sensitivity of the species to human activities
    - Legal protection for desert tortoises
    - Penalties for violation of federal and state laws
    - Project features designed to reduce the impacts to desert tortoises and promote the species' long-term survival
    - Reporting requirements
    - Procedures for moving tortoises if necessary.
- There should be no storage of trash and/or food items along the pipeline corridor from the Section 28 well field to reduce the attractiveness of the area to tortoise predators.
- YMC employees (et al., as above) should strictly limit their activities and vehicle use to the mining area and established routes of travel to reduce habitat disturbance.
- YMC employees (et al., as above) should inspect under parked vehicles when along or immediately adjacent to desert tortoise habitat along the pipeline corridor from the Section 28 well field immediately prior to moving the vehicle(s). If a desert tortoise is beneath the vehicle (using it for shade), the employee should use the procedure described in the awareness training course to avoid harm to the tortoise.
- In the event that a desert tortoise is injured or killed as a result of mine-related activities, YMC would report the circumstances to the BLM within two working days. At the direction of the BLM, YMC would implement additional

preventative measures to preclude future injury or death to desert tortoises.

To compensate for residual project impacts on the desert tortoise and its habitat after implementation of the above mitigation measures, the BLM would require or recommend implementation of the following measures.

- ♦ The BLM recommends that Category II desert tortoise habitat on state land affected by the pipeline corridor from the Section 28 well field be compensated following Desert Tortoise Compensation Team 1991 guidelines. The deed to any compensatory purchased land or compensatory funds would be donated/deposited to the BLM or other appropriate third party within one year of commencement of Yarnell Mine development activities following Desert Tortoise Compensation Team 1991 guidelines.

Mitigation measures to reduce direct mortality of bats:

- ♦ Prior to mine development, bats should be excluded from historic mine workings within the impact area by covering mine entrances with chicken wire. The timing of this exclusion will depend upon the mine development schedule and bat ecology. There are no maternity roosts on site that require consideration; however, exclusion should be planned around migration and hibernation. Mine entrances will be covered after evening emergence or after checking and cleaning shorter, safer adits.

Mitigation measures to reduce direct mortality of migratory birds:

- ♦ Site clearance including, but not limited to, vegetation and topsoil stripping and topsoil stockpiling on undisturbed habitat, during initial mine development and during phased mine expansion, should avoid the time period when migratory birds are nesting and may have vulnerable eggs or young. "Take" (per provisions of the Migratory Bird Treaty Act) would be avoided by clearing undisturbed habitats outside the spring bird nesting season. With few exceptions, none of the nesting birds known or suspected on site would be expected to attempt nesting on an area stripped of its vegetation and topsoil. Therefore, vegetation and topsoil would be stripped from areas to be mined within the current year before nesting commences. If that occurs, mining may commence in that area, and in any other previously disturbed areas, during the bird nesting season. In the event such stripping does not occur on or before the bird nesting season, disturbance to the proposed mining area should not occur until after fledging, usually by the end of May, when young-of-the-year from nests on the future mining area should have developed physically to where they could avoid any heavy equipment.

4.1.6.3 Residual Effects

The proposed Yarnell Project would affect wildlife by eliminating 182 acres of habitat, causing some direct mortality and displacing wildlife from affected areas until habitat slowly succeeds to pre-disturbance values. This would take hundreds of years in most areas.

Potential impacts from wildlife exposure to cyanide would be greatly reduced by proposed protection measures, although these measures would not be 100 percent effective.

4.1.7 AIR RESOURCES

Issues associated with air resources include the potential levels and effects from emissions of dust and potential transmission of fumes, chemicals and cyanide. Public health issues associated with Hantavirus and Valley Fever were also raised during scoping and are discussed in this section because these illnesses are transmitted by airborne means.

Emissions and subsequent off-site concentrations of all project-related air pollutants are compared to applicable federal and state air quality standards and guidelines in this analysis.

4.1.7.1 Direct and Indirect Impacts

The emissions inventory used in the following analyses is consistent with the inventory presented in the Class I Air Installation Permit Application submitted by YMC to ADEQ. All air quality modeling is based upon this inventory.

Description and Quantification of Emissions Sources. Mining and processing activities at the mine would cause emissions of particulate matter, quantified in this report as particulate matter less than 10 microns in diameter (PM_{10}). In addition, combustion of diesel fuel in both mobile and stationary sources would emit the combustion pollutants PM_{10}, nitrous oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2) and volatile organic compounds (VOCs).

The primary source of process PM_{10} emissions would be the ore crushing circuit. Crushers, screens and conveyor transfer points would all be sources of process PM_{10}. Non-process sources of particulate emissions include extracting materials by drilling and blasting, ore and waste rock handling by mine equipment, hauling of material on unpaved haul roads and wind erosion from ore and waste rock dumps.

Combustion sources at the proposed project would emit small quantities of PM_{10}, as well as the gaseous pollutants NO_x, CO, SO_2 and VOCs. Power for the crushing circuit would be provided by an on-site, diesel-fueled generator with 820-kilowatt (kW) capacity. A second generator with 365-kW capacity would be located at the processing circuit. (An additional 365-kW generator at the processing circuit would serve as a backup generator.) Non-process combustion emissions would be emitted from mobile diesel equipment used to move, load, haul and unload material. Quantification of SO_2 emissions for all diesel combustion sources is based on the assumption that diesel fuel burned on site would contain a maximum of 0.05 percent sulfur by weight.

Ore processing would also produce small quantities of emissions of hydrogen cyanide gas (HCN) and mercury (Hg). Formation of HCN is highly dependent on leaching solution pH, cyanide concentration and on-site variables, such as temperature and evaporation rate. Since fugitive HCN emissions may occur due to evaporative loss, these emissions could occur in the gold recovery areas as well as at the leach pad. Losses of HCN to the atmosphere result in decreased efficiency of gold recovery. As a result, economic incentives play a role in minimizing emissions of HCN.

The carbon regeneration kiln would heat spent carbon to drive off impurities (including Hg) in order to re-use the carbon in the gold refining circuit. The doré furnace raises the temperature of the gold-impregnated material beyond the point at which Hg volatilizes (357° F), and therefore, Hg may be emitted from this source.

Gasoline and diesel fuel would be stored on site in aboveground steel tanks. Fuel storage would result in a small quantity of emissions of VOCs due to evaporative loss from the storage tanks.

An on-site assay laboratory would include an area for sample preparation with equipment for drying, crushing, splitting and pulverizing ore samples. The maximum daily activity rate for sample pulverization is only 0.2 tons per day, and PM_{10} emissions from the assay laboratory are expected to be minimal.

A listing of all projected Yarnell Project emission sources and their associated pollutants is presented in Table 4-5. The table is divided into process and non-process/mobile emissions and identifies the likely emission sources associated with the mine's operation (i.e., crushing, leaching, hauling, etc.).

Activity Rate Assumptions. The maximum daily and annual activity rates for the project's mining and processing operations are summarized in Table 4-6. These rates are based on information provided by YMC in the MPO. For each emission category, maximum activity rates and, therefore, maximum emission rates have been assumed.

Emissions from construction activities would be similar in nature and spatial orientation to the expected emissions from mining activities. Daily activity rates, in terms of tons of material moved, during construction would be less than or equal to daily rates for the mining operation. Dust emissions (PM_{10}) from construction traffic on site and from movement and placement of earth and products of combustion (PM_{10}, NO_x, CO, SO_2 and VOCs) from diesel- and gasoline-burning mobile equipment would be the primary emissions from construction activities. Emission controls during construction would consist of watering/chemical application to haul roads, stockpiles and grading areas. Construction emissions and projected air quality impacts are not quantified separately in this section. However, off-site impacts from construction emissions would be less than or equal to impacts during mining operations. Therefore, the projected impacts associated with the mining operation serve as maximum projected impacts due to construction activities.

Also, the altered landscape (e.g., removal of overburden and construction of waste rock dumps) associated with construction activities at the project site would not influence local wind pattern or dispersion in a significant way. The height of the proposed waste rock dumps is insignificant when compared with surrounding terrain. In addition, the creation of the mine pit would not affect local wind patterns in a significant manner.

Quantification of Emissions. The estimated project emissions are based on control measures (described in the Impact Mitigation Section) and activity rates described above. In addition, emissions are calculated using emission factors from a variety of sources. Emission factors for PM_{10}, NO_x, CO, SO_2 and VOCs are taken from the fifth edition of the EPA's *Compilation of Air Pollutant Emission Factors* (AP-42, January 1995), with two exceptions. The emission factor for blasting has been obtained from an *EPA*

TABLE 4-5
Air Emission Sources

Source	Emission Species	Type*
Process:		
<u>Ore Processing</u>		
Crushing (primary, secondary)**	PM_{10}	Non-fugitive
Load/unload ore	PM_{10}	Non-fugitive
Lime silo - loading/unloading	PM_{10}	Non-fugitive
Lime feeding at crusher	PM_{10}	Fugitive
<u>Power Generation</u>	PM_{10}, NO_x, CO, SO_2, VOCs	Non-fugitive
Diesel combustion		
<u>Fuel Storage</u>		
Load/unload tanks	VOCs	Fugitive
Storage of gasoline/diesel	VOCs	Fugitive
<u>Gold Refining</u>		
Propane furnace	PM_{10}, NO_x, CO, VOCs, Hg	Non-fugitive
<u>Laboratory</u>		
Pulverizing samples	PM_{10}	Non-fugitive
Non-Process/Mobile:		
<u>Mining</u>		
Drilling	PM_{10}	Fugitive
Blasting	PM_{10}, NO_x, CO, SO_2, VOCs	Fugitive
Load ore/waste to truck	PM_{10}	Fugitive
Unpaved road travel	PM_{10}	Fugitive
Unload waste to storage	PM_{10}	Fugitive
Waste dump erosion	PM_{10}	Fugitive
Mobile sources	PM_{10}, NO_x, CO, SO_2, VOCs	Fugitive
<u>Ore Processing Area</u>		
Unload ore	PM_{10}	Fugitive
Ore storage pile erosion	PM_{10}	Fugitive
<u>Leach Pad</u>		
Load/unload ore	PM_{10}	Fugitive
Unpaved road travel	PM_{10}	Fugitive
Leaching solution evaporation	HCN	Fugitive
Leach pad erosion	PM_{10}	Fugitive
<u>Gold Refining</u>		
Leaching solution evaporation	HCN	Fugitive

* Fugitive - denotes those emissions which could not reasonably pass through a stack, chimney, vent or other functionally-equivalent opening.

** Emission factors for crushing systems incorporate emissions from the crusher and associated conveyors and screens.

TABLE 4-6
Maximum Activity Rates

Operation	Daily (tons)	Annual (tons)
Mining - ore	6,480	1,200,000
Mining - waste rock	15,120	2,695,000
Crushing	15,600	1,200,000
Leaching	15,600	1,200,000

Region VIII Interim Policy Paper on the Air Quality Review of Surface Mining Operations (EPA 1979). The NO_x emission factor used to calculate emissions from the generators is derived from information provided by the manufacturer (Caterpillar). In general, AP-42 emission factors for surface-level fugitive dust sources from mining projects are considered to be conservative and represent maximum emission estimates.

EPA emission factors are not available for HCN emissions from the leach pad; therefore, emissions are quantified based on site-specific parameters and monitoring data from a similar mining operation. EPA emission factors are also not available for emissions of Hg from the carbon reactivation kiln and doré furnace. Emissions from these sources are estimated using the emission factors developed from stack testing results from a similar mining operation, which have been accepted by the Nevada Bureau of Air Quality.

Special considerations and assumptions in the quantification process include the following.

- Emissions associated with waste rock dumps are divided between the NWRD and SWRD in proportion to the relative capacities of the dumps. The ratio of NWRD to SWRD capacity is 3.7 to 7.5.
- Particulate emissions due to erosion at the waste rock dumps have been calculated assuming that one-third of the total disturbed area would be active at any given time. Particulate emissions due to erosion at the leach pad have been calculated assuming that one-sixth of the total disturbed area would be active at any given time.
- SO_2 emissions from the diesel generator are calculated assuming that 100 percent of the sulfur in the diesel fuel is converted to SO_2 and that diesel fuel contains 0.05 percent sulfur by weight.

Table 4-7 summarizes the maximum daily, emissions, and Table 4-8 summarizes the maximum annual emissions from the proposed Yarnell Project.

Description of Modeling (Dispersion Modeling) and Quantification of Impacts. The Industrial Source Complex Term (ISCST3) dispersion model, version 95250, was used to estimate air quality impacts from the proposed project. This model is recommended by the EPA for site-specific analysis of complicated sources and is appropriate for sites with fugitive emissions and rolling terrain. ISCST3 estimates the depletion of a particular plume as particulate matter is deposited to the ground as the plume travels downwind from the source. Long-term modeling is performed with ISCST3 using the "period" averaging option. One year of meteorological data collected at the project site is used as model input. In addition, emission sources and receptor locations serve as input to the model.

TABLE 4-7
Summary of Maximum Daily Emissions
(Units in Pounds)

Source Category	PM_{10}	NO_x	CO	SO_2	VOCs	HCN	Hg
Process Controlled	249	609*	202	13.9	28.0	0.0	0.088
Mobile	51.9	846	352	21.6	47.9	0.0	0.0
Non-Process Controlled	927	320	1,260	37.6	2.7	26.7	0.0
Total Controlled	1,228	1,775	1,814	73.1	78.6	26.7	0.088

*NO_x impacts were modeled assuming no control (i.e., no ignition retard control on generators). Uncontrolled process NO_x emissions are 775 pounds/day.

TABLE 4-8
Summary of Maximum Annual Emissions
(Units in Tons)

Source Category	PM_{10}	NO_x	CO	SO_2	VOCs	HCN	Hg
Process Controlled	11.5	111*	36.9	2.5	5.1	0.0	0.0083
Mobile	6.7	110	45.8	2.8	6.2	0.0	0.0
Non-Process Controlled	71.5	16.6	65.2	1.9	0.5	4.86	0.0
Total Controlled	89.7	237.6	148	7.3	11.8	4.86	0.0083

*NO_x impacts were modeled assuming no control (i.e., no ignition retard control on generators). Uncontrolled process NO_x emissions are 141.4 tons/year.

The modeling boundary and emission sources for the Yarnell Project are shown in Figure 4-5. Emission sources are categorized by emission type (point source, area source and volume source). The generators and the crushing and processing circuits are classified as point sources with stacks. They are modeled using estimated exhaust stack parameters. Mining activities occurring within the pit, waste dumps and leaching area are classified as area sources. Haul roads are categorized as volume sources and are divided into discrete segments to distribute emissions along the haul road.

As shown in Figure 4-5, the crusher is labeled P1 and the 820-kW generator is labeled P2. The 365-kW generator, labeled P3, and the processing circuit, labeled P4, are at the ADR plant. Area sources are represented as rectangles labeled A1 through A5. The idealized rectangles for the waste dumps, A4 and A5, and the leach pad, A3, that are used in the model are

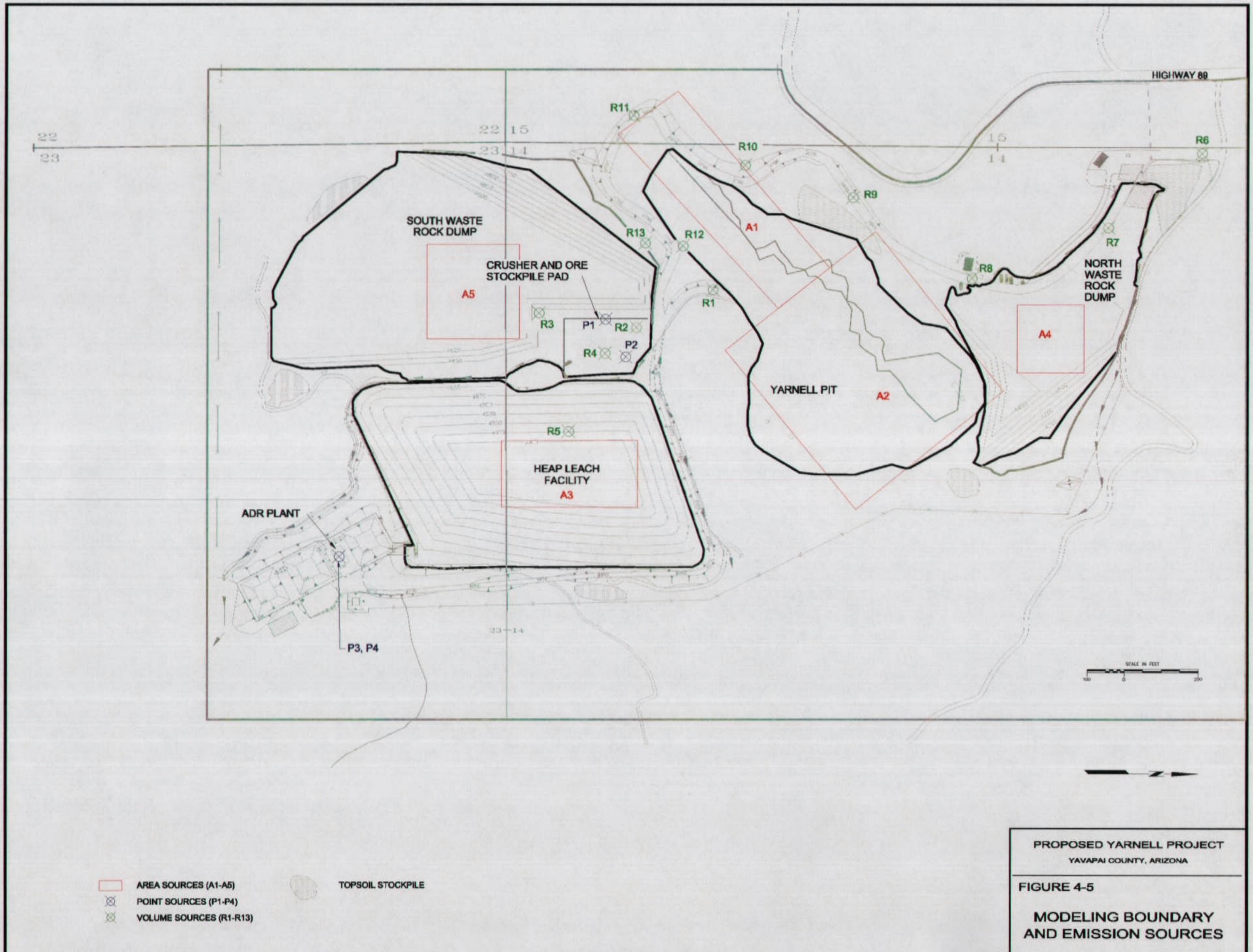

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FIGURE 4-5

MODELING BOUNDARY AND EMISSION SOURCES

smaller than the actual areas of these sites. The reason for this is that only a portion of the area of these sites would be active at a given time, and the particulate emissions due to erosion at these sites have been calculated with this in mind. The pit has been represented by two rectangles, A1 and A2, designated as the "southern" and "northern" sections of the pit. Volume source locations consist of points along three haul roads and one access road. These points are labeled R1 through R13 in Figure 4-6. Some segments of these roads overlap.

The modeling impact analyses for the pollutants NO_x, CO, SO_2, HCN and Hg were performed with the receptor grid shown in Figure 4-7, a 7.5-minute map of the mine and nearby communities. The receptor grid consists of receptors along the modeling boundary and out several hundred meters north, south, east and west. The horizontal resolution of the majority of the grid is 100 meters, but a grid with a resolution of 50 meters has been embedded in the coarser grid near the locations of predicted maximum impacts for HCN. Additionally, four receptors have been located in Yarnell and two in Glen Ilah.

A separate receptor grid has been used to model PM_{10} impacts because the maximum predicted 24-hour PM_{10} concentration does not occur in the vicinity of the fine resolution section of the grid in Figure 4-5. The receptor grid used to model PM_{10} impacts is shown in Figure 4-7. This grid also includes sections with 50-meter resolution near the locations where 24-hour and annual PM_{10} concentrations are predicted to be the highest.

Impact Estimates. The maximum estimated pollutant impacts from the proposed Yarnell Project are presented in Table 4-9. Also included are the baseline concentrations of each pollutant (if available), the location (with respect to the project property) of the receptor at which the maximum impact occurs and the applicable state and federal standards. The dispersion modeling results for each pollutant of concern are discussed in the following sections. These results demonstrate that pollutant concentrations decrease rapidly with distance from the project site and that impacts are not expected to exceed any applicable ambient air quality standards or guideline values.

This impact analysis assesses effects to air quality by comparing predicted impacts due to emissionsources at the Yarnell Mine to state and federal ambient air quality standards (Table 4-9). The federal ambient air quality standards have been established to reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of such pollutant in the ambient air in varying quantities. State ambient air quality standards must be at least as stringent as the federal standards. The latest scientific knowledge that is used by the EPA in establishing appropriate air quality standards includes health studies that consider subpopulations (the elderly, children, asthmatics, etc.).

PM_{10} - Estimated ambient 24-hour PM_{10} concentrations are presented in two ways in this analysis. The worst-case estimate of maximum 24-hour ambient PM_{10} concentrations is based on adding the predicted 24-hour impact at the maximum receptor to the maximum 24-hour background concentration measured at the site. As the discussion below details, although this method does represent the worst case maximum condition, it is unlikely to occur given the differences in meteorological conditions that produce maximum predicted impacts and maximum background

TABLE 4-9
Maximum Estimated Air Quality Impacts

Pollutant	Averaging Increment	Maximum Impact µg/m³	Baseline µg/m³	Total Concentration µg/m³	Location	NAAQS µg/m³	Other Applicable Standards µg/m³
PM_{10}	24-hour	121.8	28	149.8(1)	North	150	150(3)
	24-hour	121.8	10.2	132.0(2)	North	150	150(3)
	annual	23.5	10.2	33.7	South	50	50(3)
NO_x	annual	40.2	6.0	46.2	South	100	100 (3)
CO	1-hour	1,534	2,280	3,814	West	40,000	40,000(3)
	8-hour	412.9	2,280	2,693	North	10,000	10,000(3)
SO_2	3-hour	25.0	875	900.0	South	1,300	1,300(3)
	24-hour	8.65	144	152.7	North	365	365(3)
	annual	2.04	10	12.0	North	80	80(3)
HCN	8-hour	0.05 ppm(5)	N/A	0.05 ppm	South	---	0.3 ppm(4)
Hg	1-hour	0.49	N/A	0.49	N/A	---	1.5(3)
	24-hour	0.046	N/A	0.046	N/A	---	0.4(3)

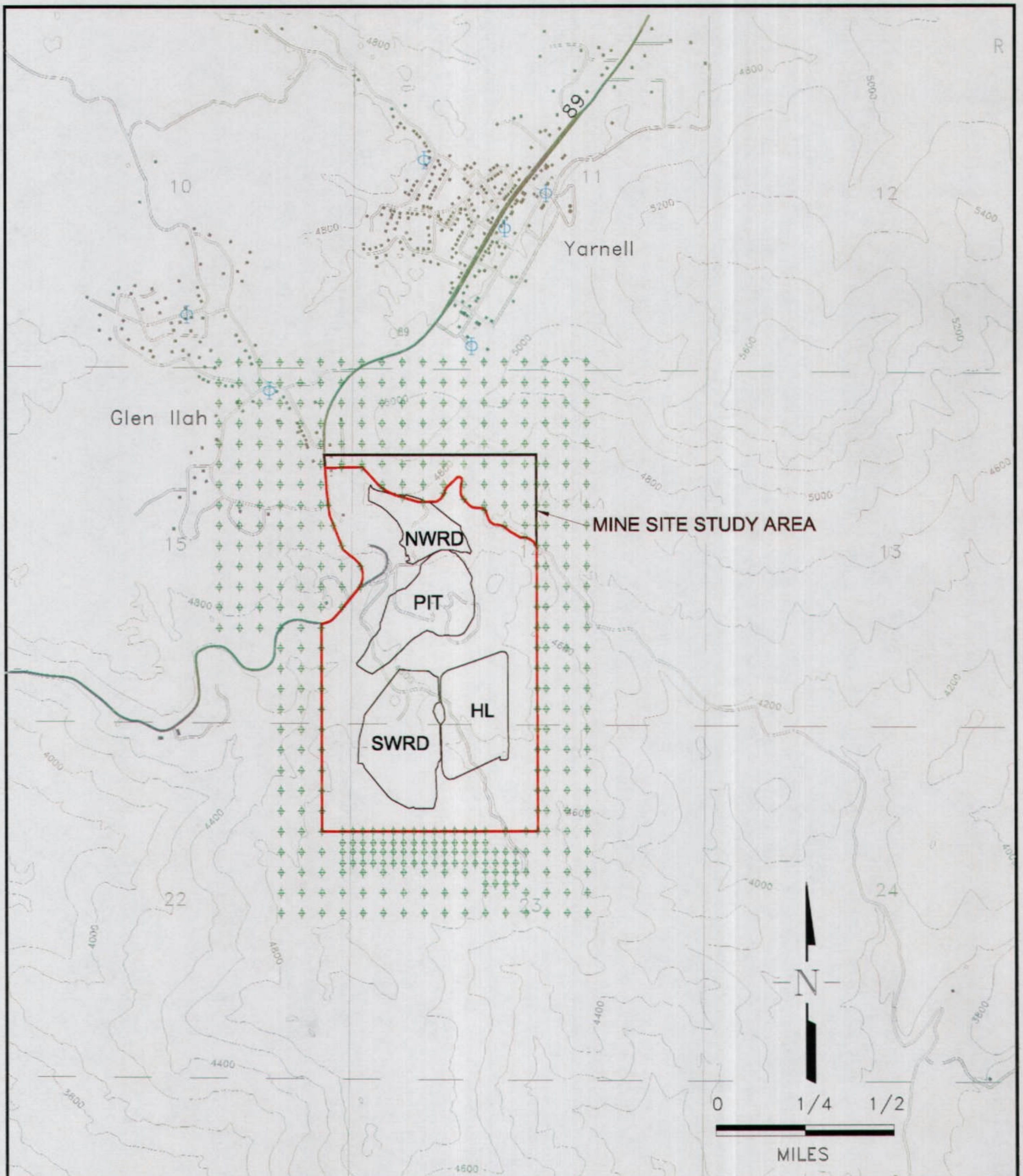
1 Worst case maximum (maximum 24-hour impact plus maximum 24-hour baseline).
2 "Representative maximum" (maximum 24-hour impact plus annual average baseline).
3 Applicable Arizona Ambient Air Quality Guideline.
4 Applicable Arizona Standard of Performance (R-18-2-730 (J)).
5 Modeled one-hour impact is shown. The eight-hour impact is expected to be approximately 70 percent of one-hour impact.

concentrations. A second, more likely ambient 24-hour PM_{10} concentration is also presented. This value is based on adding the predicted 24-hour impact at the maximum receptor to the annual average background concentration of PM_{10}.

Generally, project emissions would be expected to produce maximum 24-hour ambient air impacts during meteorological conditions characterized by low dispersion (low wind speeds, high atmospheric stability). Such stagnant conditions prohibit significant mixing of the project's emissions with ambient air. This results in higher pollutant concentrations. However, in rural areas, background PM_{10} concentrations usually reach maximum levels under a different set of atmospheric conditions. Good dispersion conditions (high wind speeds, unstable atmosphere) elevate fugitive dust levels and result in higher ambient PM_{10} concentrations. The baseline meteorological and PM_{10} data collected at the proposed Yarnell project site confirm this generalization.

The results of the dispersion modeling analysis indicate that the maximum modeled impacts due to emissions from the proposed project occur on days with low average wind speeds (daily average is 3.0 m/s). Consequently, background PM_{10} levels are likely to be at average or below average levels on these same days.

The state and federal 24-hour PM_{10} standard is 150 µg/m³. The maximum modeled concentration in the area of public access is 121.8 µg/m³ in the vicinity of the NWRD, approximately 150 meters north of the existing gravel road that makes up the northern modeling boundary line. For the worst-case 24-hour ambient concentration, the maximum 24-hour predicted impact is added to the maximum 24-hour baseline

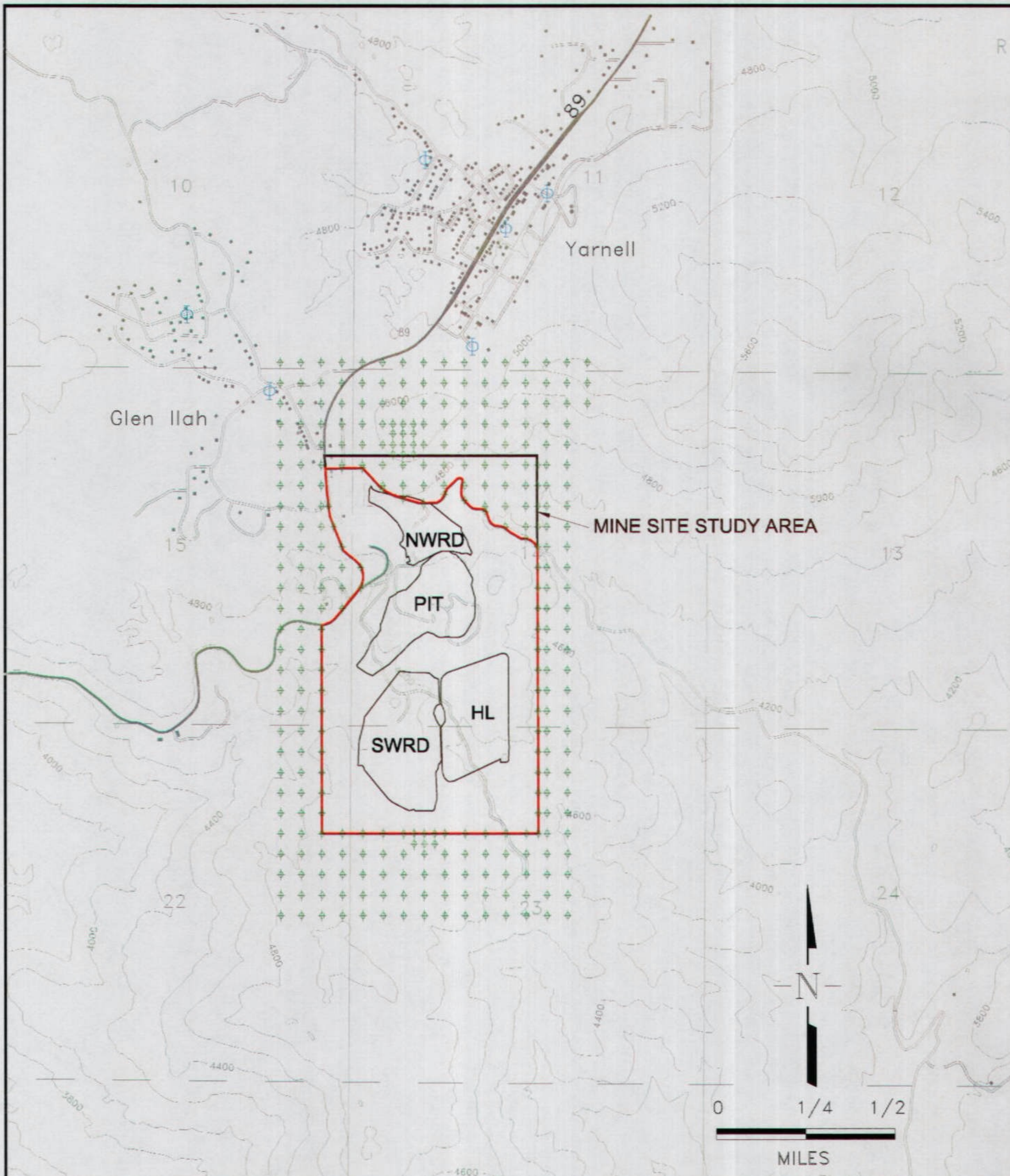


(red line)	MODELING BOUNDARY	NWRD	NORTH WASTE ROCK DUMP
Φ	DISTANT RECEPTORS	SWRD	SOUTH WASTE ROCK DUMP
+	GRID RECEPTORS	HL	HEAP LEACH FACILITY
		PIT	YARNELL PIT

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 4-6

RECEPTOR GRID FOR MODELING OF NO_X, CO, SO_2, HCN AND Hg



(red line)	MODELING BOUNDARY	NWRD	NORTH WASTE ROCK DUMP
Φ	DISTANT RECEPTORS	SWRD	SOUTH WASTE ROCK DUMP
+	GRID RECEPTORS	HL	HEAP LEACH FACILITY
		PIT	YARNELL PIT

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 4-7

RECEPTOR GRID FOR PM_{10} MODELING

concentration of 28 μg/m^3 to yield an ambient concentration of 149.8 μg/m^3, which is just below the state and federal air quality standards. This predicted 24-hour maximum concentration would occur on a day when the winds were light (average wind speed = 6 mph) and from the south throughout the entire period. Figure 4-8 shows the locations of the top five worst-case 24-hour PM_{10} concentrations, as well as worst-case concentrations at receptors near Yarnell/Glen Ilah. Predicted PM_{10} concentrations decrease markedly with distance, as evidenced by the fact the model predicted a maximum impact of only 61 μg/m^3 (50 percent of the maximum impact) at the receptor 550 meters downwind of the maximum impact location, where the impact was estimated to be 121.8 μg/m^3.

To estimate annual average PM_{10} concentrations that may result from the Yarnell Project, the annual average background concentration is added to the predicted maximum annual average impact. The state and federal standard for annual arithmetic average of PM_{10} is 50 μg/m^3. The maximum modeled impact in the area of public access is 23.5 μg/m^3. The location of the maximum annual average is on the modeling boundary of the leach pad. This impact concentration plus a baseline concentration of 10.2 μg/m^3 equals an ambient concentration of 33.7 μg/m^3, which is below the state and federal air quality standards.

In addition, the predicted impacts at receptors near Yarnell/Glen Ilah demonstrate how quickly particulate concentrations drop with increased distance from the project site. The projected annual average PM_{10} impacts at these locations are between 3 and 4 μg/m^3. These values are quite low when compared to the background PM_{10} concentration for the area of 10.2 μg/m^3 measured at the project site.

Oxides of Nitrogen - The state and federal standard for annual mean NO_2 concentration is 100 μg/m^3. The maximum modeled annual average concentration of NO_x (40.2 μg/m^3) added to a typical background concentration for rural areas (6 μg/m^3) is 46.2 μg/m^3 and occurs along the southern modeling boundary line, south of the ADR plant. The maximum modeled concentration of NO_x provides an upper-bound on the estimated NO_2 concentration because NO_x represents the total of all oxides of nitrogen. Therefore, modeled impacts show NO_2 impacts from the project to be below the state and federal standard.

Carbon Monoxide - The one-hour standard for CO is 40,000 μg/m^3. The maximum modeled one-hour CO impact (1,534 μg/m^3) added to the typical background concentration (2,280 μg/m^3) is 3,814 μg/m^3. This concentration is below the one-hour NAAQS for CO and occurs approximately 200 meters west of the SWRD.

The eight-hour standard for CO is 10,000 μg/m^3. The maximum modeled eight-hour CO impact (412.9 μg/m^3) added to the typical background concentration (2,280 μg/m^3) is 2,693 μg/m^3. This value is below the eight-hour NAAQS for CO and occurs in the vicinity of the NWRD, along the existing gravel road that forms the northern modeling boundary line.

Sulfur Dioxide - The three-hour standard for SO_2 is 1,300 μg/m^3. The maximum modeled three-hour SO_2 impact is 25.0 μg/m^3. This impact plus a typical three-hour baseline concentration for SO_2 (875 μg/m^3) is 900.0 μg/m^3 and is below the three-hour NAAQS for SO_2. The projected maximum concentration occurs 100 meters south of the southern modeling study boundary in the vicinity of the ADR plant.

The maximum modeled 24-hour SO_2 impact is 8.65 g/m^3 and occurs just north of the NWRD area along the existing gravel road that forms the northern modeling boundary. This impact plus a typical 24-hour baseline concentration (144 μg/m^3) is 152.7 μg/m^3. This concentration is well below the 24-hour NAAQS for SO_2 (365 μg/m^3).

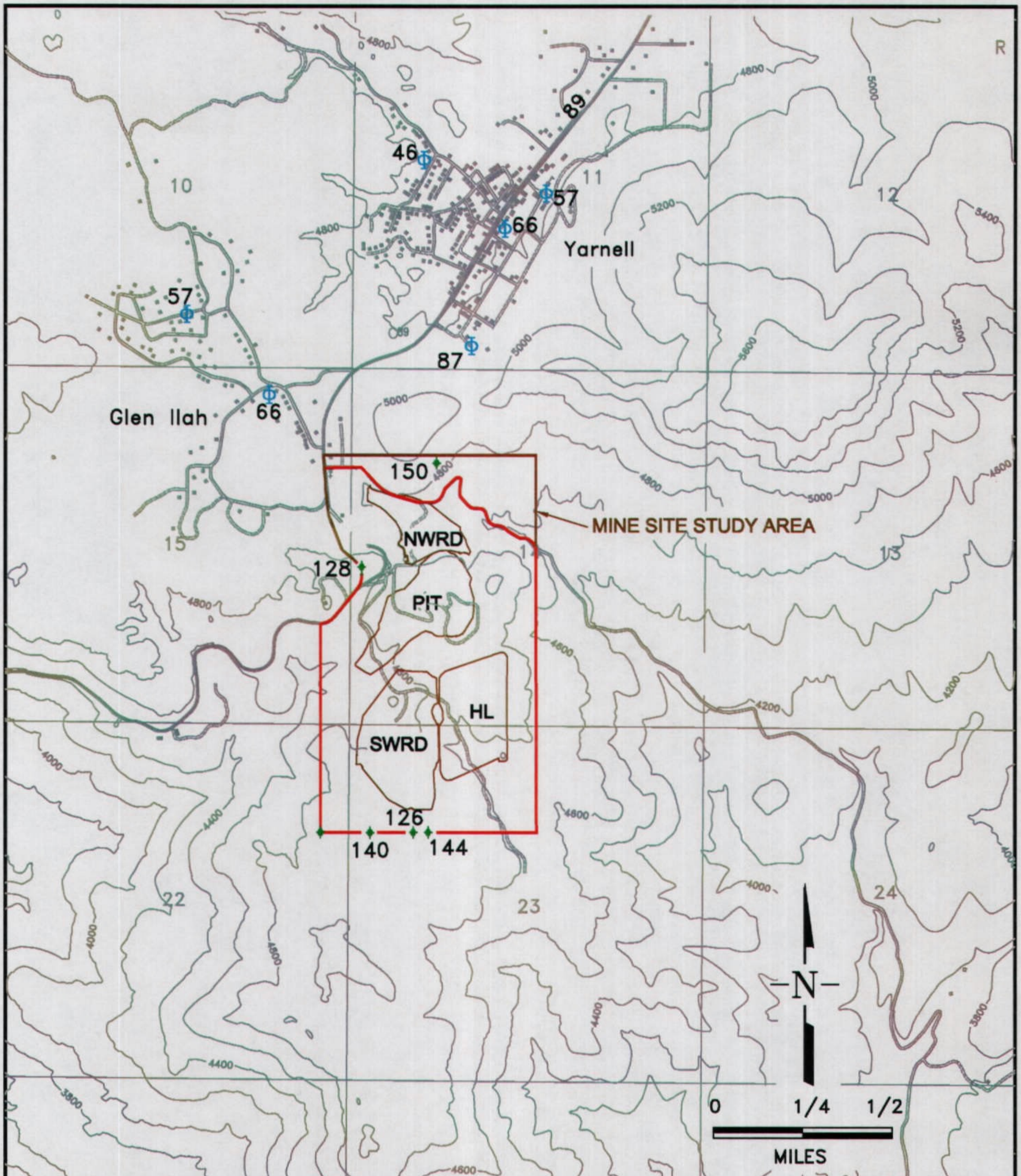
The maximum modeled annual SO_2 impact is 2.04 μg/m^3 and occurs just north of the NWRD area along the existing gravel road that forms the northern modeling boundary. This impact plus a typical annual baseline concentration (10 μg/m^3) is 12.0 μg/m^3. This value is below the annual NAAQS for SO_2 (80 μg/m^3). All of the modeled impacts for SO_2 are well below the state and federal standards.

Hydrogen Cyanide - The maximum modeled one-hour impact for HCN is 59.7 μg/m^3 (0.05 parts per million [ppm]) and occurs along the southern modeling boundary, south of the heap leach facility. This impact is below the HCN performance standard of 0.3 ppm (Arizona Administrative Code R18-2-730(J) - Standards of Performance for Unclassified Sources). This standard, however, is for an eight-hour averaging period. Eight-hour HCN impacts have not been modeled but would be less than (approximately 70 percent) one-hour impacts.

Mercury - The estimated one-hour and 24-hour maximum impacts for Hg are 0.49 μg/m^3 and 0.046 μg/m^3, respectively. These concentrations are below the one-hour Arizona Ambient Air Quality Guideline (AQG) of 1.5 μg/m^3 and the 24-hour AQG of 0.4 μg/m^3.

Three receptor locations (along the facility boundary immediately south of the carbon kiln and doré furnace) in the air quality impact model show a predicted eight-hour mercury concentration that exceeds the inhalation Reference Concentration (RfC) for mercury. The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily inhalation exposure of the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The predicted maximum eight-hour concentration at the northwest corner of the project site (in the direction of the towns of Glen Ilah and Yarnell) is more than one order of magnitude lower than the RfC for mercury.

Visibility - The nearest Class I area, the Pine Mountain Wilderness, is approximately 40 miles away. Densitometric analysis of color slides collected at a U.S. Forest Service Visibility Network site for the period of fall 1992 through spring 1996 yields a mean standard visual range (SVR) (the furthest distance one can see a landscape feature) of 159 kilometers (96 miles) and a 90-percent SVR of 283 kilometers (175 miles) for the Pine Mountain Wilderness. As Table 4-10 indicates, SVR results vary with season. Generally, visibility is poorest during the summer months and optimal during the winter months. The proposed Yarnell Project is approximately 65 kilometers from the nearest boundary of the Pine Mountain Wilderness. The physical distance between the project site and this area, along with topographic barriers to air flow and sight lines, limits the potential for any visual impact. Some localized visibility degradation may occur in the vicinity of the project site due to fugitive particulate emissions during periods of high winds or very stable conditions. However, these events would generally be short-term and intermittent in nature.



	MODELING BOUNDARY	NWRD	NORTH WASTE ROCK DUMP
Φ	DISTANT RECEPTORS	SWRD	SOUTH WASTE ROCK DUMP
♦	GRID RECEPTORS	HL	HEAP LEACH FACILITY
		PIT	YARNELL PIT

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 4-8

WORST CASE MAXIMUM 24-HOUR PM_{10} CONCENTRATIONS ($\mu g/m^3$)

TABLE 4-10
Photographic Standard Visual Range Data for the Pine Mountain Wilderness
Fall 1992 - Spring 1996

Season	90% SVR (km)	Mean SVR (km)
Fall	n/a	158
Winter	n/a	187
Spring	n/a	147
Summer	n/a	134
Annual	**283**	**159**

Notes: SVR is standard visual range or the furthest distance one can see a landscape feature.
No SVR data is available for the period winter 1994 to summer 1994
SVR data from densitometric analysis of color slides has an uncertainty of approximately 30 percent; 90% SVR is an approximation using the 80th percentile camera-based SVR values, per USFS guidance.

Source Classifications - The proposed Yarnell Project would be classified as a minor source under federal Prevention of Significant Deterioration (PSD) regulations and as a Class I source under Arizona Air Permitting regulations based upon the projected annual levels of process emissions. Emissions of criteria pollutants (CO, NO_x, PM_{10} and SO_2) from process sources are not expected to exceed major source threshold levels (250 tons per year per pollutant).

SIP Conformity - The proposed Yarnell Project is within an area that has been designated in attainment for all the criteria pollutants (i.e., historical ambient monitoring indicates that the National Ambient Air Quality Standards have not been exceeded). Furthermore, the modeling performed for this EIS indicates that exceedances of the federal ambient air quality standards are not expected. Therefore, off-site impacts due to emissions from the proposed action are not expected to hamper the state's efforts to maintain attainment status for this area and a formal demonstration of conformity with all state implementation plans (SIPs) is not required.

Public Health Concerns. As noted above, air quality standards established by the EPA and state governments incorporate public health concerns of subpopulations (the elderly, children, asthmatics, etc.). Comparison of predicted impacts to the health-based standards in and of itself considers health risks to these subpopulations. While it is possible that health conditions of some individuals may be aggravated by airborne pollutants, there are no regulatory standards that specifically apply only to sensitive populations.

The proposed Yarnell Project would be in a region that has seen outbreaks of illnesses, such as Hantavirus and Valley Fever, that are public health concerns. Based on current information, each has the potential for airborne transmission. Additionally, project-related odors have been identified as a potential public health issue. These issues are discussed below.

Hantavirus - The proposed Yarnell Project lies in a region affected by an outbreak of an illness attributed to the Hantavirus. The Hantavirus was discovered in 1993, and fewer than 200 cases have been identified since. The disease begins with symptoms such as fever, severe muscle aches, headache and cough and can progress rapidly to severe lung disease. The deer mouse has been identified as the primary carrier of the Hantavirus. A deer mouse was detected in the first baseline ecological survey conducted for the Yarnell project (October 7-10, 1991), but not in the second survey (July 6-7, 1992). However, the precise population of this species in the area and the percentage of infected animals are unknown. According to the Centers for Disease Control and Prevention (CDC), human infection may occur when infective saliva or excreta are inhaled as aerosols produced directly from the host animal (i.e., the deer mouse). Transmission may also occur when material contaminated by the rodent excreta are disturbed, directly introduced into broken skin or eyes or ingested in contaminated food or water. Many of the documented infections occurred after people disturbed rodent excrement in confined spaces, such as storage rooms. Infection can also occur if one is bitten by a host rodent. It is not known how long the hantaviruses survive after being shed into the environment by the rodents. However, the virus is rapidly inactivated when exposed to ultraviolet rays present in sunlight.

Mining activities at the Yarnell Project site have the potential to disturb areas that may be inhabited by infected rodent populations. The primary threat of exposure would be to individuals who have close (direct) contact with rodents. Public access would be restricted, thus eliminating the possibility of direct contact.

Mining activities associated with the Yarnell Project would produce dust (fugitive particulate emissions). Background PM_{10} concentrations in the area are measured to be 10.2 $\mu g/m^3$. Dispersion modeling predicts an increase of only three to four $\mu g/m^3$ for annual average PM_{10} concentrations due to emissions from the Yarnell Project in the towns of Glen Ilah and Yarnell. PM_{10} concentrations decrease rapidly with distance from the project site and the project-related PM_{10} impacts are low compared to background PM_{10} levels. The risk of exposure to the Hantavirus due to particulate emissions from the Yarnell Project is predicted to be low. The potential for exposure already exists due to windblown dust emissions from potentially contaminated areas proximate to Yarnell. Thus, although it is difficult to quantify precisely the risk of exposure to the Hantavirus and there remains some uncertainty about the transmission of this virus, it is unlikely that the Yarnell Project would increase the risk of exposure to residents living near the proposed project site.

Valley Fever - The proposed Yarnell Project is in a region of the county that has seen an outbreak of Valley Fever. Valley Fever is a lung disease caused by the fungus Coccidioides immitis. This fungus grows in soils that experience little rainfall, high summer temperatures and moderate winter temperatures. Infection occurs when fungal spores are inhaled. Valley Fever is prevalent in the desert Southwest and Mexico. Approximately one-third of the residents tested in these areas have shown positive skin-test results, and there are about 100,000 new cases in the U.S. each year. Most cases resolve on their own, as Valley Fever is a self-limiting disease (similar to flu). Upon recovery, it is believed that individuals are immune from contracting Valley Fever again. The 1990-1995 mean annual incidence rate varies with age from two cases per 100,000 population for the zero to four age group up to 28 cases per 100,000 population for 65 years old (England 1997). Exposure to wind blown dust or recently disrupted soils may increase the chances of infection. The Valley Fever fungi proliferate in the top few inches of soil after rainfall has occurred and the moisture has penetrated below the surface layer of soil. The Valley Fever spores can become airborne with disturbance of infested soil by natural or anthropogenic activities. These spores can then be transported by wind to human receptors.

Mining activities associated with the Yarnell Project would produce fugitive particulate emissions that may contain Valley Fever spores. However, researchers have noted that the organism causing Valley Fever is indigenous to Southwestern desert soil, and it is not found in agricultural soils above 4,000 feet in elevation (the Yarnell Project is at an elevation of 4,800 feet). YMC has committed to using water and chemical suppressants to minimize fugitive particulate emissions. This mitigation would reduce the potential for the creation of soil environments that tend to propagate the Valley Fever fungi. In addition, the bulk of the topsoil movement associated with the mining operation would occur during a three-to-six-month period. A major portion (40 percent) of the fugitive particulate emissions would originate from the mine's haul roads. These roads would consist of compacted, sub-topsoil material that contains little organic matter. It is not known whether these materials are as conducive to the growth of Valley Fever fungi.

Dispersion modeling analysis performed for the Air Emission Permit application shows downwind PM_{10} concentrations decrease rapidly with distance from the project site. Background PM_{10} concentrations in the area are measured to be 10.2 $\mu g/m^3$. Annual average PM_{10} concentrations in the town of Glen Ilah and Yarnell are predicted to increase by only three to four $\mu g/m^3$ due to emissions from the Yarnell Project. It is uncertain whether these increases in PM_{10} concentrations would cause similar increases above background levels in the occurrence of Valley Fever spores. Thus, although it is difficult to quantify precisely the increase in risk of exposure to Valley Fever, it is unlikely that the Yarnell Project would increase this risk significantly above baseline conditions for residents living in the vicinity of the project site.

Odors - Project-related odors from hydrogen cyanide (HCN), diesel emissions and disturbance of soil materials could result from project construction and operations. An impact analysis (Air Sciences, Inc., 1998) was conducted to estimate the potential effects of any odors on persons within the project area and nearby communities. The study made the following conclusions.

- The maximum one-hour impact from HCN predicted to occur along the southern modeling boundary would be well below the range of odor thresholds for HCN as identified by the EPA in Hydrogen Cyanide Health Effects (EPA-460/3-81026). Modeled HCN impacts at sensitive receptors in the towns of Yarnell and Glen Ilah (where public sensitivity is greater) were lower than this impact.
- Diesel emissions would not be likely to result in exceedances of the odor thresholds for major hydrocarbon constituents of diesel exhaust, and therefore, no odor impacts are expected to result from hydrocarbons emissions from project operations.
- There would be some potential that project-related emissions would exceed the odor threshold for nitrogen dioxide NO_2; actual occurrences of exceedances of this odor threshold would be expected to be infrequent.
- Odors resulting from the movement of uncontaminated soil would likely be due to the

presence of organic materials in the soil. However, because the project would be in an arid climate, soil organic content would be expected to be minimal. Odor impacts from soils would therefore be considered unlikely, with their potential occurrence limited to a very narrow time frame during initial project construction when topsoil is first disturbed. Dust control activities such as wetting/dust suppressants for roadways and water sprays for material handling would also act to minimize these odors.

Overall, effects from project-related odors would not be significant and would not constitute an identifiable threat to public health.

4.1.7.2 Impact Mitigation

Emissions from many of the sources at the proposed Yarnell Project would be controlled by implementing air pollution control measures. The emission control measures proposed by YMC for the Yarnell Project (committed to by YMC in the MPO and/or the air permit application for a Class I Air Installation Permit issued by ADEQ) are considered to be equivalent to Best Available Control Technology (BACT) for this type of source. Furthermore, the emission control measures are comparable to those identified in the *Hayden (AZ) Area PM_{10} State Implementation Plan (SIP)*. The proposed control measures are summarized in Table 4-11, along with corresponding control efficiencies. Control efficiencies are based on information contained in AP-42, manufacturers' data and previous mining experience.

- Dust emissions from non-process sources (e.g., vehicular travel over unpaved haul roads, material handling) would be minimized by watering and the application of chemical palliatives. One 5,000-gallon water truck would be maintained on site. Blast hole drills would be equipped with an appropriate combination of water injection, a pneumatic flushing device and/or dust shroud to control particulate emissions.
- High pressure water sprays or the equivalent at the primary and secondary crushers would reduce process dust emissions from the crushing circuit. In addition, emissions from ore conveyor transfer points would be controlled with water sprays or the equivalent.
- Particulate emissions from the pneumatic loading of lime to the lime silo would be controlled by a fabric filter.
- Combustion emissions of SO_2 from the mobile equipment and the generators would be minimized by using diesel fuel with a maximum sulfur content of 0.05 percent.
- Hydrogen cyanide gas may be emitted during the leaching process. The formation of HCN is highly dependent on pH, and the primary control for HCN gas emission would be maintaining a leaching solution with a minimum pH of 10.5. The project would also control HCN emissions by employing drip emitters that minimize the solution's contact with air during application.
- Mercury and particulate emissions from the carbon kiln and doré furnace used during gold refining would be controlled with a baghouse (a device that contains a large fabric bag or filter that captures particle matter as air is drawn through the device).

TABLE 4-11
Summary of Air Pollution Control Measures and Efficiencies

Source	Pollutant	Control	Efficiency
Drilling	PM_{10}	water injection, pneumatic flushing and/or dust shroud	85%
Haul roads	PM_{10}	water/chemical application	90%
Mobile equipment/generator	SO_2	0.05 % sulfur content in diesel fuel	---
Primary crushing	PM_{10}	high pressure water sprays or equivalent	90%
Secondary crushing	PM_{10}	high pressure water sprays or equivalent	90%
Ore conveyers	PM_{10}	water sprays	83%
Lime silo	PM_{10}	fabric filter	99%
Waste dump erosion	PM_{10}	water/chemical application	90%[1]
Ore storage erosion	PM_{10}	water/chemical application	90%[1]
Leach pad	HCN	drip emitters/spray bars/pH control	---[2]
Carbon kiln	PM_{10} Hg	baghouse	98% 90%
Doré furnace	PM_{10} Hg	baghouse	98% 90%
Laboratory	PM_{10}	baghouse	98%

[1] No credit was taken for these controls in the emissions inventory (due to the difficulty in quantifying emissions/controls); however, they would be implemented at the mine.
[2] Although no control efficiency is identified for these control methods, HCN emission rate calculations incorporate the implementation of these controls.

No additional mitigation measures would be required to reduce impacts to air quality.

4.1.7.3 Residual Effects

Short-term increases in air emissions would result from the proposed action. Emissions would be within regulatory limits and would decline rapidly with increasing distance from the mine. Therefore, residual effects would not be significant.

4.1.8 LAND USE

The following criteria and issues were evaluated to determine potential impacts to public access and land uses.

- potential termination or restriction of existing public access opportunities,
- proximity to any sensitive or environmentally significant areas,
- termination of an existing land use, or an incompatibility in land uses; and

- ♦ a general characterization of impact type (including location, duration and magnitude of the potential impact).

4.1.8.1 Direct and Indirect Impacts

The proposed action could affect public access and land uses by exerting a physical and/or visual influence on existing conditions. Direct effects could result from modification of existing land uses. Indirect impacts could result from altered land use patterns or access to use areas near the proposed project. Indirect effects would also result if the proposed project stimulated or encouraged the development of land uses not presently anticipated.

Effects to Public Access. Mina Road, at the north boundary of the proposed operational area, would remain open to the public. Access to and from Yarnell along state Highway 89 would remain as it currently exists except for the proposed road closures associated with blasting. These road closures are proposed to occur two times a week for 10 minutes per closure.

YMC would construct several roads within the boundaries of the proposed disturbance area, but these roads would be primarily for ore/waste rock hauling and not available for public use. The public would be restricted from direct access to mining and processing operations for security and safety reasons. Construction of the proposed water supply pipeline would not affect access to communities, businesses or any adjacent land.

Access to public land in the project area would be restricted. About 118 acres of public land would not be available for recreational activities such as hunting or hiking, but currently there is limited use of the area for these activities. Access to launch areas for hang gliding would be lost or restricted during the operation of the mine.

Overall, most effects to public access would be negligible and short term in duration. However, because Yarnell area residents need 24-hour per day, seven-day per week emergency medical access to Wickenburg along state Highway 89, the effects of the road closures could be significant without proper implementation of the traffic control plan.

Effects to Existing Land Uses. Although exploration and mining activities have historically occurred within and adjacent to the proposed project area, the construction and operation of the proposed project would introduce a noticeable temporary land use change in the area around Yarnell Hill. The mining land use would generally be incompatible with residential land use, especially in the Glen Ilah area. The Yarnell Project would also cause a short-term loss of multiple use resources in the affected area, mostly as a loss of open space and wildlife habitat.

On a more regional basis, the proposed project would not substantially change other land uses in Yavapai County or within BLM-administered land in the region. Population increases associated with the project would not be large enough to cause any identifiable change in private land use (e.g., residential or commercial uses) within Yavapai or Maricopa counties.

No parks, concentrated recreational use areas, wildernesses or protected natural areas would be directly impacted by the proposed project. The development of the proposed Yarnell Project would cause only negligible effects to recreational opportunities because existing recreational use in the project area is minimal.

Effects from the Water Supply Pipeline. The proposed pipeline corridors would be within and adjacent to many land uses including open space, wildlife habitat, historic mining, grazing, commercial and roadways. While there would be minor short-term disruption of some areas during pipeline construction, the existence of the pipeline would not result in any major identifiable conflicts with existing land uses. Since the pipeline would be buried at crossings with existing roads, vehicle access to adjacent land would not be restricted due to the presence of the proposed pipelines. The pipeline could also serve as a small barrier to illegal off-road travel.

Effects on Existing Land Ownership. With its current land ownership and agreements with other landowners, YMC has legal access to the land proposed for disturbance. No further land ownership changes associated with the project are needed or anticipated.

Effects on Grazing. The proposed project would result in restricted access to about 300 acres of the Congress grazing allotment, the loss of the Tom Cat Tank stock pond and the loss of access to the waterhole occasionally present at Cottonwood Spring. This would require a change in the existing grazing permit. These grazing impacts would not be significant because they would affect a very small and geographically peripheral portion of the grazing allotment.

Effects of Mine Closure/Reclamation. The closure, reclamation and abandonment of the proposed project would generally return affected public and private land to their pre-mining land uses as wildlife habitat and open space. Some mining and/or processing-related facilities would remain unavailable for public use because of safety concerns. Details of proposed closure/reclamation activities are described in the MPO.

Consistency with Land Use Plans. The proposed project would be consistent with the multiple use principles under which the BLM manages federal land and with the Lower Gila North MFP. However, the project would not be consistent with the Yavapai County General Development Plan, which envisions Yarnell as a quiet rural community with limited commercial and industrial development and the MSA as an area of scenic reserve (Ferguson, Morris & Associates 1975). Since the development plan is not a regulatory document, this land use planning inconsistency would not necessarily result in a need to revise the plan. However, this inconsistency demonstrates the incompatibility of the proposed mining operation with the existing county plan.

Relocation of Communication Towers. The Burlington Northern Santa Fe (BNSF) and Maricopa County communications towers would be relocated as the proposed project is developed. Tower relocation sites have not yet been chosen, but would involve private land transfers and specific locations for the relocated towers. Any necessary building permits and/or environmental approvals associated with the new sites would be obtained by BNSF and Maricopa County. BNSF and Maricopa County may choose to relocate the towers prior to YMC receiving decisions on the permits necessary for operation of the proposed project. The BLM has no regulatory authority over the tower relocations as long as no federal land is involved.

4.1.8.2 Impact Mitigation

The applicant has proposed environmental protection measures such as reclamation, closure and security activities to reduce potential adverse effects. Discussion of emergency access to the area during blasting periods is in the Transportation section of this EIS (Section 4.1.12). No additional mitigation measures would be required.

4.1.8.3 Residual Effects

While the proposed operation would be consistent with BLM land use designations, implementation of the project would be inconsistent with county land use plans and goals, given the incompatibility between the mining land use and nearby residential areas in Glen Ilah. Implementation of the project would limit non-mining uses of the mining area; however, after reclamation and closure activities, the operational area would generally be consistent with wildlife habitat and open space land uses. The loss of the Tom Cat Tank stock pond and access to the waterhole occasionally present at Cottonwood Spring would be a residual effect to grazing.

4.1.9 VISUAL RESOURCES

Daytime and nighttime views from nearby residences and State Highway 89 would be affected by the proposed action. The assessment of visual impacts is based upon impact criteria and methodology described in the BLM Visual Contrast Rating System, summarized in Section 3.6.1 of this EIS. Effects to visual resources are assessed to address such issues as the type and extent of actual physical contrast resulting from the proposed action and the level of visibility of a specific facility, activity or structure from areas such as nearby residences and roads. Comparison of these contrasts to Visual Resource Management objectives for affected land indicates the magnitude of potential impacts.

4.1.9.1 Direct and Indirect Impacts

Any project that introduces new or changed forms, lines, colors and textures to a landscape would have an impact on the visual character of the area. A number of factors must be considered in the evaluation of visual impacts. Primary among these factors is the issue of how visible the changes are from viewpoints most likely to be used by people. A number of subjective and objective factors must be considered in a visual impact analysis. Among these factors are the number of viewers to be affected, viewer sensitivity, distance and atmospheric conditions of viewing, existing and historic land uses and scenic quality of directly impacted and adjacent areas.

A description of the visual resource existing environment in VRM terminology is provided in Section 3.6.1. Key observation points (KOPs) have been chosen to represent views of the proposed mining operation (see Figure 3-18). The largest numbers of viewers would observe the mine area from KOPs 1, 2 and 3; fewer from KOPs 4 and 5; views from KOPs 6 and 7 would be visible only from those specific residences. The mining operation would not be visible from much of Yarnell because the view would be blocked by a ridge of Antelope Peak. In Glen Ilah, mine views from many residences would be blocked by hills, hollows, vegetation or boulders. From Glen Ilah, the mine would be most visible from areas near State Highway 89 and the vicinity of Lakewood and Foothill drives. The mine would not be visible from the North Ranch area (the Escapees travel club/retirement community) south of Congress.

TABLE 4-12

Summary of Projected Visual Effects During Operations and After Reclamation

	Projected Effects During Operations		**Projected Effects After Reclamation**	
KOP	**Effect Magnitude***	**Meets Visual Class Objective?**	**Effect Magnitude***	**Meets Visual Class Objective?**
1	Weak	Yes	Weak	Yes
2	Strong	No	Strong	No
3	Moderate	Yes	Weak-Moderate	Yes
4	Moderate	Yes	Moderate	Yes
5	Strong	No	Strong	No
6	Strong	No	Strong	No
7	Strong	No	Strong	No

*Effect Magnitude Criteria (Based on Contrast Rating):

Weak - The element contrast can be seen but does not attract attention.

Moderate - The element contrast begins to attract attention and begins to dominate the characteristic landscape.

Strong - The element contrast demands attention, will not be overlooked and is dominant in the landscape.

Table 4-12 summarizes the projected contrast rating effects of the proposed operation on the views from the seven KOPs. As shown in the table matrix, the visual contrast of the proposed action with the existing landscape ranges from a "weak contrast" rating to a "strong contrast" rating, depending on viewer location, distance from the site and time of day (daylight or darkness). This evaluation of impact was performed by using the standard BLM Visual Contrast Rating worksheets (available in BLM project files) and computer simulations of impacts (see Appendix I). The visual contrast ratings shown in the matrix are based on the final contours (maximum height and lateral extent) of the various project components. A summary of the visual contrasts from each KOP is also presented in this section.

Types of Potential Impacts. In general, the three primary visual impacts of the proposed project would be:

- the introduction of new landforms that contrast with the existing landscape on the basis of form, line, color and texture;
- project illumination during nighttime operating hours and
- fugitive dust generated, causing a dust plume that contrasts with the surrounding clear air and increases project visibility.

These effects would all be most noticeable during the proposed six years of active mining (e.g, short term), but the introduction of new landforms would generally remain for the long term.

A summary of the mining-related visual effects as viewed from each identified KOP is discussed below. At full production, strong contrasts are identified in four of the seven KOPs. Effects from closure and reclamation activities would only slightly lessen these contrasts in most cases. Because of the strong contrast which would be only slightly lessened during reclamation, effects on visual resources would be significant in both the short and long term.

Daytime Effects of New Landforms at Peak Mining-Related Conditions. Daytime effects of the proposed project as simulated from each KOP are identified below.

KOP-1: View from State Highway 89 in Congress - When viewed from KOP-1, the proposed action would contrast weakly with the existing landscape because of the eight-mile distance to the mine site. The pit would be visible, but would be identifiable only with binoculars. The disturbance visible from this viewpoint would not dominate the view and would be consistent with the Class III visual objectives.

KOP-2: View Northeast from State Highway 89 - The pit, topsoil stockpile, SWRD and haul roads would be visible from this KOP. These facilities would create a strong contrast with the existing landscape in all four contrast categories (form, line, color and texture). The mining disturbance would dominate the view and would not be consistent with Class III visual objectives.

KOP-3: View Southeast from State Highway 89 - The pit would be the only facility seen from this viewpoint. Because of the distance to the mine site, buildings in the foreground and midground and rolling hills blocking some of the view of the site, there would be a moderate contrast with the existing landscape. Contrasts would take the form of color and texture. The disturbed areas would not dominate the view and would be consistent with Class III visual objectives.

KOP-4: View Southeast from Intersection of Lakewood Drive and Foothill in Glen Ilah - This view is similar to KOP-3 except that KOP-4 is an additional 400 to 500 yards from the proposed site and would not have as many obstructions blocking direct views of the mine site. The pit would be the only facility visible from this viewpoint. Because of the additional distance, the mining-related disturbance would not dominate this view. Primary contrasts would take the form of color and texture, but the moderate contrasts would be consistent with Class III visual objectives.

KOP-5: View South from Mina Road - This KOP would consist of a direct view of the pit and NWRD because there are no structures, vegetation or other objects which would block the view. These facilities would exhibit a strong contrast with the existing landscape and dominate the view. Primary contrasts would take the form of color, texture and line and would not be consistent with Class III visual objectives.

KOP-6: View Southeast from Residence - This viewpoint would be the same direction as KOP-3 and KOP-4, except that KOP-6 would be much closer to mine facilities. The pit, haul roads, topsoil storage pile, heap leach pile and SWRD would be visible from this KOP. There is some blockage of the facilities to the left portion of the view because of dense shrubby vegetation. However, even with this vegetation screen, the facilities would dominate the view. Contrast with the existing landscape would be strong and occur in all categories (form, line, color and texture). This KOP would not be consistent with Class III visual objectives.

KOP-7: View East from Residence - From this KOP, the pit, heap leach pile, SWRD, topsoil stockpile and haul roads would be visible in a panoramic-style view. Because this KOP is at a higher elevation than other KOPs, the viewer would be looking directly across and/or downward toward these facilities. The facilities would totally dominate the view and contrast strongly with the existing landscape in form, line, color and texture. This KOP would not be consistent with Class III visual objectives.

Daytime Effects of New Landforms After Completion of Closure/Reclamation Activities. Post-mining reclamation would reduce the ultimate visual impacts of the proposed operation. Vegetation would replace barren areas and blend in with undisturbed areas. Because the pit would be opened or "day lighted" to the west, it is not a typical open pit. Therefore, pit backfilling is not practical and the pit wall would remain a major visual impact. Eventually, the color contrasts of the pit and other visible mine elements would weaken slightly as rock weathers and darkens to a hue closer to that of the surrounding terrain. Erosion would soften the geometric shape of the elements, reducing contrasts in form and line. Specific visual effects after reclamation are projected for each KOP below.

KOP-1: View from State Highway 89 in Congress - Since the pit generally remains in its peak-mining shape after reclamation, this view is the same as that described in the peak-mining conditions section above. Because of distance, the effect would not dominate the landscape and would be consistent with the Class III objectives.

KOP-2: View Northeast from State Highway 89 - This view shows successful reclamation of haul roads, the topsoil stockpile and SWRD. Because the pit generally remains in its peak-mining condition after reclamation, the effect would still dominate this viewpoint and would not be consistent with the Class III objectives.

KOP-3: View Southeast from State Highway 89 - Since the pit generally remains in its peak-mining condition after reclamation, this view is the same as that described for the peak-mining conditions. Because of the vegetation and buildings in the foreground, the effect would be weak to moderate. Effects would not dominate the landscape and would be consistent with the Class III objectives.

KOP-4: View Southeast from Intersection of Lakewood Drive and Foothill in Glen Ilah - Since the pit generally remains in its peak-mining condition after reclamation, this view is the same as that described for the peak-mining conditions. Effects would remain moderate and would not dominate the landscape. This would be consistent with the Class III objectives.

KOP-5: View South from Mina Road - This view shows successful reclamation of the NWRD. However, strong contrasts remain with surrounding terrain and the presence of the pit is still dominant. Contrast effects would remain strong and would not be consistent with the Class III objectives.

KOP-6: View Southeast from Residence - This view shows successful reclamation of the SWRD and the heap leach facility. However, the presence of the pit is still dominant. Contrast effects would remain strong and would not be consistent with the Class III objectives.

KOP-7: View East from Residence - This view shows successful reclamation of the SWRD and heap leach facility. However, strong contrasts remain with surrounding terrain, and the presence of the pit is still dominant. Contrast effects would remain strong and would not be consistent with the Class III objectives.

Nighttime Effects of Operations. YMC has proposed to continue some operations (e.g., mining, hauling, crushing and pad loading) 24 hours per day, five days per week. Even without 24-hour-per-day active mining, some lighting would be required for the leach area, parking and security. However, additional lighting would be required to facilitate 24-hour-per-day mining of waste rock. This situation would require outdoor lighting in some areas of the mine site. In the MPO, YMC proposed that portable light plants (metal halide) would be used to light the active mining areas and the active waste rock dumps. Lighting would also be necessary at the crusher, ADR plant and shop. As proposed, all lights would be hooded and directed away from the highway and nearby residences.

Even though lights would not be directed at any populated or other off-site areas, the proposed lighting would still be visible from all KOPs. The effect would generally take the form of a non-point glare (e.g., a lighted pit or waste rock dump face) rather than a specific direct light source. The intensity of light would be somewhat muted because the lights would be directed away from viewers, but the intensity would probably still be greater than typical street lights for mine safety purposes. While this would not cause a viewer any eye trauma or cause one to shield the eyes during a direct view of the lighted areas, nighttime views of the mine site could show extensive activity in an area which is not currently lighted.

Nighttime visual effects on State Highway 89 users would generally be minor to moderate because of the short duration of their views. Depending on specific circumstances, some drivers could be distracted by these unexpected lights. Visual effects on some nearby residential areas would be moderate to strong because the glare from the lights would be constant. Some persons in the immediate mine vicinity could notice an adverse effect on the nighttime visibility of the sky and stars. Overall effects of nighttime use of lighting would be significant on residential areas immediately adjacent to the mine site.

Effects of Dust on Visibility. Dust would be generated by mining/processing operations, and the potential effect of this dust on visibility is a concern of local residents. Visibility can be defined as the degree to which ambient air pollutants obscure a person's ability to see a given reference point through the atmosphere. The more a reference point is obscured, the poorer the visibility. As discussed in the Air Quality section, at present the visibility in the area is commonly affected by hazy conditions.

Dust from the proposed operations would be visible under some circumstances from all KOPs. Depending upon climatic conditions, project-related dust effects would range from minimal to the appearance of a haze over the project area. These events would generally be short term and intermittent in nature. Visibility effects would not be in violation of federal and state air quality standards, but could be annoying to residents either physically or psychologically.

Visual Effects of the Pipelines. The proposed pipeline corridors were shown previously in Figure 2-9. The proposed four-inch pipeline and disturbed corridors would generally be visible only by persons in proximity to the 10,000-gallon water storage tanks and pump stations associated with the pipelines. As described in Section 2.1.6.4, several types of pipe are proposed for the water supply pipeline. The HDPE pipe would be black and the steel pipe would have a black or red-rust color. Yelomine (or equivalent material) PVC pipe would be used where higher water pressures would occur. Yelomine pipe is manufactured from a specially formulated PVC compound which contains impact modifiers and ultraviolet inhibitors, and it normally has a light yellow color. It is also available in green, brown, white and other colors, given an appropriate lead time when ordering.

The pipeline would follow existing disturbance as much as possible and be placed directly on the ground. Therefore, existing vegetation and topography would screen the pipeline from ordinary vantage points. Portions of the pipeline along County Road 109 (between Well 2BCD and the Section 28 well field) may be visible to vehicular traffic. All pipeline segments would be temporary and remain in place only during project operations and reclamation. The pipeline would not cross any protected or restricted areas. Overall, the visual effects of the pipeline are minor and are much less than the other proposed project facilities.

4.1.9.2 Impact Mitigation

YMC has proposed reclamation measures, including landscape contouring and revegetation, to reduce adverse contrast effects to visual resources. The practicality and effectiveness of a tree planting program by YMC along State Highway 89, Mina Road and in Glen Ilah will be evaluated by the BLM if the project is approved. In addition, visible facilities would be painted a desert tan or other color acceptable to the BLM to reduce visual effects. Pipeline color would also be coordinated with the BLM. Lights would be shielded and directed downward to reduce nighttime glare.

4.1.9.3 Residual Effects

The disturbances and facilities associated with the proposed project would cause a noticeable visual effect which would become greater over the anticipated six-year operational period. Many of the visual effects would be permanent. Reclamation efforts would only partially lessen the impacts to the existing visual resources, and visual effects would continue to be significant over the long term.

4.1.10 CULTURAL RESOURCES

4.1.10.1 Direct and Indirect Impacts

Section 106 of the National Historic Preservation Act and the implementing regulations (36 CFR 800) specify that potential effects must be assessed for those resources determined eligible or potentially eligible for listing on the National Register of Historic Places (NRHP).

Table 4-13 provides a summary of the seven historic properties in the study area, their recommended NRHP status and projected impacts. National Register-eligible sites include the Yarnell Overlook, a historic Native American site; the Biedler Mine and Edgar Shaft, both historic mines; and the Mina-Genung Road. The Yarnell Overlook site would not be directly impacted by mining activities. However, indirect adverse effects could occur through increased accessibility, which could make the site more vulnerable to artifact collecting or other types of disturbance. The Biedler Mine and Edgar Shaft would be directly impacted by the construction of the open pit and the SWRD. These sites, significant for their informational value, have been fully documented and additional field studies would yield minimal

TABLE 4-13
Management Recommendations for Cultural Resources

Site Number	Site Name	Site Type	NRHP Status	Impact	Recommendations
AZ N:13:8 (ASM)	Biedler Mine	Mine and trash scatter	Eligible	Within the proposed South Waste Rock Storage Area	Completely recorded No further work
AZ N:13:9 (ASM)	Edgar Shaft	Mine and trash scatter	Eligible	Within proposed Yarnell pit	Completely recorded No further work
AZ N:13:10 (ASM)	State High-way 89 segment	Abandoned highway	Not-eligible	No impact within proposed mine facility boundaries	No further work
AZ N:13:11 (ASM)	Yarnell Overlook	Stone enclosure and artifact scatter	Eligible	No direct impact, but possible disturbance associated with greater activity in the area	Develop and implement a data recovery plan
AZ N:14:18 (ASM)	-	Trash scatter	Not eligible	No impact, outside proposed facilities	No further work
AZ N:14:19 (ASM)	Yarnell Mine	Mine	Not eligible	Within proposed Yarnell pit, North Waste Rock Dump and Storage Areas	No further work
AZ N:14:20 (ASM)	Mina-Genung Road segment	Road	Eligible	No impact, outside proposed facilities	No further work

information. Therefore, the loss of these sites has already been mitigated through complete recording.

Two historic road segments, outside the proposed facilities, would not be directly impacted by the mining operation. An abandoned segment of State Highway 89 is not eligible for the National Register. The portion of the NRHP-eligible Mina-Genung Road near the project area has remained in continuous use and has no associated historic structures, artifacts or aspects of construction that would be affected.

Two mining-related sites, the historic Yarnell Mine and AZ N:14:18 (ASM), a trash scatter, are not NRHP-eligible due to poor integrity, and existing remains have been fully recorded and documented. The Yarnell Mine was important in the area's history, but successive mining operations on private land have obliterated earlier historic features. The Yarnell Mine area would be directly impacted by the open pit, NWRD and storage areas. AZ N:14:18 (ASM) would not be directly impacted by the mining operation.

4.1.10.2 Impact Mitigation

All historic sites in the MSA, except the Yarnell Overlook site, have been fully documented, mapped and photographed. Any potential adverse effects to the Yarnell Overlook site would be mitigated through development and implementation of a data recovery plan approved by the BLM in consultation with the SHPO and Native American tribes. This plan would include, but is not limited to, excavation, artifact collection and analysis, additional site mapping, oral histories, additional archival research and site photography.

Additional discoveries of archaeological sites are unlikely. However, the Yarnell Mining Company would be required, by a stipulation in the mining plan and under A.R.S. 41-865, to report any new discovery and to cease activities in the immediate vicinity until the discovery is evaluated by a professional archaeologist and appropriate treatment is determined by the BLM or the Arizona State Museum. The State Museum's jurisdiction would be limited to the discovery of burials on private land.

4.1.10.3 Residual Effects

Implementation of the data recovery plan at the Yarnell Overlook site would greatly reduce or eliminate potential effects on significant cultural resources. Residual effects are negligible and not significant.

4.1.11 INDIAN TRUST RESOURCES

The U.S. has a trust responsibility, executed through the Secretary of the Interior in accordance with Secretarial Order 3175, to uphold legal and treaty obligations of the federal government to Native American tribes. These obligations require a reasonable and good faith effort to identify and consider the effects of decisions on Native American treaty rights, lands and tribal government planning and resource management programs.

4.1.11.1 Direct and Indirect Impacts

The nearest Indian community is the Yavapai-Prescott Indian Tribe, approximately 30 miles northeast of the MSA near Prescott. This tribe and other Yavapai communities would be given the opportunity to participate in studies of the Yarnell Overlook, a possible historic Yavapai site. The proposed action would have no effect on tribal lands or communities, treaty rights or tribal government planning and resource management programs. Indian trust resources would not be affected under the proposed action or any of the other EIS alternatives.

4.1.11.2 Impact Mitigation

There would be no mitigation measures required.

4.1.11.3 Residual Effects

There would be no residual effects.

4.1.12 TRANSPORTATION IMPACTS

Transportation issues include the effects of additional mine-related traffic, the potential for accidents and other safety concerns, the need for additional road maintenance and the effects of the proposed road closures for blasting. The potential impacts resulting from the transportation of hazardous material to the site is addressed in Section 4.1.14.2.

4.1.12.1 Direct and Indirect Impacts

Mine employees, contractors and equipment suppliers would generate additional traffic on State Highway 89 and Mina Road in the Yarnell/Glen Ilah area. As further discussed below, potential impacts resulting from this additional traffic include congestion on area roads, additional accidents and increased road maintenance costs. Road closures during blasting would also impact transportation in the area.

TABLE 4-14
Sources of Mine Employees Commuting to Mine Site

Area of Origination	Construction	Operation
Yarnell	11	10
Congress	5	5
Prescott	20	18
Other areas of Yavapai County	20	18
Wickenburg	20	18
Phoenix/Maricopa County	24	22
Total	**100**	**91**

Mine-Generated Traffic. As discussed in Section 4.1.14.2, mine-related traffic would be expected to originate from as far north as Prescott and as far south as Phoenix. With the exception of the Yarnell-based workers, all mine-related traffic is expected to arrive and depart the site only on State Highway 89 and Mina Road. Table 4-14 shows the projected number of mine employees during both construction and operation of the proposed project. Most of the employees would arrive and depart at shift changes, which are proposed for 7:45 am, 3:45 pm and 11:45 pm. The first shift (beginning at 7:45 am) would have more workers than the other two shifts. Therefore, the greatest number of employees arriving and departing the site at any one time would be approximately 40 to 50 workers. However, as some carpooling is expected, the number of vehicles would likely be less.

In addition to employees, an average of approximately four delivery vehicles per day would be expected to arrive and depart the site. Two of these deliveries would be packages and letters from delivery services such as UPS and Federal Express, whose delivery vehicles would presumably already be in the area at least occasionally. The other two deliveries would be fuel or process reagents.

Use of vehicles to ship the doré bar product to an off-site refinery would be minimal. Only about four doré bars would be produced each month.

For a 24-hour period, the combination of employee, delivery and shipping vehicles represents less than a five percent increase in traffic on State Highway 89 (compared to 1995 traffic volumes between State Highway 71 and Shrine Road as shown in Table 3-18).

Level-of-Service. A level-of-service (LOS) analysis was conducted for State Highway 89 from U.S. 93 to Ponderosa. LOS is a method of qualitatively describing the traffic conditions on a particular roadway (Transportation Research Board 1994). LOS takes into consideration factors such as speed, number of lanes, percentage of trucks, the number of side-road access points, freedom to maneuver and traffic interruptions. There are six levels of service, each given a letter rating of "A" to "F." "A" represents the best driving conditions, "F" the worst. Using 1995 traffic volumes, the LOS on the section of State Highway 89 under study was determined to be "A." A second analysis was conducted using future traffic volumes, including the addition of project-related traffic. With these future traffic volumes (including the less than five percent project-related increase noted above), LOS was again determined to be "A."

Therefore, LOS on State Highway 89 would not be affected by the addition of Yarnell Project traffic.

Accidents. The additional traffic which would be generated by the proposed project has the potential to increase the number of accidents on area roads. The increase in the number of accidents is expected to be at most proportional to the increase in traffic, which is five percent. Using the 1993 to 1995 accident data in Table 3-28 for State Highway 89 from State Highway 71 to Peoples Valley as a basis, there would be an additional 0.5 multi-vehicle accidents and an additional three single-vehicle accidents over a three-year period, or approximately one additional accident annually. While the additional annual accident would impact emergency response organizations, almost all of the additional accidents are likely to involve only one vehicle (i.e., running off the road, hitting an animal, etc.).

Road Maintenance. In general, mine-related traffic would only travel on State Highway 89 and approximately the first 1,000 feet of Mina Road. Daily traffic would consist of approximately 100 workers and four deliveries. Workers would travel in automobiles and light-duty trucks (with some carpooling expected), and the four delivery vehicles would consist of one tractor-trailer ("18-wheeler"), one single-axle truck and two small delivery vans (on average). ADOT does not have absolute criteria with which to judge the significance of the impact of these added vehicles. However, it would be reasonable to consider a 20-percent increase in truck traffic a significant impact. While there are no truck data available for State Highway 89 or Mina Road, it is assumed that the four added vehicles per day do not constitute a 20-percent increase in truck traffic. The 100 employee vehicles per day represents only a five-percent increase in traffic on State Highway 89.

Any additional maintenance cost which would be incurred by Yavapai County (for Mina Road) or the state of Arizona (for State Highway 89) would likely be offset by the tax revenue which would be generated by the proposed project. Both the county and the state would receive tax revenue (through property and other taxes) from the proposed project. Refer to Section 4.1.16.2 for more information on tax revenues.

Road Closure. Under the proposed action, YMC would stop traffic on State Highway 89 during blasting operations as a public safeguard. The proposed blasting schedule calls for two blasts each week. The blasts are to occur only on weekdays, only during daylight hours and on a regularly scheduled basis (the schedule would be set on a week-to-week basis). Traffic would be stopped for approximately 10 minutes per blast. Northbound traffic would be stopped approximately 300 feet north of Milepost 275, and southbound traffic would be stopped approximately 1,850 feet north of Milepost 276. This area is south of Glen Ilah, so access to Glen Ilah would not be affected. Traffic would also be stopped on Mina Road. Permanent signs would be installed to warn motorists that they are traveling in a blast area.

Traffic control would be conducted by employees or contractors of YMC. The personnel controlling traffic would be in radio contact with the blast supervisor and would not release traffic until the "all clear signal" is given. Prior to the first production blast, YMC would submit a traffic control plan to the ADOT specifying sign placement and traffic control procedures. The plan would include a procedure for coordinating emergency vehicle service from the town of

Wickenburg to the town of Yarnell and surrounding communities. The blast control supervisor would have a clear view of the section of State Highway 89 adjacent to the blasting area and would be in radio contact at all times. Blasting would be halted immediately in the event that emergency vehicles needed to use the highway (see also Section 4.1.16.2).

4.1.12.2 Impact Mitigation

The only impact to the transportation network in the Yarnell/Glen Ilah area that requires mitigation is the stoppage of traffic during blasting. This would inconvenience area residents and could impact the ability for emergency vehicles to get to and from Wickenburg. As described above and in the MPO, YMC has outlined a plan for minimizing these impacts. In addition to blasting schedule and road closure notification to ADOT, YMC should also make road closure plans available to the County Sheriff's Office and the general public on a weekly basis (see also Section 4.1.14.2).

4.1.12.3 Residual Effects

During construction and operations, additional traffic (compared to current conditions) and the potential for additional traffic hazards would be generated by commuting employees and other project-related traffic. If the operation is implemented, there would be potential effects to emergency access to the Yarnell area from the south. However, the proposed road closures would represent only 0.2 percent of the time in a week. It is extremely unlikely that closures would coincide with the ambulance trips from Wickenburg (which average about 100 trips to the Yarnell area per year). Although emergency access is a significant issue and there could be a potential for delays in emergency access, the proposed blasting/transportation procedures incorporate a contingency plan for minimizing or preventing delays in such situations.

Upon reclamation of the proposed mine site, there would be no residual impact to the area's roadway network with the exception of road wear. Again, the cost of repairing any road wear that occurs would likely be offset by tax revenues generated by the project.

4.1.13 NOISE

Project-related noise could affect public health and qualify of life in nearby communities. As discussed in Section 3.9.3, there are no federal, state or county regulations that apply to the off-site noise that would be generated by the proposed project. As a result, noise impact was assessed using impact criteria defined by the U.S. EPA (1974).

Two sets of criteria were selected for use in evaluating the impacts of the proposed project. These criteria are presented in Table 4-15. The first set, public health, contains criteria considered adequate to protect against hearing loss and to protect public health and welfare. Specifically, the potential for noise-induced hearing loss is negligible if community noise levels are limited to 70 dBA (L_{eq}), and the potential for speech interference (i.e., the inability to hold a conversation outdoors in a normal tone of voice) is minimized if community noise levels are limited to 55 dBA (L_{dn}).

The second set of criteria shown in Table 4-15 are generally accepted guidelines for the audibility and community reaction to new sources of noise. If a new source of noise is approximately 3 dBA louder than ambient noise levels, it will be barely audible and,

TABLE 4-15
Noise Impact Criteria

Public Health		Audibility and Community Reaction		
To Protect	Limit Noise To	If Project Noise Exceeds Ambient Noise By	Project Noise Would Be	Expected Community Reaction Would Be
Against hearing loss	70 dBA (L_{eq})	3 dBA	barely audible	none
Health and welfare	55 dBA (L_{dn})	5 dBA 10 dBA	audible distinctly audible	some complaints numerous complaints

Source: Based on information in U.S. EPA 1974.

therefore, likely to elicit no complaints. If a new source of noise is 5 dBA louder than ambient noise levels, it will be audible by most of the general population and likely to elicit some complaints. At a level 10 dBA louder than ambient, noise from a new source will be distinctly audible and likely to elicit numerous complaints. These criteria are based on the results of a number of community noise studies summarized by the U.S. EPA. While many of the studies were conducted in areas more heavily populated than Yarnell/Glen Ilah, the criteria are expected to provide a good indicator of potential impacts.

4.1.13.1 Direct and Indirect Impacts

Noise Prediction Methodology. Noise levels from the proposed mining activities were predicted at six receptor locations shown in Figure 4-9. Locations 1 and 2 represent individual residences. Receptors 3, 4 and 5 represent three areas of Glen Ilah. Location 6 represents Yarnell. Noise from the proposed mining activities would result mainly from diesel-powered earthmoving equipment such as bulldozers, haul trucks and loaders. Other noise sources include the crusher, electrical generators and portable light plants. Noise from blasting is much different in level and character than that from diesel-powered equipment and is discussed in Section 4.1.13.2. Noise levels were predicted in terms of the average hourly noise level (L_{eq}) and the day-night noise level (L_{dn}). As mining is proposed 24 hours per day and noise levels are expected to be relatively constant throughout the course of any given day, the hourly average L_{eq} provides a representation of the average noise level expected from the mine at any time. The L_{dn} provides a level which reflects the greater impact of nighttime noise.

Both the L_{eq} and L_{dn} were predicted by extrapolating the noise level of each piece of equipment (measured by the manufacturer at a distance of 50 feet) to the distance of each receptor. The extrapolation included the effects of divergence (noise decreases as it travels away from a source), atmospheric absorption, the attenuation expected to be provided by hills and ridges, as well as the reflection of noise off of the pit wall.

The effect of wind on noise propagation was also included in the predictions. Wind direction and wind speed data collected at the proposed project site in 1992 and 1993 were used to predict the percentage of time each receptor would be upwind from the proposed project. When a receptor is upwind from a source and the wind speed is at least 10 miles per hour, noise from the source is bent skyward in the direction of the receptor (Power Plant Construction Noise Guide, Empire State Electric Energy Research Corporation, May 1977). The result is a reduction of noise by at least 20 dBA below that which would be expected under non-upwind conditions. Non-upwind conditions, which include when the winds are calm (less than 10 mph), will change over the life of the proposed project as mining operations change. To simplify presentation of the data, only the loudest predicted level of the three years is presented herein.

As discussed previously, noise levels were predicted for both upwind and non-upwind conditions. Based on wind direction data measured at the proposed mine site, all six receptors are expected to be upwind of the mine approximately 21 percent of the time during the daytime (7 am to 10 pm) and approximately 65 percent of the time during the nighttime.

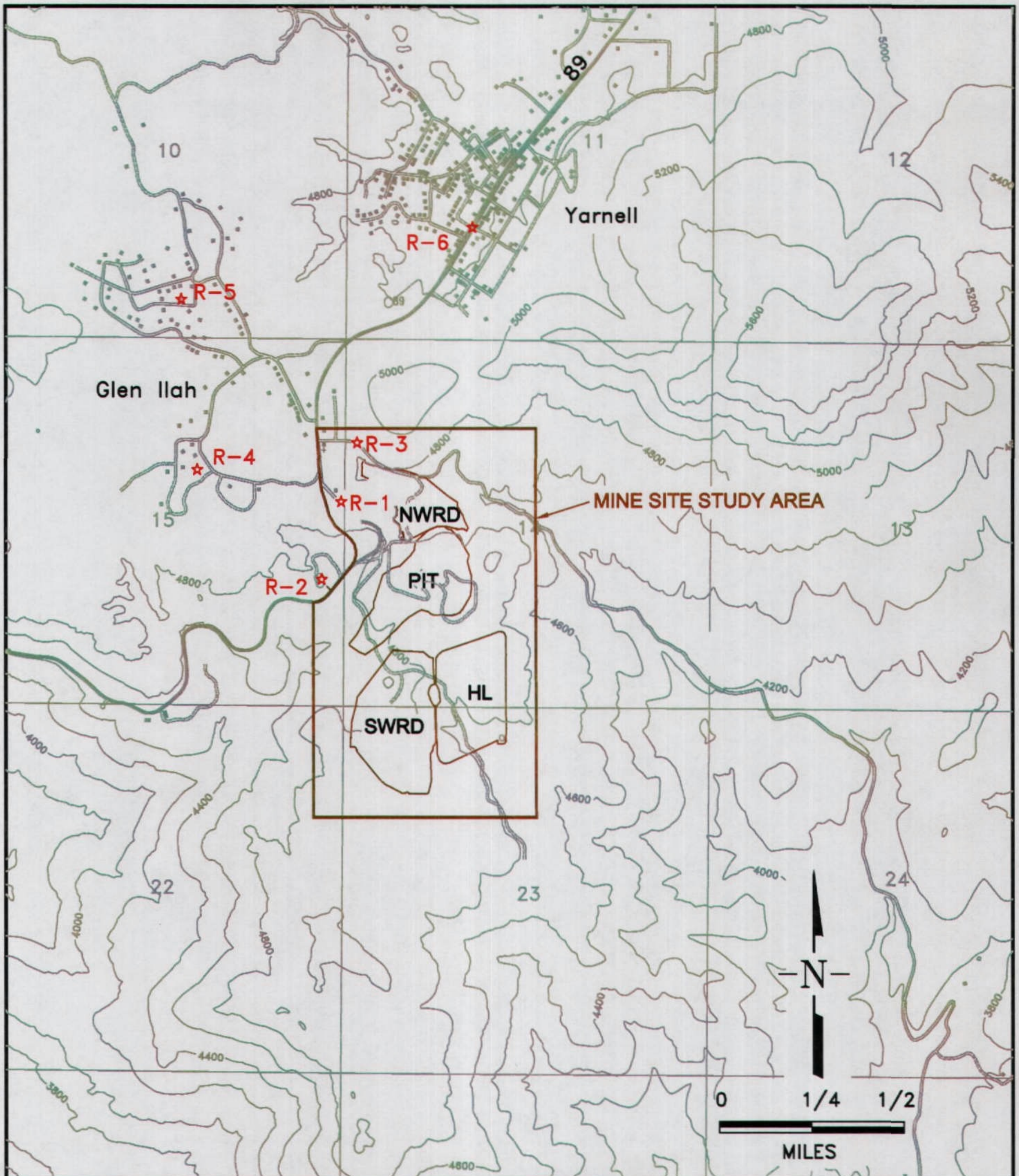
The predicted noise levels are shown in tables 4-16 and 4-17 in conjunction with the impact criteria discussed above. Table 4-16 presents the average hourly L_{eq} and the L_{dn} at each receptor for both upwind and non-upwind conditions. Table 4-17 presents the

TABLE 4-16
Predicted Noise Levels
(dBA)

Receptor	Predicted L_{eq}		Hearing Loss Criteria	Predicted L_{dn}		Health and Welfare Criteria
	Non-upwind	Upwind		Non-upwind	Upwind	
1	55	35	70	61	41	55
2	69	49	70	75	55	55
3	57	37	70	63	43	55
4	55	35	70	61	41	55
5	32	12	70	38	18	55
6	24	4	70	32	12	55

TABLE 4-17
Predicted Noise Level Increases

Receptor	Non-upwind Noise Level Increase and Expected Community Reaction		Upwind Noise Level Increase and Expected Community Reaction	
	Daytime	Nighttime	Daytime	Nighttime
1	13 dBA numerous complaints	20 dBA numerous complaints	0 dBA none	0 dBA none
2	27 dBA numerous complaints	34 dBA numerous complaints	7 dBA some complaints	14 dBA numerous complaints
3	15 dBA numerous complaints	22 dBA numerous complaints	0 dBA none	2 dBA none
4	13 dBA numerous complaints	20 dBA numerous complaints	0 dBA none	0 dBA none
5	0 dBA none	0 dBA none	0 dBA none	0 dBA none
6	0 dBA none	0 dBA none	0 dBA none	0 dBA none



M-1 ☆ NOISE MEASUREMENT LOCATIONS
NWRD NORTH WASTE ROCK DUMP
SWRD SOUTH WASTE ROCK DUMP
HL HEAP LEACH FACILITY
PIT YARNELL PIT

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 4-9

BASE NOISE MEASUREMENT LOCATION

difference between predicted mining noise levels and measured ambient noise levels. Daytime and nighttime ambient noise levels of 42 and 35 dBA, respectively, were used for this comparison. These levels were derived from the measured ambient noise levels discussed in Section 3.9.2. The table shows the difference in mining and ambient noise levels and the corresponding level of community reaction expected based on the criteria presented in Table 4-15.

The following paragraphs describe the noise levels and noise impact expected at each receptor. As none of the predicted noise levels exceed the 70-dBA criteria for the protection against hearing loss, this impact criterion is not discussed further.

Receptor 1 - Receptor 1 is a residence in Glen Ilah approximately 2,000 feet northwest of the proposed pit and 1,100 feet west of the NWRD. While there is a small hill between this residence and most of the proposed operations, predicted noise levels are relatively loud due to its proximity. During non-upwind conditions, the predicted L_{dn} exceeds the EPA's 55-dBA criterion for the protection of human health and welfare, and mining noise levels are expected to exceed ambient levels by 13 to 20 dBA. These levels would likely result in numerous complaints. Mining noise would be barely audible during upwind conditions.

Receptor 2 - Receptor 2 is a residence on the west side of State Highway 89 approximately 1,500 feet west of the proposed pit. There is direct line of sight between this residence and most of the mining operations. The predicted L_{dn} equals or exceeds EPA's health and welfare criterion during both non-upwind and upwind conditions. Mining noise levels are expected to be 27 dBA above daytime ambient noise levels and 34 dBA above nighttime levels. These levels would likely result in numerous complaints.

Receptor 3 - Receptor 3 represents the group of residences on Mina Road near its intersection with State Highway 89. There is a small ridge which breaks line of sight from these residences to most of the mining operations. During the first year of mining, pit operations, which will take place at elevations as high as 5,000 feet MSL, and the hauling of ore to the NWRD will be the most audible mining activities. During non-upwind conditions, predicted mining noise levels exceed the EPA's health and welfare criterion and are 15 to 22 dBA above ambient noise levels. These levels would likely result in numerous complaints. Mining activities are expected to be inaudible during upwind conditions.

Receptor 4 - Receptor 4 represents those residences in the southern part of Glen Ilah. The closest mining activity would be the haul road to the NWRD at a distance of approximately 3,000 feet. Line of sight from these residences to the mine site would vary, as this area consists of many small hills and large boulders. In general, however, there would be no direct line of sight to the mine. Similar to Receptor 3, the mine is expected to be very audible during non-upwind conditions and inaudible during upwind conditions. The predicted L_{dn} exceeds EPA health and welfare criterion, and the noise from mining operations is expected to result in numerous complaints.

Receptors 5 and 6 - Receptor 5 represents the residences in the northern part of Glen Ilah, which are at least one mile from the proposed mine site. Receptor 6 represents Yarnell, which is about a mile from the proposed mine and behind a large ridge. Noise from mining activities is expected to be inaudible at these locations at all times and under all wind conditions.

Based on the results of the predicted noise level analysis, project-related noise would be heard by residents and other persons near the mine site. Many persons in this area would consider this noise as a major adverse effect on their perceived quality of life and lifestyles. Therefore, effects are considered significant. Effects would lessen during reclamation and cease after activity at the site is ended.

4.1.13.2 Impact Mitigation

There is currently one main mitigation measure incorporated into the MPO and included in the noise predictions. That measure is the location of the crusher and processing plant behind the ridge containing the Yarnell deposit. At this location, much of the noise from these sources would not reach area residences. If shown to be feasible and effective in blocking noise from traffic on haul roads, construction of earthen berms or barriers would be required as an additional mitigation measure.

4.1.13.3 Residual Effects

Because no additional mitigation is proposed, residual effects would be as described above. Adverse effects would be significant over the short term.

4.1.14 BLASTING

Blasting concerns include impacts to the stability of natural features including boulders and aquifer systems, as well as the potential for damage to residences, structures, utility lines and roads.

4.1.14.1 Direct and Indirect Impacts

Blasting operations would be conducted at the Yarnell mine twice per week during daylight hours, generally between 9 am and 6 pm. The potential effects resulting from blasting operations are ground motion, air blast, flyrock and dust.

Effects from Ground Motion. Ground motion, a shaking of the ground as a result of blasting, can cause damage to structures. Ground motion or peak particle velocity (PPV) is measured in inches per second.

Research conducted by the U.S. Bureau of Mines found that safe PPV criteria for low-frequency (less than 30 Hz) ground vibrations were 0.75 in/sec for modern gypsumboard houses, 0.50 in/sec for plaster-on-lath interiors and up to 1.0 in/sec with new construction. It should be noted that these levels were determined for cosmetic damage to structures or superficial interior cracking of the type that often occurs in homes independent of blasting. YMC has committed in the MPO to conduct blasting operations in compliance with the OSM Blasting Regulations. At higher frequencies (above 30 Hz), a PPV of 2.0 in/sec is safe and allowable under the OSM regulations.

Two test blasts were performed by DBA, Inc. as part of the baseline environmental studies. In each of the blasts, a total of 300 pounds of explosives was detonated instantaneously in three drill holes. The weight of explosives detonated was greater than the 235 pounds/delay that would be used initially by YMC in its blasting operations. In both test blasts, the PPV measured at the two nearest residences was below 0.05 in/sec. At the Maricopa Tower, the PPV was 0.389 in/sec (288 feet away) from blast number one and less than 0.10 in/sec (877 feet away) in blast number two.

These PPV levels are well below the safe criteria for property damage. Based on the information obtained from the test blasts, vibration levels at the residences nearest the blast sites should not approach the 0.5 in/sec minimum criteria.

Yarnell Water Improvement Association water mains in Glen Ilah and several lots are inside the MSA in the northwest corner. The closest water main is about 1,750 feet from the nearest blasting area (crest of the pit). This water line is about 600 feet farther from the blasting area than the Lynn residence, where blasting vibrations would be monitored. Vibration would also be monitored at the Wilhite residence, the closest residence to blasting operations (approximately 850 feet). Vibration levels monitored 1,142 feet from the test blast were less than 0.05 in/sec. Vibration from blasting would not be expected to damage these water lines. However, the water lines should be included in YMC's pre-blast surveys to document the construction and condition of the water lines. Therefore, a mitigation measure to conduct a pre-blast survey of these water lines has been recommended in Section 4.1.14.2.

As the pit deepens and rock structures change, the vibration characteristics of the mine would also change. An estimate of PPV was made using a general use equation from the Dupont Blasters Handbook (16th edition, page 426). The equation predicts a PPV of about 0.3 in/sec at the closest residences to the blast site using the scaled distance that YMC proposed in its blasting plan. This is still well within the safety criteria for structural damage at the nearest residences. The general use equation also results in higher predicted PPV values at the Maricopa Tower than those measured in the test blast (1.78 in/sec predicted vs. 0.389 in/sec measured). Under its proposed initial blasting plan to detonate 235 pounds of explosive per delay, utilizing the scaled distance formula would allow YMC to blast up to about 840 feet from the tower. YMC would relocate the two microwave towers currently on the property.

As noted above, the OSM Blasting Regulations include alternatives to the scaled distance formula selected by YMC for its initial blasting plan, which could allow YMC to detonate more explosive per eight milliseconds delay, thus increasing vibration levels to near the regulatory limits. No damage would be expected, but the degree of annoyance could increase.

Effects from Flyrock, Dust and Gas. Rock cast into the air from blasting operations is referred to as flyrock. Excessive flyrock usually results from a poorly designed blast or from zones of weakness in the rock. YMC proposes to log blast holes during drilling and report any unusual structures, voids, soft rock, mud seams and ground faults to the blasting supervisor so that special precautions can be taken when loading these holes. This procedure would help to minimize flyrock caused by any of the problematic conditions.

Flyrock would mainly be a hazard to mine personnel and equipment since access to the blasting area is controlled and traffic on Highway 89 and the gravel road through the area would be stopped during blasting. It is unlikely that flyrock would cause any off-site damage or safety hazard.

Blasting operations would also generate a dust and gas plume. This plume would slowly dissipate and may result in increased dust at residences nearest the site. Gases from blasting are primarily carbon monoxide and oxides of nitrogen. An orange tint of the plume would indicate the presence of nitrogen oxides, which is usually the result of inefficient detonation due to wet conditions or weak or degraded explosives.

Effects from Airblast. Air overpressure or airblast is the airborne shock wave from the detonation of explosives. Airblast may or may not be audible, depending on its frequency. The main causes of airblast are the movement of burden (earth) and release of expanding gas into the air. The loudness of the airblast is not an indication of its magnitude.

Airblast is also affected by terrain and by atmospheric conditions such as temperature inversions, overcast conditions, strong winds and other conditions that can focus and intensify the airblast. As noted in the OSM Blasting Guidance Manual, air overpressure is difficult to predict with any level of certainty. Airblast levels from the two test blasts were less than 115 dB, except for a 126-dB level recorded at the Maricopa Microwave Tower some 288 feet from the test blast number one site. Operating blasting conditions would differ from the test blast. Once operations have begun, blasting would usually be conducted with an exposed pit wall and voids, and weakened rock conditions may be encountered. The presence of mud seams, void spaces and weak zones can contribute to airblast through the release of the gas pulse.

YMC proposes to take precautions when loading these areas to prevent excessive airblast. The first damage effects from airblast are broken windows at the nearest residences. The Bureau of Mines research indicates occasional breakage of plate glass can occur at 141dB, while normal size window pane breakage can occasionally occur at 151 dB or slightly higher. These levels are higher than the maximum recorded in the test blasts and the OSM limits and would not be expected to occur from the proposed blasting operations. The Bureau of Mines noted in Bulletin 656 that blasting operations designed to keep vibration less than 2.0 in/sec PPV do not generate the air blast overpressures that are significant factors causing damage to residential structures.

Annoyance Effects. Both vibration and airblast could be expected to cause annoyance to persons near the mine site. Annoyance is very subjective and depends on public perception of the mining operation. It is difficult to define an annoyance level for airblast because a particular event may or may not be audible. Annoyance from air overpressure is completely subjective and can depend on whether or not the event is audible. Levels exceeding 120 dB produce annoyance and fright from rattling of the structure as is the case with sonic booms. Airblast from blasting operations could cause annoyance at the nearest residences to the blast site. An inaudible low frequency airblast less than 120 dB may be perceived, but go largely unnoticed, while a higher frequency (audible) blast of the same magnitude may be annoying. Complaints about vibrations can occur at any level; however, they are unusual below 0.08 in/sec PPV. Complaints can be expected at a PPV of around 0.25. Depending upon the blast location, PPVs could be in this range in Glen Ilah and Yarnell. Therefore, complaints could come from the closest residents to the blasting operations and may come from residents of Glen Ilah and Yarnell as well.

In addition to the vibration and airblast annoyances, traffic delays would likely cause annoyance for people stopped during blasting operations. Northbound and southbound traffic would be stopped approximately 2,000 feet and 1,500 feet, respectively, from the blasting area. People who would be stopped may perceive the vibration and airblast, may hear the warning sirens of the blast and could even be startled or uneasy. The degree of annoyance would likely be subjective, depending on the individual's perception of the operation, the individual's urgency to get to his or her destination and the overall awareness of the situation and process. To reduce the degree of annoyance, YMC narrowed the blasting time period from the "daylight" hours to generally between the 9 am to 6 pm period. More precise blasting schedules for highway closure would be submitted to the ADOT on a weekly basis.

Effects from Falling Rocks and Boulders. Soils with the presence of large surface boulders occur in the area. The maintenance division of the ADOT in Prescott indicated (personal communication, August 9, 1996) that falling rocks are a continual maintenance task along State Highway 89. Rocks are dislodged after nearly every storm and freeze-thaw cycle. On occasion, dislodged rocks have been discovered after high winds. Considering the rock movement from normal weather and erosion, blasting operations could contribute to increased rock movement and resulting hazards.

Blasting operations would be conducted within several hundred feet of State Highway 89. The frequency of falling rock and subsequent hazards could increase by an unknown degree. Impacts from blasting would be short term, and no damage to property would be expected from blasting operations. It is unlikely that potential hazards from dislodged boulders near Glen Ilah residences would increase. However, the potential hazards along State Highway 89 from dislodged rock may increase. Implementation of planned mitigation measures should minimize potential hazards from dislodged boulders.

4.1.14.2 Impact Mitigation

YMC would comply with OSM regulations designed to prevent property damage and safety hazards from blasting operations. In addition, YMC proposes to conduct pre-blast surveys of dwellings and structures within a certain radius of the blasting site. Surveys would be performed to document the condition of the property prior to conducting blasting operations.

YMC would limit airblasts to 129 decibels (dB) (actual limitations vary depending on the frequency of the measuring system). Ground motion would be controlled by the use of millisecond delays to separate the explosives used in a blast into a number of separate detonations. If the interval between delays is at least eight milliseconds, the detonations can be treated separately, and the effects are not cumulative.

The OSM regulations contain formulas known as scaled distance equations and several other methods to control ground motion. The scaled distance formula determines the weight of explosives that can be detonated within any eight-millisecond period based on the distance of a structure from the blast. The scaled distance formula would be used by YMC to control vibration at nearest residences.

YMC proposes measures to ensure public safety, including pre-blast inspections of slope conditions within a certain radius of the proposed blast area. Routine visual inspections would be conducted along the slopes above the highway to document (using 35mm photography) existing slope conditions and to identify any potential safety hazards. The visual inspections would complement existing ADOT inspections, which includes daily driving of State Highway 89 and observing potential rock hazards. In addition, ADOT personnel patrol the highway after every significant storm or every freeze-thaw cycle.

YMC would use a packaged emulsion blasting agent where wet conditions are encountered, which should minimize production of gases such as nitrogen oxides. Additional discussion regarding air quality impacts is presented in the Air Quality Section of this chapter.

Additional mitigation measures could be considered to further reduce the impacts of blasting, including the following.

- YMC could further limit its time window for blasting from the proposed 9 am to 6 pm period. Blasting should be avoided in the more tranquil early morning and late afternoon periods. By confining the blasting period to the higher community activity periods and by informing the public more closely when blasting can be expected, the degree of annoyance may be reduced.
- YMC should not increase the quantity of explosives detonated per eight milliseconds delay above the maximum obtained from the scaled distance formula used in Table 7.2 of the MPO.
- Blasting in certain atmospheric conditions, such as during inversions, overcast (low ceiling) and strong wind periods, can deflect or intensify airblast. Blasting during these conditions should be avoided.
- The use of a "noiseless" detonating cord such as Nonel or burying of conventional detonating cord should occur to reduce airblast and noise.
- Notice of road closures should be made generally available to the local public and the County Sheriff's Office on a weekly basis as they would be to the ADOT. Closure times should be posted on signs along the stretch of highway and made otherwise available to the public. This would allow individuals to plan for closures and reduce annoyance from road closures. A road closure sign should be posted on a flat segment of Highway 89 downhill from the mine. This would alleviate a dangerous condition of heavy trucks parked on a steep grade waiting to proceed to Yarnell.
- The slope monitoring plan proposed by YMC could be enhanced to specifically document means to assess pre-mining slope conditions and boulder placement where a hazard could be created by blasting operations. Hazardous areas could be identified and monitored during operations. If specific hazards were identified, blasting vibration could be controlled near the hazardous areas and potential hazards could be removed or otherwise mitigated.
- YMC should conduct a pre-blast survey of the Yarnell Water Improvement Association water mains in the northwest corner of the MSA. The survey should at a minimum attempt to document the construction methods, location and condition of the water lines.

4.1.14.3 Residual Effects

Effects of airblast, vibration and traffic delays could cause annoyance during the six years of mining.

4.1.15 HAZARDOUS MATERIALS AND CYANIDE MANAGEMENT

4.1.15.1 Direct and Indirect Impacts

Hazardous Materials. Relatively large volumes of hazardous and potentially hazardous chemicals and materials would be transported to and stored within the project area including blasting agents and explosives, solid and liquid sodium cyanide, hydrochloric acid, ammonium nitrate, diesel fuel, gasoline and motor oil. The transport, storage and handling of these materials would represent an ongoing potential for spills that could adversely affect the environment and the safety of the public and project employees.

In addition to the potential for a spill or accident involving a specific hazardous material, some of the chemicals and other materials stored in the project area are incompatible and reactive substances. The MPO states that reactive materials would not be stored near each other. Furthermore, the use of these chemicals at a gold mine is a standard practice and recognized potential hazard, which employee training and proper handling practices would be expected to prevent. It is extremely unlikely that the use of any materials within the project mine and process areas would pose any risk to individuals off site.

There would be a potential for public safety-related impacts due to the transport of hazardous chemicals to the project area via public highways and access roads. Hazardous chemical spillage occurring due to a transport accident is unlikely, but the potential for occurrence cannot be entirely eliminated.

YMC has proposed a number of plans and procedures to reduce the potential effects of spills or accidents.

- project design construction and reclamation,
- site security and safety measures,
- fire protection procedures,
- emergency response and notification procedures,
- best management practices for materials, transportation, handling and storage,
- contingency planning for accidental discharges,
- spill prevention control and countermeasure planning and
- compliance with U.S. Mine Safety and Health Administration (MSHA) and National Institute for Occupational Safety and Health (NIOSH) provisions.

These procedures would be implemented by YMC throughout all phases of the project including reclamation and closure. Therefore, the potential adverse effects resulting from the transportation, storage and handling of hazardous materials is not considered significant.

Potential Hazards from Use of Cyanide in Ore Processing. Cyanide has been used in various processing methods to extract metals from ore for more than 100 years. The technology of using cyanide as part of a heap leach process was refined in the 1970s. Commercial applications of the technology have rapidly grown because it is one of the only economically feasible methods to extract gold and silver from low-grade ore deposits.

Sodium cyanide is a hazardous substance which is toxic to living creatures. Because of its toxicity, there are many concerns related to its use, including:

- its extreme toxicity,
- the transportation of cyanide to the project site,
- the potential hazardous effects to employees during handling and use,
- the possibility of a spill during handling and storage at the mine site,
- the hazards associated with the production of hydrogen cyanide gas (HCN),
- wildlife deaths, particularly of migratory birds, by drinking cyanide process solutions from open ponds,
- spills that could contact surface or groundwater, affecting human drinking water or fish and wildlife and
- the adequacy and enforcement of existing laws and regulations governing mining operations that use cyanide.

Sodium cyanide has a fairly complex chemistry. In heap leach operations, the cyanide solution must be maintained under carefully controlled conditions. Otherwise, the solution begins to decompose, making the solution both less useful for extracting gold and less hazardous.

While cyanide is lethal in large (acute) doses, it does not accumulate in the body as a result of a number of small exposures over time (it has a low chronic toxicity). When cyanide is ingested, highly toxic hydrocyanic acid can form and react with iron in the blood to destroy the blood's ability to carry oxygen to the body. If the dose is strong enough, death could result. If not, the kidneys purge cyanide from the blood and the body recovers.

Although employees at heap leach operations work in proximity to the process solutions, there are no known cases of accident or severe illness directly due to cyanide exposure. This is due to several factors. Cyanide in the process solutions would be of a dilute concentration (less than 500 ppm) and operating conditions are tightly controlled to prevent the formation of HCN gas.

Forms of cyanide include free cyanide, weak to moderately strong aqueous complexes with metals and solid compounds that vary in solubility. In the natural environment, cyanide breaks down to less harmful substances. The main mechanisms of cyanide degradation and attenuation include volatilization, biodegradation complexation, adsorption and oxidation to cyanate (California Mining Association 1992).

Volatilization of cyanide is one of the main attenuation mechanisms in the unsaturated zone (Smith and Mudder 1991). If soils buffer the pH to below about 8.3, volatilization will occur, with the limiting attenuation time factor being the rate at which HCN gas migrates through soils.

Biodegradation occurs mainly under aerobic conditions and depends on the amounts of oxygen, organic matter and cyanide-degrading bacteria available in soils.

Cyanide may also form relatively insoluble precipitates with other metals that are not readily dissolved in water.

The conversion of cyanide to less harmful substances can occur rapidly depending on site-specific characteristics. As such, cyanide breaks down into harmless substances upon exposure to ultraviolet light, minerals and micro-organisms frequently found in soils. Precipitation or other contact with water can also quickly dilute cyanide solutions to non-toxic levels.

Transportation of Hazardous Materials. The following hazardous materials would need to be transported to the mine on a regular basis (delivery frequencies approximate).

- lime (two deliveries per week),
- sodium cyanide (two deliveries per month),
- caustic soda (one delivery per month),
- anti-scaling agent (four deliveries per year) and
- diesel fuel and gasoline (about one and one-half deliveries per week).

All of the shipments would arrive at the mine via truck. Lime would be delivered in bulk and transferred to on-site silos. Sodium cyanide would be delivered in solid briquette form in one of three commercially available containers (stainless steel bins, lined plywood boxes or bulk containers) depending on market availability. Caustic soda and other chemical agents would be delivered in drums. Fuels would be delivered by tanker trucks and off-loaded into on-site storage tanks.

Most of the hazardous materials would be expected to originate in the Phoenix area, with the exception of fuels which may originate more locally. Deliveries from the Phoenix area would likely take one of the following two routes to Yarnell:

- I-10 to I-303 to US 60 to US 93 to SH 89
- I-17 to SH 74 to US 60 to US 93 to SH 89

The probability estimate of a hazardous materials shipment being involved in an accident and releasing material into the environment was calculated using the method developed by Harwood et al. (1990). The methodology is an adaptation of what the authors refer to as "the most widely accepted risk assessment model for identifying preferred routes for hazardous materials transportation." The model referred to is that developed by the Federal Highway Administration and published in *Guidelines for Applying Criteria to Designate Routes for Transporting Hazardous Materials, 1980.*

The calculation takes into consideration current truck accident rates, the probability that an accident will cause a release of hazardous material, the length of the route traveled from the source of the material to the mine and the number of deliveries over the life of the project. Over the six-year life of the mine, the probability estimate of a release of hazardous materials was calculated to be 0.02 for both of the routes. That is, over the life of the mine, 0.02 accidents resulting in a release would be expected to occur.

All of the hazardous materials would be transported by commercial carriers in accordance with Title 49 of the U.S. Code of Federal Regulations and licensed by the Arizona Department of Transportation. Shipping papers must be readily available and contain information describing all materials, associated health risks and procedures for handling spills.

4.1.15.2 Impact Mitigation

As noted above, YMC has incorporated measures into its proposed plans to control potential effects from hazardous materials including cyanide. Reclamation and closure activities include rinsing (neutralization) of the heap leach, reclamation of the solution ponds and disposal (in an approved waste disposal site) of any hazardous wastes. No additional mitigation measures would be required. In addition, ADEQ would process an aquifer protection permit including provisions for groundwater protection. Mitigation measures to reduce the potential effects of cyanide on wildlife are discussed in the Wildlife section of this chapter.

4.1.15.3 Residual Effects

With proper implementation of YMC's plans, residual effects to public and employee health and safety would be negligible. However, the potential for project-related accidents or discharges of hazardous materials cannot be totally eliminated through implementation of these plans.

4.1.16 SOCIOECONOMIC CONDITIONS

Social and economic issues include potential effects to employment, income, property values, local businesses, tourism, tax revenues, crime rates, public services, social structures and quality of life. The magnitude of potential social and economic impacts from implementation of the proposed project is quantified in this analysis wherever possible. In addition, there would be qualitative impacts. For example, effects to existing social structures and to quality of life are highly subjective based on individual and group values, beliefs, goals and expectations; these effects can only be discussed in qualitative terms.

4.1.16.1 Direct and Indirect Impacts

Major factors which would affect the timing and magnitude of socioeconomic impacts from the Yarnell Project include:

- economic and other study area characteristics as discussed in Chapter 3,
- the project hiring schedule (timing and number of employees),
- the existence of a locally available workforce,
- the need for additional workers (and their dependents) to migrate into the area,
- the attitudes and public perceptions of existing residents of the study area,
- the willingness and ability of these residents to adjust to lifestyle disruption and other change and
- perceived and real risks to health or the environment.

Once the above factors are assessed, other effects of the proposed project can be estimated. For example, total project employment and the number of inmigrating workers and families would be the primary determinants of project-related effects to local economic conditions, population, housing needs, community services and infrastructure needs, and fiscal conditions of affected government jurisdictions. Social effects would be primarily determined by the degree of change to existing social structures, lifestyles and quality of life compared to the willingness and ability to adjust to these changes.

Effects to elements of the existing social and economic environments would be considered either adverse or beneficial depending upon individual and/or group values, beliefs and goals. For example, persons who are "anti-project" (based on scoping comments) generally tend to believe that any benefits of the project would be outweighed by adverse changes to the quality of their lives. Persons who support the proposed project would tend to believe that economic benefits (e.g., employment and wages) outweigh adverse effects and/or that the need for mining satisfies a societal need for certain products.

Impact Assessment Approach. Because future economic conditions are unknown, a series of reasonable assumptions must be made to estimate the potential effects of employment on population and other elements of the existing socioeconomic environment. In addition to assuming the level and timing of inmigrating employees and their families, assumptions must be made as to the residency location of local hires (existing residents of the study area) and where the inmigrating workers/families would live. For purposes of this impact analysis, residency areas have been identified as follows.

- Yarnell
- Congress
- Prescott
- Other Yavapai County
- Wickenburg
- Other Maricopa County

Assumptions used in this analysis are summarized in Table 4-18. The projected residency areas reflect, in part, initial information from employment applications received by YMC.

All assumptions used in this impact analysis were generated independently from any YMC data, but the YMC employment applications were used to verify that the potential employment base would include a very broad geographic area (including both Yavapai and Maricopa counties) and that interest of existing residents for this type of work is high. The assumptions are reasonable, given all current information, and are consistent with a wide body of literature and other EISs on mining employment demographics, mining employee willingness to commute, typical multiplier effects for mining projects and other factors. The importance of assumptions in projecting impacts is illustrated in the Assumption Sensitivity Analysis discussion later in this section.

Effects to Employment, Income and the Economy. All mine alternatives would have a measurable short-term effect on employment and income within the study area. Because the effects would be spread out over a fairly large area, no one community would be the recipient of this employment/income effect. Therefore, it is unlikely that there would be a large-scale boom/bust economic cycle associated with the project. However, effects of the relatively high-paying mining jobs within the specific rural portions of the study area (e.g., Yarnell, Congress and other rural areas within Yavapai County) would be significant compared to current conditions. The employment and income benefits of the proposed project would be short-term in duration.

Direct Employment Effects - An important factor affecting social and economic effects is the number, type and schedule of direct project employment. Projected employment requirements and schedule considerations, as proposed by YMC, include:

- facility construction is projected to take three months with YMC acting as the general contractor;
- local subcontractors would be hired as needed on a short-term basis for site preparation, liner installation, crusher installation, process plant construction and buildings;
- peak construction employment would be about 90 workers;

TABLE 4-18
Assumptions Used in Projecting Potential Effects to Employment, Population and Housing

Category	Assumption
Employee Immigration - Construction, Operations and Indirect Workers	20%
Local Hire - Construction, Operations and Indirect Workers	80%
Indirect Employment Multiplier	.45 indirect per 1 direct
Proportion of Immigrating Workers Married:	
Construction	30%
Operations	80%
Indirect	60%
Children per Immigrating Worker:	
Construction	.1
Operations	1.3
Indirect	.5
Percent in School	65%
Residency Area of Local Hired (Construction and Operations):	
Yarnell	10%
Congress	5%
Wickenburg	20%
Prescott	20%
Other Yavapai County	20%
Other Maricopa County	25%
Residency Area for Immigrating Workers (Construction and Operations):	
Yarnell	15%
Congress	5%
Wickenburg	20%
Prescott	20%
Other Yavapai County	20%
Other Maricopa County	20%
Housing Units Needed by Immigrating Employees (Construction, Operations and Indirect)	1 unit per worker

- a team of core management personnel (five to 10 persons) would be recruited from existing company personnel and/or from the mining industry in the western U.S.; and
- although actual employment numbers could vary slightly from projections, current estimated operations phase manpower requirements include:

Mining	33 employees
Crushing	12
Processing	14
Maintenance	15
Engineering	6
Administration	9
TOTAL	89

YMC has committed to hire and train local workers as much as possible. YMC has identified 57 operations phase positions (out of the total projected 89 jobs) which could be filled through company-provided training efforts.

YMC anticipates hiring approximately three professionals for engineering and administrative positions which may require employee inmigration into the study area. It is also possible that some skilled positions may require inmigration of employees.

The majority of workers needed during the construction phase of the project would be employed by contractors retained by YMC. These contractors would be on site during relatively short periods, not to exceed the projected three-month construction period. Some contract personnel would be expected to commute relatively long distances (e.g., from the Phoenix metropolitan area); others would bring campers for short stays in area RV parks or stay in regional apartments or motels.

Estimated direct project-related employment effects are shown in Table 4-19. Even though the project would be near Yarnell, there would be relatively few persons living in Yarnell who would be associated with the project through direct employment. Yavapai County would contribute the majority of workers. Because direct employment would be spread out among a number of residency areas, the number of project workers would constitute a very small percentage of existing employment in all residential areas.

Most direct employees are projected to be local hires (e.g., persons already living in residency areas within the overall study area). This would limit the need for direct employment through worker inmigration. Table 4-20 shows the projected sources and levels of local hires for the project.

Indirect Employment Effects - Growth in basic industries such as construction and mining creates indirect employment opportunities, primarily in the service and retail trade sectors (e.g., in restaurants and retail stores). Because there is easy access to existing major retail centers in urban areas (e.g., Wickenburg, Prescott and northern Phoenix) and because the employment is projected to be spread out among a variety of residential areas, indirect employment effects from the proposed project would not be extensive.

Most mining workers are not expected to remain in the Yarnell area beyond their working hours because of the lack of entertainment facilities in Yarnell. It is possible that Yarnell could see an increase in employment associated with restaurants, taverns, gas stations and other service establishments. However, since most workers would be commuting to the Yarnell area for their work shifts, workers would have other opportunities for fulfilling these needs.

Peak indirect employment (see Table 4-21) is projected to be 44 persons in Project Year 1. Most indirect workers would be existing residents of the study area.

Income Effects - Average income (wages) per new mine operations phase worker would be about $36,000 per year. These wages would be consistent with existing mining and construction wages throughout the western U.S. These wages, however, would be higher than average wages in the study area and would be attractive to many persons seeking higher wages. Total direct operations phase annual income would be more than $3.2 million.

Generally, workers would spend most of their earned wages in their permanent residence community.

TABLE 4-19
Total Direct Employment by Residency Area

	Construction	Operations
Yarnell	11	10
Congress	5	5
Prescott	20	18
Other Yavapai County	20	18
Total Yavapai County	56	51
Wickenburg	20	18
Other Maricopa Communities	24	22
Total Maricopa County	44	40
TOTAL	**100**	**91**

TABLE 4-20
Direct Local Hires by Residency Area

	Construction	Operations
Yarnell	8	7
Congress	4	4
Prescott	16	14
Other Yavapai County	16	14
Total Yavapai County	44	39
Wickenburg	16	14
Other Maricopa Communities	20	18
Total Maricopa County	36	32
TOTAL	**80**	**71**

TABLE 4-21
Total Indirect Employment by Residency Area

	Construction	Operations
Yarnell	2	5
Congress	1	2
Prescott	5	9
Other Yavapai County	5	9
Total Yavapai County	13	25
Wickenburg	5	9
Other Maricopa Communities	5	10
Total Maricopa County	10	19
TOTAL	**23**	**44**

TABLE 4-22
Total Annual Direct and Indirect Income During Operations Phase by Residency Area

	Operations
Yarnell	$435,000
Congress	210,000
Prescott	783,000
Other Yavapai County	783,000
Total Yavapai County	2,211,000
Wickenburg	783,000
Other Maricopa Communities	942,000
Total Maricopa County	1,725,000
TOTAL	**$3,936,000**

These expenditures by workers would generate indirect employment (see discussion above). Assuming an average annual income of $15,000 for indirect workers, total annual income due to direct and indirect employment would be about $3.9 million during the operations phase (see Table 4-22).

Other Economic Effects - The proposed project could affect existing business patterns and the emerging economy in Yarnell concerning tourism and antiques/arts. The sources for these effects could arise from potential conflict with businesses and/or their customers with mining-related effects such as noise, traffic and degradation of visual or air resources. Some visitors could be displaced because of these effects, and some businesses could have to adjust to project-related changes in the local economy in Yarnell. Generally, however, many travelers passing through Yarnell are on their way to other destinations, and most of the businesses in Yarnell are located in areas where the effects of dust and noise would be minimal. It is unlikely that the proposed project would significantly reduce the number of persons traveling on State Highway 89 or reduce their inclination to shop at Yarnell businesses or visit the Shrine of St. Joseph. The ultimate magnitude of any effects cannot be predicted at this time; any effects would occur over a period of years until they became more integrated into the economy.

Permanent or Temporary Closure - At the end of the mining operations, employment would be scaled back as mining is curtailed and final closure and reclamation begin. After project closure, former project employees would either leave or remain in the study area. Social and economic adjustment to closure of the project would occur over a period of years.

The mine could experience temporary shutdowns or periods when operations and, therefore, employment may be cut back. Cyclical production slowdowns are difficult to predict because such events are due to a combination of circumstances including fluctuations in metal prices, labor costs, production costs, profitability of the mining company and effects of national and international political and economic events.

The length of time unemployed workers would be willing to wait for work to continue would be influenced by the availability and terms of unemployment or severance pay, availability of other job opportunities and strength of ties to the community. Noticeable economic and social stresses within the study area could occur during transition periods involving re-hiring of direct and indirect employees and/or hiring of new employees to replace those who may have left the area after being laid off.

Effects to Population. All action alternatives would cause a short-term but small population increase in the study area. Population effects are measured by the number, timing and location of the inmigrating population associated with the proposed project. The new population includes direct employees, indirect employees, spouses and children living with their parents.

Generally, population effects would parallel employment requirements. Population growth would total about 74 persons in the overall study area, as shown in Table 4-23. The population of Yarnell would grow by an estimated 10 persons. This increase would constitute about 1.25 percent of the existing population in Yarnell. Project-related population increases in any residency area would not exceed 1 to 2 percent of the existing population. Population-related effects would not be significant.

Effects on Housing and Property Values. The project would have effects on housing and property values. Potential effects are summarized below.

Housing Needs - All action alternatives would have a short-term effect on housing in the study area. Housing availability and costs would be a major determinant of residency location decisions by inmigrating workers.

Based on the residence location assumptions discussed previously, housing effects would be spread throughout the study area according to where inmigrating workers live. Local hires (existing residents of the study area who would commute to the site from their existing homes) would not require new housing.

Projected housing effects are shown in Table 4-24. Housing needs would generally be met by existing supply in all residency areas, and incremental housing demand effects would not be significant. Any new mobile home park development in unincorporated Yavapai County would have to meet county zoning requirements and be in conformance with U.S. Department of Housing and Urban Development (HUD) standards.

Property Values - Yarnell residents have expressed concern over potential adverse effects to property values because of the presence of the mine. These residents believe that declines in property values could accrue because of direct views of the mining operations and facilities, exposure to noise and other reasons related to the desirability of Yarnell as a residential location.

Another concern is that there will be a limited demand for nearby property at any price. A local realtor, Hill Top Realty, reports that since they "have begun disclosing the possibility of this mining project and recommending that prospective buyers read the mining plan ..., we have lost sales several times and, of course, especially sales of those properties near the mining area" (Hill Top Realty, 1996).

While property and housing sales have still occurred in the Yarnell area since the time that the

TABLE 4-23
Inmigrating Population by Residency Area

	Construction	Operations
Yarnell	5	10
Congress	2	4
Prescott	7	15
Other Yavapai County	7	15
Total Yavapai County	21	44
Wickenburg	7	15
Other Maricopa Communities	8	15
Total Maricopa County	15	30
TOTAL	**36**	**74**

TABLE 4-24
Housing Needs for Inmigrating Population

	Construction	Operations
Yarnell	3	4
Congress	1	1
Prescott	5	5
Other Yavapai County	5	5
Total Yavapai County	14	15
Wickenburg	5	5
Other Maricopa Communities	5	6
Total Maricopa County	10	11
TOTAL	**24**	**26**

mining project was announced by YMC, it is also clear that there is a great deal of uncertainty about property values in the area. Many potential buyers and sellers are waiting to see what happens with the mining project. This uncertainty will likely remain until a decision on the mine is made, and the project either goes forward into development/production or is not developed and all mining-related activities at the site cease.

This uncertainty over property values, however, has not necessarily affected assessed values derived by the County Assessor's office. By state law, assessed values are based on market values and, therefore, represent one indicator of recent and current property values in any specific area. Generally, assessed values in and around Yarnell including Glen Ilah have steadily increased in recent years. The Assessor's office does not typically consider potential adverse effects (e.g., a nearby mining project) on property values until they occur, based on actual sales data (Yavapai County Assessor's Office, 1996).

A preliminary review (Yavapai County Assessor's Office 1997) of property/housing sales in the Glen Ilah area indicated that there were three properties which have been sold and subsequently resold during the 1995-96 period. Both the original sale and subsequent resale of the three properties would have occurred after the Yarnell Project had been formally proposed in the original (1994) MPO submitted by YMC to the BLM. Therefore, this sales data could give some indication of the effect of the proposed mine on property values. In all three cases, the subsequent resale of the property was higher than the original sales price. In another case, a property which sold in May 1994 (before the mine was proposed) was resold at a higher price in February 1996 (after the mine was proposed). Of course, every property is different, and it is clear that the proposed action would affect the marketability and subsequent market value of some property greater than others.

Based upon available relevant literature and evidence collected from the area, several general conclusions can be made about changes in the marketability of property and property values caused by the proposed project.

- There is some evidence that the potential for mining development has already adversely affected the marketability of some existing properties in the immediate vicinity of the mine (e.g., Glen Ilah or other residences with a direct view of the mining site).
- While marketability of some properties has already been affected, there is no indication that a widespread downward trend in property values had occurred by 1996 (based on the limited sales data noted above).
- It is likely that property values in the immediate vicinity of the mine site would tend to decrease during mining operations.
- Affected property values could be expected to increase to some extent as reclamation proceeds and operations cease.
- There is no indication that property outside the immediate vicinity of the mine has already been affected either in marketability or in value.
- There is no indication that property outside the immediate vicinity of the mine would be substantially affected in the future either in marketability or in value.
- If the mine is approved and developed, there appears to be no legal requirement for any compensation to affected landowners or homeowners whose properties decrease in value.

Public Services and Infrastructure. Because most employees are projected to be local hires and any inmigrating population would be spread out among a relatively large study area, public and infrastructure effects from the Yarnell Project are generally not expected to be significant. Since Yarnell, Congress and parts of the other Yavapai County residential areas are unincorporated communities, many identifiable effects on public services would be borne by Yavapai County. Other residential areas such as Prescott, Wickenburg and the northern Phoenix metropolitan area are incorporated cities with sufficient public services such that identifiable effects from the small inmigrating population would be negligible. Therefore, the discussion below is focused on Yavapai County and other special districts in the Yarnell area.

Public Safety - Sheriff's Department concerns associated with the proposed mining project would include increased demand for general police services, traffic flow disruptions and operational concerns including the ability to respond to emergencies which could be affected by the proposed road closures of State Highway 89. It is uncertain if additional Sheriff's personnel would be needed within the Yarnell District based upon the specific potential effects of the mine (Yavapai County Sheriff's Office, 1996).

With the increasing population, traffic and overall level of activity in the Yarnell area, there is the potential for additional crime. Any increase in crime would be dependent on a number of factors, including:

- characteristics of employees, other new residents and transients who move into the area,
- the degree of divisiveness among different segments of the community (see Social and Quality of Life Effects in this section),
- the ability of the County Sheriff's Department to respond to criminal activities and to maintain a strong presence in the area to deter crime (see above) and
- various local and regional economic and social conditions (employment, income, interest rates, etc.) which affect individual and group socioeconomic well-being.

Because of these unknowns, any specific quantitative level of crime increases cannot be projected with any certainty at this time.

The effect of potential road closures on ambulance and sheriff access to Yarnell was also a major issue raised during scoping. If an ambulance from Wickenburg were to be blocked at the road closure point from access to Yarnell, necessary time to attend to life-threatening emergencies could be lost. Furthermore, because Sheriff's deputies could be on either side of the road closure at any specific time, access for the deputy to the other side of the closure point could be affected (see Sections 4.1.12 and 4.1.14 for additional discussion of the road closure effects).

The Yarnell Project would be within the Yarnell Fire District. YMC would have a water pump truck on site available for fire control and train its employees in basic fire control operations through federal MSHA requirements. However, in extreme situations, the mine would need to call upon the Fire Department for assistance. Additional indirect fire calls are also possible because of the slightly increased population in the Yarnell area and the potential for traffic accidents or other emergencies.

Water Supply - The effects of groundwater pumping on local water users is discussed in Section 4.1.4.4.

Sewage Disposal - Much of the rural portion of the study area relies on septic systems for sewage disposal, while the major urban centers have central community sewage disposal systems. Because of the existing capacity and relatively small population inmigrating into the large study area, there should be minimal effects of the project on sewage disposal.

Solid Waste - Because of the relatively small project-related inmigration into a large study area, population-related solid waste effects should be minimal. YMC has stated that it plans to have a local solid waste collection contractor handle any solid wastes generated at the mine site. This contractor would be required to dispose of YMC's solid wastes at an approved facility (either a transfer station or at an approved, permitted landfill). Effects would not be significant.

Other Public Utilities - All growth-related impacts from the proposed project to the supply of natural gas, electricity and telephone service could be accommodated by the existing systems in all affected areas. Effects would not be significant.

Health Care and Social Services - Health care facilities and personnel are expected to be adequate to accommodate population growth related to the proposed project. Major health services for Yarnell and other rural Yavapai County areas are provided by hospitals in Wickenburg, the northern Phoenix metropolitan area and Prescott.

Educational Facilities - Based on the assumptions provided in Table 4-21, the estimated number of inmigrating school-age children associated with the proposed project is shown in Table 4-25. The estimated 20 total new students during the project operations phase would be spread out into the various residency areas in which their parents live. Affected school districts would generally have adequate personnel and physical capacity for the projected new school-age children, although the Yarnell elementary school would be nearing its capacity.

State and Local Government Fiscal Effects. Effects from the Yarnell Project would not require extensive new government programs or the construction of new infrastructure. However, annual operating costs for affected governmental units may increase through additions of personnel or equipment to serve the growing population.

Table 4-26 and the following summarize potential impacts of the Yarnell Project on government finances.

- Based on its expected rate of gold production, current gold prices and existing Arizona tax rates, it is expected that YMC would pay about $130,000 per year in severance taxes to the state of Arizona. Part of this annual severance tax payment would be retained by the state, but part would be distributed to county and municipal governments, as well as school districts throughout the state, including those in Yavapai County.
- It is estimated that the Yarnell Project would result in property taxes of approximately $460,000 per year to Yavapai County (as collectors) for the county itself, the state of Arizona, the Yarnell Elementary School District, the school equalization program, Yavapai Community College, Yarnell Fire District and other relevant taxing jurisdictions which are allowed to collect property taxes. This payment amount would gradually decline due to depreciation of assets and reduction of the mineral value associated with the land as the gold is mined from the deposit. The actual amounts of future property tax payments would depend primarily on the tax rates for each jurisdiction and the central valuation of the project developed by the state Division of Property Valuation and Equalization.
- Corporate income taxes payable to the federal government and state of Arizona would depend on the profitability of the project. Most of any state corporate taxes paid by YMC would be retained by the state, but a portion would be distributed to Arizona's incorporated cities and towns under the state's Urban Revenue Sharing Program.

TABLE 4-25
Inmigrating School Children by Residency Area

	Construction	Operations
Yarnell	0	3
Congress	0	1
Prescott	1	4
Other Yavapai County	1	4
Total Yavapai County	2	12
Wickenburg	1	4
Other Maricopa Communities	1	4
Total Maricopa County	2	8
TOTAL	**4**	**20**

Table 4-26
Categories of Potential Economic Effects on Government Finances

Category	Potential Economic Effect
Extraction of mineral resource	Increased severance taxes
YMC facilities and operations	Increased property taxes
Employee and indirect residential and business development	Increased property taxes
YMC corporate profits	Increased corporate income taxes
Direct and indirect wages	Increased income and other employment taxes
YMC purchases	Increased sales taxes
Employee and indirect purchases	Increased sales taxes
Government expenditures for increased demand for services and infrastructure	Increased expenditures

- Many of the products and supplies purchased by YMC for the proposed project would be subject to the state sales tax. Total annual supply costs for the project are estimated by YMC to be about $3.6 million.
- With the estimated increase in population and school-age children, there would be increases in government service and facility demands requiring county, school district and special district expenditures. The most direct effects from the project, which would occur within the immediate Yarnell/Glen Ilah area, would be offset with the property tax payments noted above. Other residency areas would receive only negligible increased revenue directly due to project implementation, but incremental expenditures would also be negligible because of the relatively small number of persons projected to migrate into each residency area.
- Operation and maintenance costs for school districts throughout Arizona are equalized by the state on a per student basis. Capital costs have historically been funded solely by the school district property tax, although a recent Arizona

Supreme Court decision ruled that capital fund inequities need to be rectified so that bonding capacities for school districts throughout the state are equalized. Because of the relatively small number of new students within any given school district including the Yarnell Elementary School District, no capital expenditures due to the project are projected. Any school district operation/maintenance costs due to the project-related inmigration should be covered through school district property taxes and the school equalization program.

Overall, because the population inmigration and associated public service/infrastructure needs associated with the proposed project are not extensive, the fiscal burden of the project on affected jurisdictions would not be significant.

Social and Quality of Life Effects. Social benefits and costs are generally perceived differently by different people. The magnitude and extent of social effects are determined by many factors, primarily 1) the influence of individual and/or group values, goals and beliefs and 2) the willingness and/or ability of a person or group to adapt to changes in their social environment and associated quality of life. Social effects would result from project-related direct and indirect effects such as noise and traffic, perceived deviant behavior associated with newcomers in the community, forced changes in regular patterns of behavior and lifestyle and changes in perceived physical health and psychological well-being.

Effects are very subjective and individualist in nature, and there are no readily available units of measure to use in estimating potential effects to one's social environment and quality of life. Therefore, much of the discussion is qualitative rather than quantitative, and emphasis in this analysis is on disclosure of the potential range of effects which could accrue to various persons.

The project-related changes would be similar for all mine alternatives. Social structures, social character and quality of life in the Yarnell area would experience both short-term and long-term effects from project implementation. Whether the effects would be considered beneficial, adverse, or both, depends on individual and group values, beliefs and goals. Other residential areas would not experience the high degree of effect experienced by Yarnell residents. Further discussions by residential area are presented below.

Yarnell Residential Area - A variety of concerns or perceived negative effects from mine development were expressed by Yarnell residents during the public scoping. Public concerns with a direct link to social structures include exposure to outsiders with different behaviors and characteristics, a perceived increase in the potential for criminal behavior associated with these outsiders, unwanted social influences from miners and unwanted economic effects such as declines in property values. Influences which could adversely affect quality of life include noise and blasting, degradation of visual resources and air quality, anxiety about exposure to cyanide and road closures due to blasting.

Based on these concerns, there is substantial opposition to the proposed mine from current residents of Yarnell. An "anti-mine" faction has already developed, as evidenced by the placement of numerous "stop the mine" signs and scoping comments. These opponents of the mine generally feel that project-related opportunities for profit or positive change would be outweighed by the negative changes in lifestyle and quality of life discussed above. If mining occurs, project opponents would feel frustrated because they had been unable to control factors affecting their lifestyle and quality of life. They would feel the project was forced on them by outsiders with no real stake in the community. Additionally, feelings of alienation and a breakdown of community integration could occur for these individuals.

A less vocal "pro-mine" faction of the Yarnell community has also developed. This is evidenced by a "start the mine" sign showing signatures of those who support mine development. Yarnell residents who favor development of the proposed mine would generally believe that the opportunity for economic benefit (e.g., employment, wages and business opportunities for profit) and/or the societal need for mining gold outweighs any perceived negative changes to social structures and quality of life. Project proponents may feel cheated by losing out on these economic opportunities if the mine were not developed.

Inmigration of project workers to the Yarnell area could result in a high degree of conflict between newcomers and existing residents. This is because of the strong likelihood that the existing controversy (e.g., as evidenced by the presence of the "anti-mine" and "pro-mine" factions in the community) over the mine would continue as the mine begins operations. Inmigrants associated with the mine would generally not be welcomed into the community by the persons in the "anti-mine" faction, and social structures could center on "pro-mine" and "anti-mine" issues and groups. If the mine is developed, it is likely that some portion of the existing population would leave the Yarnell area with animosity toward the mining company and its personnel.

Congress Residential Area - While the Congress residential area is about the same size as Yarnell, the residents of Congress might be more receptive to the presence of mining workers because of the long and more recent history of mining in the area. The lack of an organized "anti-mine" group in Congress also might make mining-related inmigrants more comfortable compared to Yarnell. Social structures and quality of life for residents of Congress would not be greatly affected by the presence of the mine or by the presence of mining-related personnel in the community.

Residents of the North Ranch area south of Congress, including the Escapees travel club/retirement community, would not be directly affected to any great degree by the operation. However, some residents of this area may continue to express concern about potential environmental effects of the operation on their air, water and quality of life.

Wickenburg Residential Area - Based on scoping comments, there is evidence of some opposition to the mine by residents of the Wickenburg area. However, most residents would not be directly affected by the presence of the mine in Yarnell and would, therefore, not be expected to have strong emotions to either support or oppose the mine. Wickenburg, as a larger city with a more diverse economy than either Yarnell or Congress, would offer more housing and other infrastructure to potential mining-related inmigrants. Social structures would also be more diverse; mine employees (whether they be inmigrants or local hires) would not substantially affect or be affected by social structures in the Wickenburg area.

Prescott Residential Area - Prescott has developed into a major regional center fueled primarily by economic growth in tourism and services. With recent population growth, there is an abundance of skilled construction workers and other tradesmen in the Prescott area who would be candidates for employment at the mine in Yarnell. The economy and social structures in the Prescott area are sufficiently diverse so that mine employees would not create substantial conflict with existing residents. Because most residents of the Prescott area would not be directly affected by the presence of the mine, quality of life for the vast majority of these residents would generally not be affected by mine development.

Other Yavapai and Maricopa County Residential Areas - In addition to the Yarnell, Congress, Wickenburg and Prescott residential areas, a number of other communities could serve as a residency area for project workers within both Yavapai and Maricopa counties. Since access to the proposed mine site in Yarnell is relatively easy through the existing highway system and because many persons would be attracted by the relatively high wages associated with the project, commuting distances of more than 100 miles would not be prohibitive.

YMC had received employment inquiries by mid-1996 from persons living in Yavapai County communities such as Peeples Valley, Hillside and Bagdad in addition to Yarnell, Congress and Prescott. Because of the association and proximity between Yarnell and Peeples Valley, social structures could be somewhat affected by the presence of project-related workers in Peeples Valley. Other Yavapai County communities are far enough from the project-related controversy that social structures and quality of life in these places would generally not be measurably affected by the presence of mining workers.

Assumption Sensitivity Analysis. The results of the impact analysis described in the previous sections (termed the base case analysis in this discussion) are dependent upon a number of assumptions (shown previously in Table 4-18). If assumptions used in the analysis do not occur, the effects of the Yarnell Project would be different than those projected in the base case analysis. To show how assumptions affect the estimates of employment, population inmigration and other socioeconomic variables, an alternative case was developed.

This alternative case consists of changes in the assumptions used in two important areas - the local (existing resident) hiring rate and the indirect employment effects from the new project-related jobs. While the base case projection of 80 percent local hiring for project-related workers is reasonable given current information, there are many external factors which could lessen the actual local hiring rate. There is also some uncertainty as to the proper indirect employment multiplier.

A review of 10 recent socioeconomic analyses within EISs for proposed mining projects in eight states (both rural and non-rural settings) used indirect multipliers for the mining operations phase ranging from 0.4 to 0.76 indirect workers for every one direct worker. Other applicable economic relationships were reviewed for non-mining projects in Arizona, and similar assumptions have been used for non-mining projects. For the Yarnell Project base case analysis, a multiplier of 0.45 was used. While this assumption seems reasonable given all available information and recent experience, a higher multiplier would lead to more indirect employment and more population inmigration. Consideration of a higher multiplier will help account for the uncertainty of ultimate economic effects.

The two specific assumption changes in the alternative case analysis include:

- the local (existing resident) hiring rate for operations workers is reduced from 80 percent in the base case to 50 percent in the alternative case and
- the indirect employment effects of basic Yarnell Project operations employment is increased from 0.45 indirect workers per new job to 0.9 indirect workers per job.

All other assumptions and data used in the base case are used in this alternative case analysis.

Population effects of the analysis are presented in Table 4-27. With these assumption changes, the peak cumulative population increase in the study area due to the Yarnell Project would be 89 persons during the construction phase compared to 36 persons in the base case, with an increase of 174 persons during the operations phase compared to 74 persons in the base case. As with the base case, this inmigrating population would likely be spread among communities and rural areas in both Yavapai and Maricopa counties.

The most important population increase in this alternative case would be in Yarnell, with an increase from 10 persons inmigrating during operations in the base case to an estimated 25 persons in the alternative case. While this is not a large number of persons relative to the entire study area, 25 additional mining-related persons in Yarnell (requiring an estimated nine housing units) would pose both economic and social disruptions to the existing conditions in Yarnell. In addition to the specific potential for these population effects associated with the alternative case scenario, there would be slightly higher effects compared to the base case in areas such as indirect income, housing demand and demand for community services.

TABLE 4-27
Inmigrating Population by Residency Area
Base Case Compared to Alternative Case

	Base Case		Alternative Case	
	Construction	Operations	Construction	Operations
Yarnell	5	10	13	25
Congress	2	4	4	9
Prescott	7	15	18	35
Other Yavapai County	7	15	18	35
Total Yavapai County	21	44	53	104
Wickenburg	7	15	18	35
Other Maricopa Communities	8	15	18	35
Total Maricopa County	15	30	36	70
TOTAL	**36**	**74**	**89**	**174**

From the comparisons between the base case and alternative case, the importance of local hiring and indirect project effects can clearly be seen. Monitoring of employment, population and income data would be necessary to determine the actual location, magnitude and duration of impacts.

4.1.16.2 Impact Mitigation

No regulatory standards apply to the mitigation of socioeconomic impacts, and no specific mitigation measures are proposed.

4.1.16.3 Residual Effects

Residual effects on the socioeconomic environment are discussed in the sections above. The most prominent effect may be a decline in some existing residents' quality of life (especially in the Glen Ilah area) due to visual effects, noise, lifestyle disruptions and potential property value declines.

In the long-term, after the completion of mining and reclamation, the effects of noise, dust and traffic disruptions would cease and property values would be expected to stabilize. However, visual impacts and anxiety about remaining environmental impacts could continue to affect the quality of life.

4.1.17 ENVIRONMENTAL JUSTICE

The proposed action and alternatives were evaluated for issues relating to the social and economic well-being and health of minorities and low income groups. Such issues are termed environmental justice issues (see Section 3.10.8).

An Environmental Compliance Memorandum (Department of the Interior, 1995) addresses the issue of defining disproportionate effects on minority or low-income communities or groups. According to this guidance, disproportionately high and adverse environmental or human health effects would occur if there would be significant impacts affecting such a population, or if risks or effects to such populations would appreciably exceed those on the general population or other appropriate comparison group.

4.1.17.1 Direct and Indirect Impacts

The Yarnell area's overall poverty rate of 18.4 percent is relatively consistent with the statewide level, and there is no evidence of any specific low income or minority population near the proposed mine site which would incur the specific identifiable effects disclosed in this EIS. The closest residences would be most affected, but these are not exclusively low income or minority households. Many persons in the area, most notably in Glen Ilah, would be affected by the project, but no minority or low income group would receive a disproportionately higher level of effect than any other persons in the general population of the area.

The nearest Native American tribe to the proposed mine site is the Yavapai-Prescott Indian Tribe, approximately 30 miles away at Prescott. No migrant worker communities or activities are near the proposed mine.

4.1.17.2 Impact Mitigation

There would be no mitigation measures required.

4.1.17.3 Residual Effects

There would be no residual effects.

4.2 ALTERNATIVE 1 -- NO ACTION ALTERNATIVE

Implementation of the Yarnell Project as proposed by YMC would result in a variety of environmental impacts as described in this EIS. Under Alternative 1, the no action alternative, the BLM would not approve the proposed mining operation. This alternative would eliminate those impacts which the proposed operation would generate. A summary of the effects associated with the no action alternative is presented below. The BLM can implement the no action alternative only if the proposed operation (with mitigation) would result in unnecessary or undue degradation of federal land.

While the no action alternative would prohibit the mining operation as proposed by YMC (e.g., involving federal land managed by the BLM), mining could still theoretically occur under some circumstances on private and state land only. The potential for mine development not requiring BLM approval and the adequacy of the environmental regulatory framework to protect the public interest with mining on private land is discussed below in Section 4.2.13.

4.2.1 GEOLOGY AND MINERAL RESOURCES

If the no action alternative were to be implemented, the orebody would remain in the ground. Exploration on and around the site would probably continue to some extent. Interest in the mineral resource may continue, and plans for a similar operation could be submitted in the future. A plan to mine the resources involving only private land could also be developed (see Section 4.2.13). Existing topography would not be modified by development of the open pit, waste rock dumps and heap leach facility as proposed in the MPO.

4.2.2 SOILS

Selection of the no action alternative would mean the site would remain in its present condition. The impacts to soils resources as a result of the proposed action would not occur. The present erosion rate would continue; the current erosion rate is elevated over natural conditions due to the present disturbance on site.

4.2.3 WATER RESOURCES

Under the no action alternative, the impacts to water resources described from development of the proposed project would not occur. The development of the water supply system proposed in the MPO would not take place. Well TW-01 on federal land would be plugged and reclaimed or assigned to the BLM for stockwatering and wildlife purposes.

4.2.4 VEGETATION

If the no action alternative is implemented, no vegetative cover would be disturbed as described in the MPO, and the proposed operation site would remain in its present condition.

4.2.5 WILDLIFE

Selection of the no action alternative would leave the proposed operational site in its present condition. Wildlife habitat would remain as it is, and no additional impacts to wildlife would occur. If YMC dropped its interest in the Yarnell property, the company would be required to reclaim any disturbance from its exploration activities, thereby benefitting the quality of the land as wildlife habitat over the current situation.

4.2.6 AIR RESOURCES

Under this alternative, the air quality would remain essentially the same as it is now. Concentrations of all regulated pollutants would remain at their present levels. Additional emissions from the proposed Yarnell Project would not occur.

4.2.7 LAND USE

Under the no action alternative, the impact to existing land uses of open space, grazing and wildlife habitat would not occur. Current land uses are compatible with BLM and county management plans; therefore, reclassification of land uses would not be necessary. The land use conflict between mining and residential land uses also would not occur.

4.2.8 VISUAL RESOURCES

The no action alternative would leave the site as it exists, and the proposed operational facilities would not be developed. No additional visual impacts would occur. After reclamation of disturbed land from YMC's exploration activities, the visual impacts caused by existing scars from historic mining disturbances, roads, adits and drill sites would remain present at the site.

4.2.9 CULTURAL RESOURCES

The no action alternative would eliminate any impact of the proposed action to the identified cultural resources in the area. Deterioration of these sites would continue from exposure to weather and other natural elements. Alteration or destruction of sites could result from continued exploration and by the actions of recreationalists.

4.2.10 TRANSPORTATION

The no action alternative would not alter existing conditions associated with highways and roads. Potential access effects to and from Yarnell/Glen Ilah from proposed road closures on State Highway 89 would not occur, and emergency access would remain as it currently exists.

4.2.11 NOISE

Increased project-related noise in the vicinity of the mine site would not occur if the proposed operation was not implemented.

4.2.12 SOCIOECONOMICS

The no action alternative would postpone or eliminate the effects associated with employment, income and local government revenues stemming from the proposed action. While growth and development in the region would continue with or without the proposed Yarnell Project, the perceived significant adverse effects on quality of life and lifestyle for persons in the immediate vicinity of the mine site (e.g., Glen Ilah) would not occur.

4.2.13 POTENTIAL FOR MINE DEVELOPMENT NOT REQUIRING BLM APPROVAL

YMC is proposing to develop its patented mining claims at the proposed Yarnell Project site through the MPO review and approval process. Because federal land managed by the BLM would be involved in the project as proposed by YMC, the BLM is responsible for federal review and authorization of the MPO. The BLM's roles in reviewing and approving the MPO include environmental analysis under NEPA and 43 CFR 3809 "Surface Management" regulations as discussed in Chapter 1 of this EIS.

However, YMC or another firm could conduct mining operations in the future at the proposed site through use of private and possibly state land only. Under the no action alternative, YMC or another firm would not be prohibited from obtaining approval and developing a revised project on non-federal land. As such, the no action alternative would not prohibit mining in the Yarnell Project area and the resulting impacts. If YMC were able to use private land for its mining and processing operations, BLM approval of an MPO would not be necessary.

According to U.S. law, an alternative to mine development under an MPO (requiring BLM approval) provides that claim holders on public land may submit a patent application to the BLM to acquire title to land for which they hold mineral claims or may complete a land exchange. However, at this time, a moratorium is in effect by the federal government, and patent applications can be submitted only when, and if, the moratorium is lifted. Upon completion of the patent (if the moratorium is lifted) or land exchange, the land would be privately owned, and the owners could proceed with their mine plans without BLM authorization. In addition to the land patenting and/or land exchange possibility, much of the land proposed for development at the Yarnell Project site is already privately owned. In theory, YMC or any other party with mineral rights on private land could arrange for an alternative facility location plan which would not use BLM-managed land, thereby excluding the BLM from the review/approval process. While the likelihood of either of these possibilities cannot be known at this time, the BLM must consider this possibility under the no action alternative.

It is a misconception that loss of BLM administration and public ownership of the affected land means complete loss of federal and/or state jurisdiction for mining or mining-related activities such as pipeline construction. Whether mining activities occur on public or private land (or a combination of both), YMC would have to acquire a number of federal and state authorizations to implement foreseeable mining uses. Furthermore, many of these permits (such as the Title V air quality permit and the Aquifer Protection Program permit) and the Arizona state reclamation rules provide for public notification and review prior to issuance of these permits. They also require review and re-authorization for any proposed major modifications of the mine activities for which a permit has been issued.

As part of the oversight responsibilities for mining on public land, the BLM requires that federal reclamation requirements be addressed in the MPO and that adequate bonding or financial assurance is provided by the proponent to ensure that post-closure reclamation can be completed as proposed. While the BLM would no longer provide federal oversight of reclamation in situations involving only private land, a mine on private land would still be subject to state reclamation requirements through the recently passed Arizona Mined Land Reclamation Rules, which became effective on July 20, 1996, and were revised in January 1997.

4.3 ALTERNATIVE 2 — ELIMINATION OF THE SOUTH WASTE ROCK DUMP AND PLACEMENT OF ALL WASTE ROCK INTO THE NORTH WASTE ROCK DUMP

As discussed in Chapter 2 of this EIS and shown in Figure 2-2, YMC has proposed placement of waste rock within two permanent waste rock dump sites, termed the SWRD and the NWRD. Analysis of alternatives to the proposed action has identified a feasible alternative which would eliminate the SWRD site and subsequent placement of all waste rock into the NWRD. This alternative to the proposed action is analyzed as Alternative 2 in this section. Other portions of the Yarnell Project operation and associated impacts would remain the same as those proposed by YMC under this alternative.

Alternative 2 would have slightly different effects than the proposed action. Effects on those elements of the human environment which would be different than those of the proposed action are identified below. All other effects would remain essentially the same as under the proposed action. Effects on resource areas such as geology, land use (slightly different configuration of affected lands) and socioeconomics would generally be the same as the proposed action; therefore they are not discussed below.

Expansion of the NWRD site would result in a net decrease in disturbed area within the MSA of about 20 acres. The expansion would cover the delineated wetland downstream of the dump and require reconstruction of Yarnell Creek and re-establishment of the wetland.

4.3.1 OPERATIONAL EFFECTS

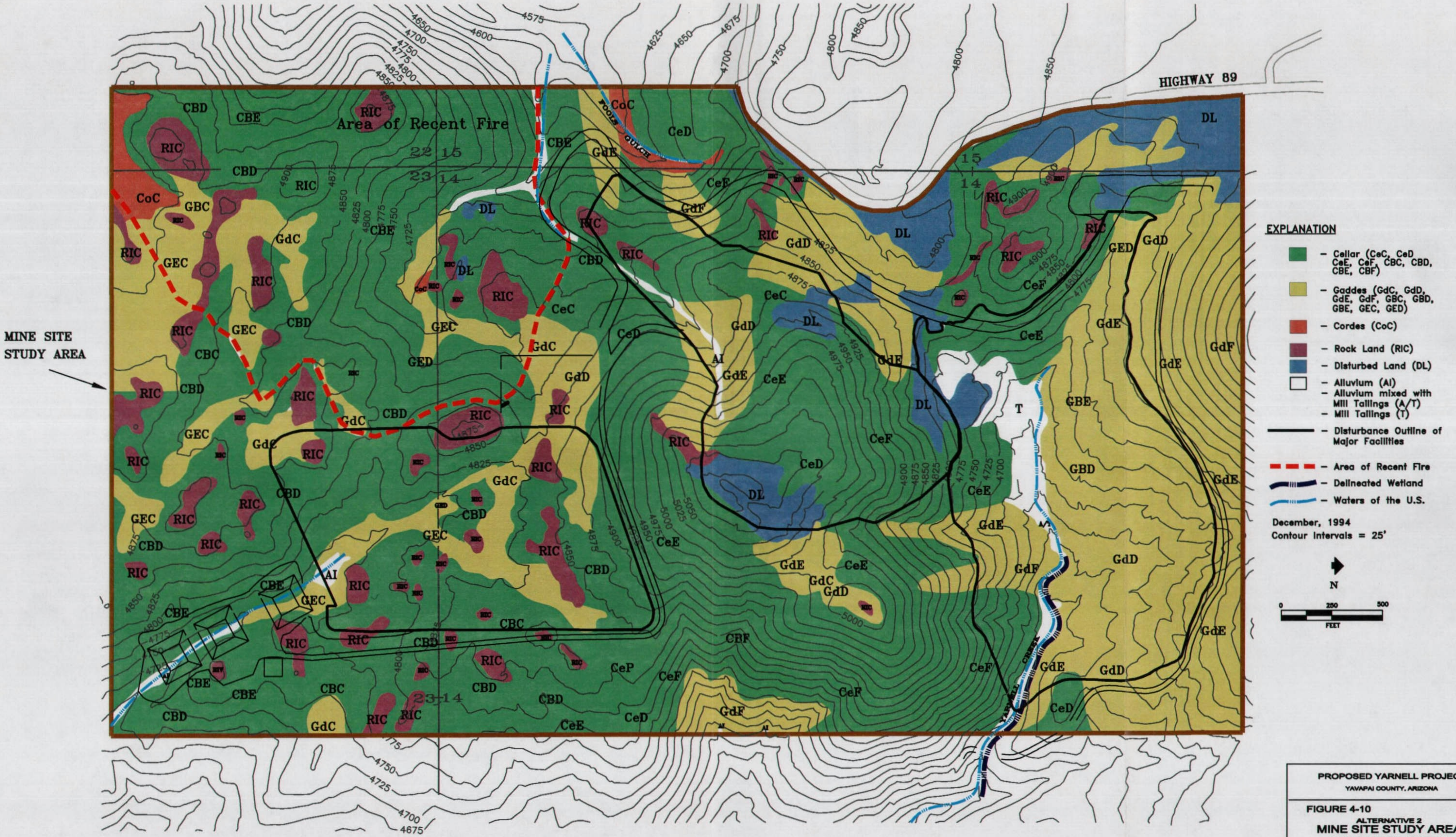
The expanded NWRD would be end-dumped in a single lift of 250 to 300 feet. The potential for slides and rolling rocks at the waste rock dump site during operations would be increased with this alternative. The reclaimed slope of the dump would be approximately 600 feet long, increasing the potential for erosion and stability problems. Since the height of the NWRD would remain the same in the area where it would cover the existing tailings, no stability problems from placement on the tailings would be expected. Construction of the diversion system and siltation ponds for the SWRD would be eliminated. Project costs are estimated to be about 16.4 percent higher compared to the proposed action under Alternative 2. Activities would be conducted closer to Glen Ilah for a longer time.

4.3.2 TOPOGRAPHY

The elevation of the top of the expanded NWRD would remain the same, but the height would increase about 100 feet because it expands downstream. The existing depressions and saddles where the SWRD would have been constructed would not be replaced by a mound with long, steep side slopes. While this would permanently alter topography in the area in a slightly different manner than the effects of the proposed action, effects would not be considered significant.

4.3.3 SOILS

Under this alternative, there would be about 127 acres disturbed in the MSA, as shown on Figure 4-10, compared to 147 acres under the proposed action, and 48 acres would be converted to 2:1 slopes or steeper (about the same as under the proposed action).



PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE 4-10
ALTERNATIVE 2
MINE SITE STUDY AREA
DISTURBED AREAS
SOIL TYPES MAP

Alternative 2 would also result in the loss of 1,200 linear feet of the Yarnell Creek drainage and the linear strip of hydric soils associated with wetlands along a 1,200-foot section of this stream. However, this alternative would increase the salvageable topsoil by 30,000 cubic yards compared to the proposed action because the north part of the MSA contains a thicker layer of salvageable topsoil than other parts of the project area. This would provide additional topsoil that could be used in reclamation.

4.3.4 WATER RESOURCES

The impacts to water resources would be the same as for the proposed action, described in Section 4.1.4, except for the following.

- The surface water and groundwater quantity and quality in Fools Gulch would not be affected by the SWRD. This is because Alternative 2 eliminates the SWRD, which would be at the headwaters of Fools Gulch.
- Increased erosion may occur temporarily in Yarnell Creek during reconstruction of 1,200 feet of the Yarnell Creek drainage as a result of construction activities associated with the expanded NWRD. About 800 feet of the Yarnell Creek wetland would be buried by the NWRD and additional wetland damaged by construction of the sediment retention structure and other activities. Cottonwood Spring would be covered by the expanded NWRD. Pumping of YMC-04 and pit dewatering would lower water levels and reduce or eliminate flow at Cottonwood Spring as discussed in Section 4.1.4.3. After pumping ceased, water would recover to near premining levels within about two years. The large boulders at the base of the NWRD would perform similar to a rock drain, and the flow from Cottonwood Spring may reappear at the toe of the NWRD. Any flow from the spring would be captured in the sediment retention structure and seep into bedrock along with any other surface water contained by the structure. The expanded NWRD would permanently fill an additional 900 feet of jurisdictional waters of the U.S. (1,800 feet total), regulated by the U.S. Army Corps of Engineers (COE). A comprehensive wetland mitigation plan would have to be approved for the COE to issue a 404 permit to the Yarnell Mine. This mitigation plan could require the Yarnell Mine to create a new wetland to replace the one that would be destroyed.

4.3.5 VEGETATION

Alternative 2 would have overall effects on vegetation similar to those under the proposed action, but would disturb about 20 less acres. However, this alternative would result in a 0.1-acre impact to a high quality wetland and relocation of a 1,200-foot section of Yarnell Creek, as shown on Figure 4-11.

4.3.6 WILDLIFE

The total wildlife habitat disturbed by mining would be reduced approximately 20 acres under this alternative. The incremental disturbance associated with Alternative 2 would primarily affect oak shrubland habitat. The habitat that would not be affected in the eliminated SWRD is also an oak shrubland, one that burned in the late 1980s.

As noted above, Cottonwood Spring, a 0.1-acre wetland area, and a 1,200 foot reach of Yarnell Creek would also be lost under Alternative 2. While limited in size, this reach ofYarnell Creek and its associated wetlands represents a high value wildlife habitat. Lowland leopard frogs occur at this spring, and potential, but apparently unoccupied, habitat for Arizona Southwestern toads occurs downstream of the NWRD site in Antelope Creek. Unless frogs are relocated downstream, they would be killed during waste dump development. Unless long-term stability and erosion concerns associated with the steep slopes (50 percent) of the dump are resolved, sedimentation could adversely affect future habitat suitability for these and other aquatic/riparian wildlife downstream.

As a net effect of this alternative, a smaller acreage of wildlife habitat is affected, but the habitats affected are of higher value to wildlife, principally as a seasonal water source for the overall wildlife community and as habitat for the relatively rare lowland leopard frog. Because flow from Cottonwood Spring may reappear near the toe of the expanded NWRD, it is likely that seasonal water in Yarnell Creek below the rock dump would continue to be available during and following reclamation. Furthermore, because the affected wetlands would be replaced, the adverse effects to wildlife would not be significant in the long term.

4.3.7 AIR RESOURCES

The reduction in particulate emissions caused by the smaller overall surface area used for waste rock disposal and the elimination of combustion emissions associated with the (eliminated) SWRD associated with Alternative 2 would be offset by likely increases in particulate and combustion emissions. This would be due to the required relocation of 4,000 feet of the active Mina Road and the construction, modification and maintenance of ancillary support structures such as sediment control and diversion structures. Emissions associated with material handling and hauling would probably decrease slightly due to the overall reduction in haul road distance for the consolidated NWRD compared to haul distances associated with both dump sites in the proposed action. Overall, total air quality impacts associated with this alternative would be similar to or slightly less than those predicted for the proposed action. All regulatory thresholds and limits would still have to be met, and effects would not be considered significant.

4.3.8 VISUAL RESOURCES

In comparison to the proposed action, this alternative would adversely affect the view most dramatically from KOP-5. Viewers at this KOP would see the expanded NWRD, which would extend down the canyon to the left of the view and cross Mina Road. The NWRD would be about 100 feet higher (although the top elevation remains the same) compared to the KOP-5 simulation for the proposed action. Viewers at KOPs 2, 6 and 7 would have a slightly improved view compared to the proposed action because these viewers would not see the (eliminated) SWRD. The overall visual impact from Alternative 2 is slightly less than the proposed action, since the SWRD visible from State Highway 89 would be eliminated. However, the pit would still be the predominant feature contrasting with existing visual resources and effects would remain significant.

4.3.9 CULTURAL RESOURCES

Consolidation of waste rock disposal to the NWRD would not disturb the Biedler mine site and would

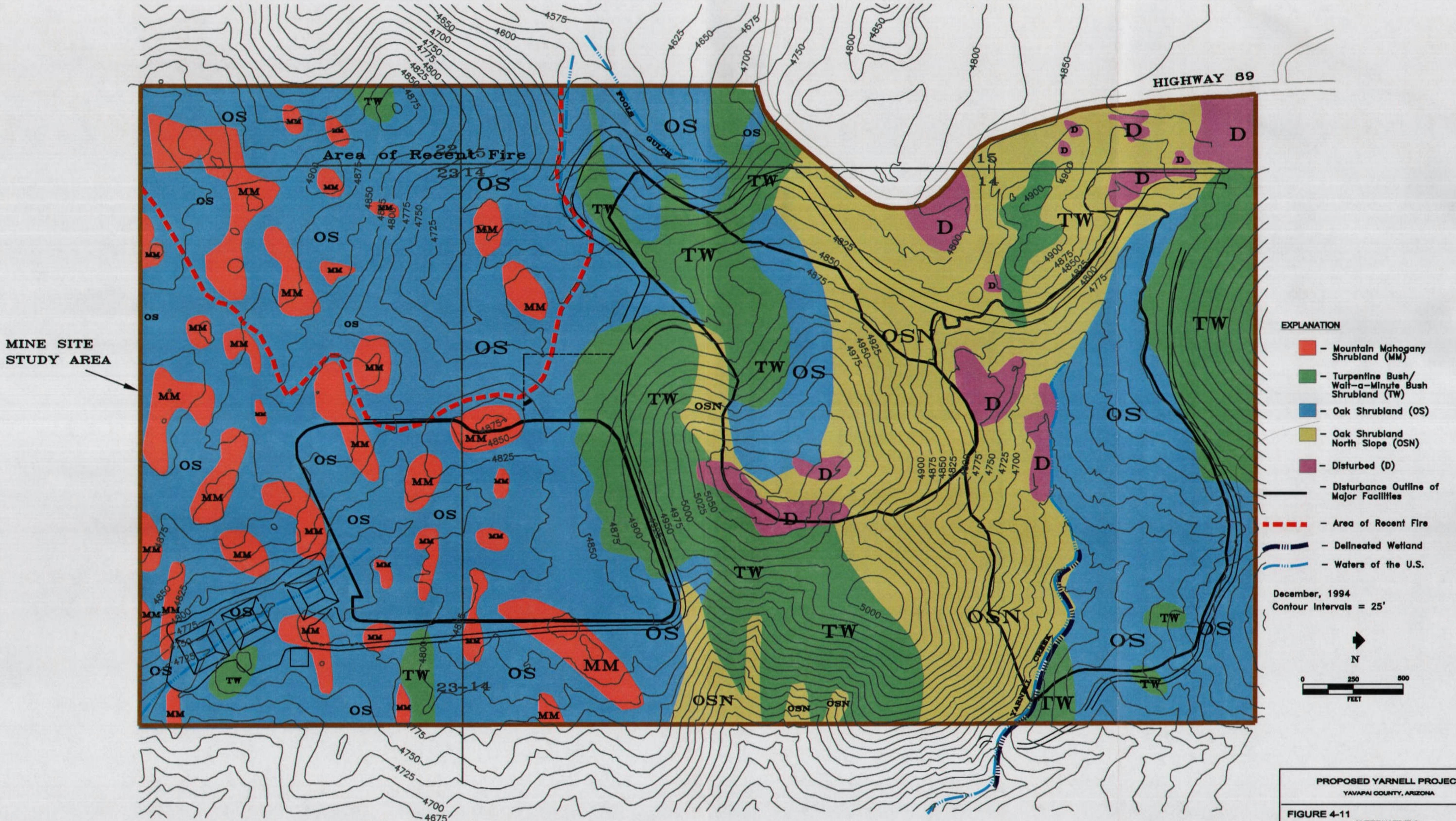


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FIGURE 4-11
ALTERNATIVE 2
MINE SITE STUDY AREA
DISTURBED AREAS
VEGETATION TYPES MAP

reduce the number of sites, isolated occurrences and/or pits and other isolated mining features that would be destroyed under the proposed action. However, these resources have been completely documented, and little or no information would be lost. A portion of the Mina-Genung Road would need to be relocated. Relocation would adversely affect the road's integrity of place, one of the qualities which make it eligible for the NRHP. Alternative 2 therefore would cause a significant impact to the site. This alternative would not change the potential for indirect impacts to the Yarnell Overlook as discussed in Section 4.1.10.2.

4.3.10 TRANSPORTATION

In addition to the transportation impacts associated with the proposed action, Alternative 2 would require the relocation of approximately 4,000 feet of the Mina Road. A specific route for relocation was not selected in the MPO. This would be a short-term impact caused by possible delays, traffic congestion and inconvenience to those needing access to points along this road from State Highway 89 in Yarnell (access would be at the Mina Road intersection with State Highway 89) until the road was relocated. This alternative would, therefore, also slightly change traffic patterns compared to the proposed action. To minimize the impact to those who use this road, the relocated road should be in place prior to the closure of the section which is to be used as part of the NWRD. With this mitigation, effects are not considered significant.

4.3.11 NOISE

In comparison to the proposed action, noise from mining activities under Alternative 2 would change only at Receptor 3. In the first two years of mining, noise levels in the area of Receptor 3 would be dominated by noise from the pit and increased activity at the NWRD would not be noticeable. After the first two years of mining, noise from activity at the expanded NWRD would dominate noise levels at Receptor 3. At this point in the operation, noise levels (hourly L_{eq}) at Receptor 3 would be 61 dBA during non-upwind conditions and 41 dBA during upwind conditions, a four-dBA increase over the noise levels projected for the proposed action. The level of 61 dBA exceeds EPA's 55-dBA criteria for the protection of public health and welfare, and as it is greater than 10 dBA over ambient noise levels, noise would be expected to be distinctly audible and increase the significance of the impact on Receptor 3 even further.

4.4 ALTERNATIVE 3 -- ELIMINATION OF THE NORTH WASTE ROCK DUMP AND PLACEMENT OF ALL WASTE ROCK INTO THE SOUTH WASTE ROCK DUMP

As discussed in Chapter 2 of this EIS and shown in Figure 2-2, YMC has proposed placement of waste rock within two permanent waste rock dump sites, termed SWRD and NWRD. Analysis of alternatives to the proposed action has identified a feasible alternative which would eliminate the NWRD and subsequent placement of all waste rock into the SWRD. This alternative to the proposed action is analyzed as Alternative 3 in this section. Other portions of the Yarnell Project operation would remain the same as those proposed by YMC under this alternative.

Alternative 3 would have slightly different effects than the proposed action. Effects on those elements of the human environment which would differ from those under the proposed action are identified below. All other effects would remain essentially the same as under the proposed action. Effects on resource areas such as geology, land use (slightly different configuration of affected lands), transportation and socioeconomics would generally be the same as the proposed action; therefore, they are not discussed below.

Expansion of the SWRD would result in a net decrease in total disturbed area within the MSA of about 22 acres. The height of the redesigned dump would be approximately the same as the heap adjacent to it, but approximately 100 feet higher than the SWRD under the proposed action.

4.4.1 OPERATIONAL EFFECTS

As mentioned above, under Alternative 3, the height of the SWRD would be raised approximately 100 feet relative to the proposed action. With this height increase, it is likely that the dump would be constructed in two lifts. Therefore, the potential impacts from slides, rolling rock and size segregation would be similar to those under the proposed action. The regraded face of the reclaimed dump would be 200 feet longer, and the potential for erosion would be increased compared to the proposed action. The added height of the dump would probably be the final lift placed on the dump. Therefore, little reclamation of the dump could occur prior to mine completion. Construction of the diversion system and siltation ponds associated with the NWRD would be avoided, as would the potential to impact the wetland area downstream of the NWRD. Project costs are estimated to be about nine percent higher compared to the proposed action under Alternative 3.

4.4.2 TOPOGRAPHY

The SWRD site would be about the same areal extent, but result in a higher (about 100 feet) structure compared to the proposed action and would be about the same height as the adjacent heap. Approximately 1,400 feet of the upper portion of the Yarnell Creek Valley would not be filled with waste rock and replaced by the steep side slopes of the NWRD. While this would permanently alter topography in the area in a slightly different way than the effects of the proposed action, effects would not be considered significant.

4.4.3 SOILS

Under this alternative, there would be about 125 acres (as shown on Figure 4-12) requiring a topsoil cover compared to 147 acres under the proposed action, and 68 acres would be converted to 2:1 slopes or steeper (about 20 more acres than under the proposed action). Alternative 3 would reduce the salvageable topsoil by 24,000 cubic yards compared to the proposed action. This would provide less available topsoil for use in reclamation than either the proposed action or Alternative 2. The increased height of the dump relative to the proposed action would increase slope length by about 200 feet. Erosion would be enhanced with the increase in the length of the dump face. However, the net increase of erosion from the SWRD would be offset because there would no erosion from the (eliminated) NWRD. Overall, effects would not be considered significant.

4.4.4 WATER RESOURCES

The impacts to water resources would be the same as under the proposed action, described in Section 4.1.4, except for the following.

- The surface water and groundwater quantity and quality of Yarnell Creek, Cottonwood Spring and the delineated wetland would not be affected by the NWRD. This is because Alternative 3 eliminates the NWRD at the headwaters of Yarnell Creek (Figure 2-11). Pumping of well YMC-04 and pit dewatering could still impact flow to Cottonwood Spring until water levels recover about two years after pumping ends.
- The NWRD would not permanently fill 900 feet of streambed delineated as waters of the U.S.

4.4.5 VEGETATION

Alternative 3 would have overall effects on vegetation similar to those under the proposed action, although less vegetation would be impacted. Specifically, about 22 acres of oak shrubland (which would be disturbed with the proposed action at the NWRD site) would not be disturbed under this alternative, as shown on Figure 4-13. However, this alternative would result in about 20 more acres of 2:1 or steeper slopes. These slopes would be difficult to reclaim, so there would be a potential for unsuccessful revegetation over a larger area relative to the proposed action and Alternative 2.

4.4.6 WILDLIFE

The total wildlife habitat disturbed by mining would be reduced approximately about 22 acres under Alternative 3 compared to the proposed action. While the benefits associated with covering and reclaiming the historic tailings at the head of Yarnell Creek would not occur under this alternative, there would be minimal impacts to Yarnell Creek, Cottonwood Spring and its small, flanking wetlands near the NWRD. The gain of oak shrubland habitat, while beneficial, would not be significant. Overall, this alternative would impact wildlife to a lesser degree than the proposed action or Alternative 2 as a result of the smaller acreage of less valuable habitats affected.

4.4.7 AIR RESOURCES

The reduction in particulate emissions caused by the smaller overall surface area used for waste rock disposal under Alternative 3 and the elimination of combustion emissions associated with elimination of the NWRD would be offset by likely increases in particulate emissions due to the required 100-foot increase in dump height and the slight increase in hauling distance. Overall, total air quality impacts associated with this alternative would be similar to those predicted under the proposed action. All regulatory thresholds and limits would still be met, and effects would not be considered significant.

4.4.8 VISUAL RESOURCES

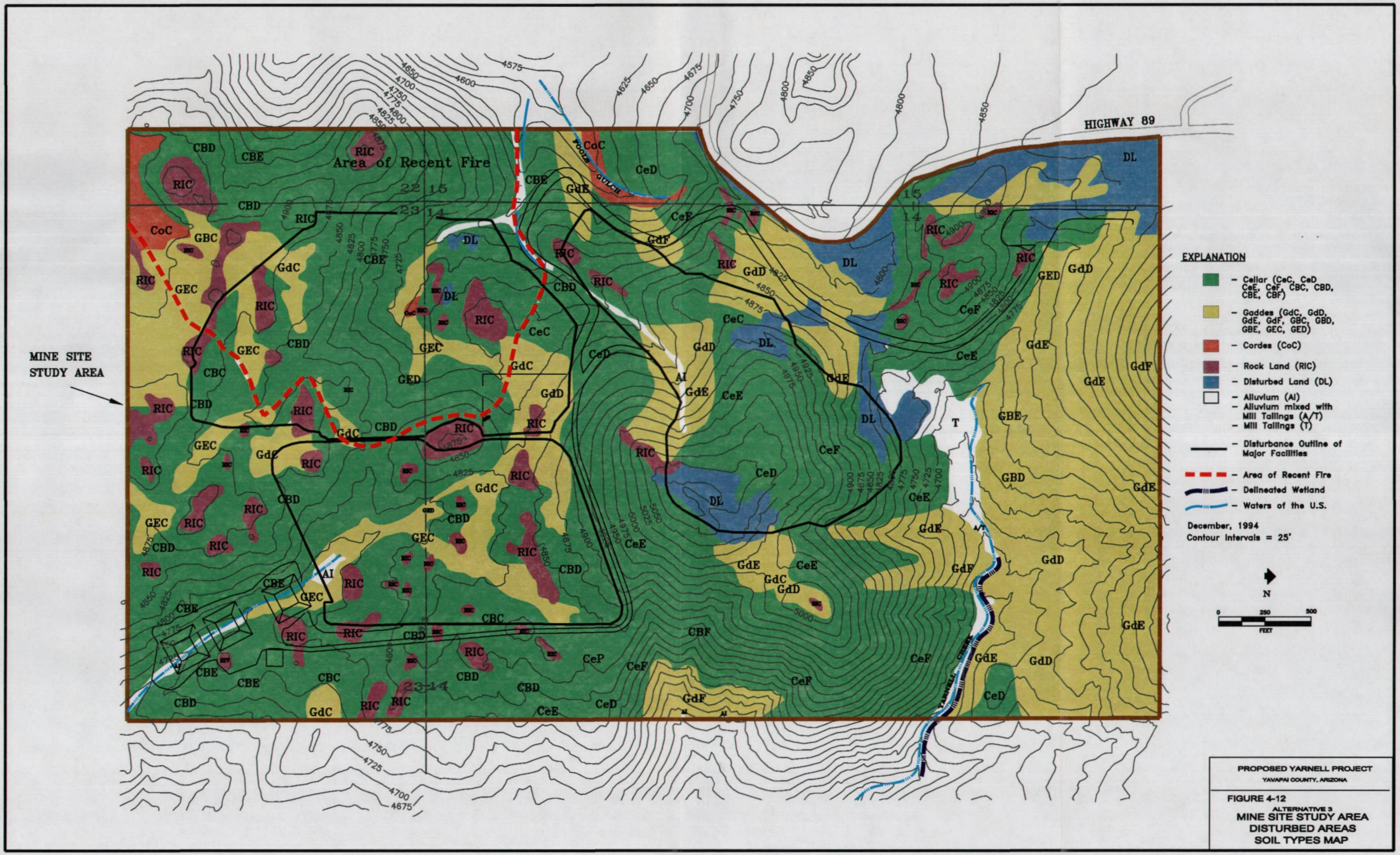
In comparison to the proposed action, this alternative would change the views from KOP-2, KOP-5, KOP-6 and KOP-7. Viewers at KOP-2 would see the expanded SWRD, which would appear to be about 30 percent higher than the height projected under the proposed action. Viewers at KOP-5 would have an improved view compared to the proposed action because they would not see the (eliminated) NWRD. Viewers at KOP-6 would see the height of the SWRD rise to approximately the same height as the heap so that the dump would "cover" the view of the heap (the heap would be behind the expanded SWRD). Viewers at KOP-7 would see the dump extend upward and cover approximately half of the heap facility. Alternative 3 would have an "overall" greater visual impact due to the larger size of the SWRD visible from State Highway 89. However, the pit would still be the predominant feature contrasting with existing visual resources, and effects would remain significant.

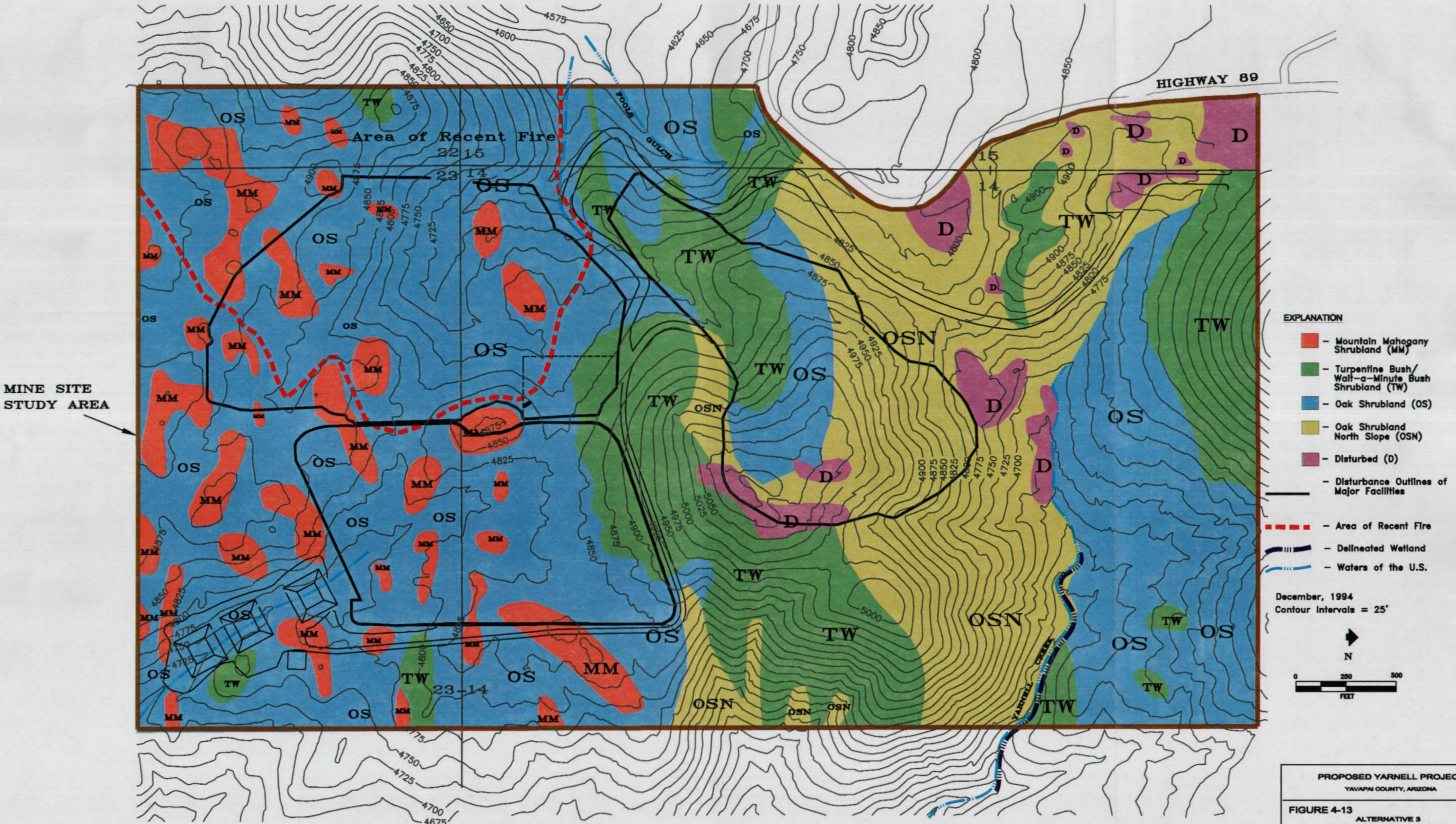
4.4.9 CULTURAL RESOURCES

Consolidation of waste rock disposal to the SWRD would reduce the number of sites, isolated occurrences and/or pits and cairns that would be destroyed by the proposed project. Although the historic Yarnell mine site would be less affected (or, subject to less disturbance) than under the proposed action, that area has poor integrity and all identified cultural resources have been adequately documented. Therefore, the impact would not be significant. This alternative would not change the potential for indirect impacts to the Yarnell Overlook as discussed in Section 4.1.10.2.

4.4.10 NOISE

Under Alternative 3, noise levels would decrease at receptors 1 and 3 and remain the same at all other receptors relative to the proposed action. Noise levels (hourly L_{eq}) at Receptor 1 are estimated at 54 dBA during non-upwind conditions and 31 dBA during down conditions, a one-dBA decrease over the proposed action. The non-upwind noise level is one dBA less than the EPA's 55-dBA impact criterion, greater than 10 dBA over nighttime ambient noise levels and nine dBA over daytime ambient noise levels. Noise levels at Receptor 3 would be 42 dBA during non-upwind conditions and 22 dBA during upwind conditions. This is 15 dBA less than the noise levels predicted under the proposed action. The level of 42 dBA would represent nighttime conditions. Overall, noise effects would remain significant.


HIGHWAY 89
Area of Recent Fire
MINE SITE STUDY AREA
EXPLANATION
- Cellar (CeC, CeD CeE, CeF, CBC, CBD, CBE, CBF)
- Gaddes (GdC, GdD, GdE, GdF, GBC, GBD, GBE, GEC, GED)
- Cordes (CoC)
- Rock Land (RIC)
- Disturbed Land (DL)
- Alluvium (Al)
- Alluvium mixed with Mill Tailings (A/T)
- Mill Tailings (T)
- Disturbance Outline of Major Facilities
- Area of Recent Fire
- Delineated Wetland
- Waters of the U.S.
December, 1994
Contour Intervals = 25'
N
0 250 500
FEET
PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA
FIGURE 4-12
ALTERNATIVE 3
MINE SITE STUDY AREA
DISTURBED AREAS
SOIL TYPES MAP



PROPOSED YARNELL PROJECT
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FIGURE 4-13
ALTERNATIVE 3
MINE SITE STUDY AREA
DISTURBED AREAS
VEGETATION TYPES MAP

CHAPTER 5

CUMULATIVE IMPACTS

5.0 CUMULATIVE IMPACTS

Cumulative impacts are defined as the sum of all past, present and reasonably foreseeable future impacts resulting from other activities in the study areas for each element of the human environment. The purpose of the cumulative impact analysis in this draft EIS is to evaluate the significance of the contributions to cumulative impacts from the proposed action. The cumulative impact analysis is accomplished in a four-step process.

- Identify study areas for each element of the human environment,
- identify the timeframes and other characteristics for relevant past, present and reasonably foreseeable activities in these study areas,
- estimate the cumulative effects of these activities plus those effects of the proposed Yarnell Project and
- identify the significance of any cumulative effects.

Cumulative impact study areas vary somewhat in size depending on the anticipated impact region for a given resource when the combination of all past, present and reasonably foreseeable impacts are considered. For most of the physical and biological resources (e.g., air, water, geology, soils, cultural resources, vegetation, wildlife and land use), the primary cumulative impact study area is the area proposed for project-related disturbance and the immediately adjacent lands; regional factors are also considered but to a lesser degree. For other elements of the human environment (e.g., socioeconomics, transportation, noise and visual resources), the areas for impact assessment are a larger region that focuses analysis on considerations such as the residents, communities (e.g., Yarnell/Glen Ilah) and roads which could be impacted.

5.1 PAST, PRESENT AND REASONABLY FORESEEABLE ACTIVITIES

5.1.1 PAST ACTIVITIES AND DISTURBANCES

Past activities and disturbances associated with the lands in and around the Yarnell Project area have traditionally been associated with mining. As described briefly in Chapter 1, the proposed project area has a long history of gold mining and exploration activities. Historical mining-related disturbances such as roads, mine shafts, tailings and other waste disposal areas and construction/excavation activities are clearly evident on the site, although mining has not occurred for more than 50 years. These historical disturbances have disrupted elements of the human environment such as soils, vegetation and wildlife. Because of the direct relationship of these historical disturbances with the proposed Yarnell Project activities, these past activities have been considered in the project-specific impact analysis described in Chapter 4.

5.1.2 PRESENT ACTIVITIES AND DISTURBANCES

5.1.2.1 Project Area

The major present activity on the proposed project site is exploration and site-management activities conducted by YMC for purposes of defining the geologic reserve proposed for mining and processing. These activities have taken place on both private land and federal land managed by the BLM. Activities on federal land have been conducted in accordance with BLM regulations. Exploration activities have included development of roads, drilling of exploration holes and conducting other mining-related testing and study.

Even with the historical and current mining/exploration activities on proposed project lands, much of the project area contains natural vegetation and serves as open space and wildlife habitat. Activities on immediately adjacent lands are generally rural in nature and include limited recreation and grazing. Existing mining activity in the immediate area is limited to the Alvarado Mine, a sand and gravel pit on private land southwest of the proposed Yarnell mine site. As described in Chapters 3 and 4, the proposed project area would be within the viewshed and noiseshed of nearby residential areas (especially in Glen Ilah) and for persons using the existing road system (State Highway 89, Mina Road and roads within Glen Ilah). Local water resources are used by existing residents and commercial businesses in accordance with Arizona water law.

5.1.2.2 Regional Area

In addition to the proposed Yarnell Project, other regional mining activities could have a cumulative effect on some elements of the human environment. The existing Cyprus Bagdad copper mine near the town of Bagdad (30 miles from Yarnell) plans to operate with its existing 520-person workforce until about the year 2030. The primary effect of this operation from a cumulative impact perspective is on the socioeconomic conditions in Yavapai County.

Yavapai County has grown substantially in recent years. This growth has occurred through major development in the service and retail trade sectors and an increase in population associated with retired persons. Growth in the Yarnell area has occurred at a much slower rate than the county as a whole and has been supported by limited development of the service sector. Congress and Wickenburg also are growing and developing into retirement destinations.

5.1.3 REASONABLY FORESEEABLE ACTIVITIES

The types of reasonably foreseeable future activities commonly included in a cumulative impact analysis include mineral exploration, mining and processing projects, other resource extraction projects, major housing developments, military activities, water development and/or conservation projects, agricultural activities and recreational developments and/or activities. To be "reasonably foreseeable," a project must have been formally planned, proposed and announced to the public. For example, to be reasonably foreseeable, a mining project involving federal land would need to be formally proposed through the submittal of an MPO to the federal land manager such as the BLM. A reasonably foreseeable activity could be sponsored by either the private or public sector.

With regard to the proposed project area, immediately adjacent lands and the Yarnell community, there are no known specific proposals in the above categories which have been formally proposed and/or announced to the public. Therefore, the cumulative impact analysis involving these lands would include consideration of historic and present activities only. If the Yarnell Project were to proceed, it would be the major source of cumulative impacts, which would be similar to the direct and indirect impacts described in Chapter 4.

On a more regional level, the current growth and development trend is expected to continue. This would result in increased economic activity, population, urbanization and conversion of currently open space/undeveloped land to residential and commercial uses.

5.2 RESOURCE EVALUATIONS

5.2.1 GEOLOGICAL RESOURCES AND TOPOGRAPHY

Mining and other major resource extraction projects are very pertinent types of activities relevant to cumulative impact analysis because they impact geological resources through the excavation and covering of geologic materials and topography through the introduction of major new landforms. Historical mining operations have modified localized geological resources and topography, and the currently operating Bagdad mine has been the major source of modified geological resources and topography on a regional level. The proposed Yarnell Project would add to this level of modification. However, there are no other mining projects which are reasonably foreseeable. Therefore, the major source of impact to the environment is from the proposed action.

5.2.2 SOILS

Impacts to native soils from past exploration and mining activities were largely the result of the excavation of soils and construction of drill pads, mine adits and access roads. Development of the proposed action would contribute approximately 182 acres to the cumulative disturbance of native soils in the area. These soil resources would be salvaged to the extent possible, and reclamation of areas disturbed by the proposed action may return these salvaged soils to productive use. The major source of cumulative impact to the environment is from the proposed action. Effects are not considered significant.

5.2.3 WATER RESOURCES

There are no other major existing or planned future activities in the WRSA that would add to the impacts of the proposed action described in Section 4.1.4 or alternatives two and three (sections 4.3.4 and 4.4.4, respectively). As a result, no cumulative hydrological impacts in the WRSA were identified beyond those associated with the proposed action.

5.2.4 BIOLOGICAL RESOURCES

Historic disturbances have altered the ecology and biological resources of the proposed project area through removal and/or modification of soils, vegetation and associated wildlife habitat. Past mining activities and current YMC activities have also probably resulted in direct wildlife mortality. These activities have cumulatively added to the loss of native vegetation and wildlife associated with growth, development and urbanization on a regional level. On a more local level, the proposed action would be the primary factor to consider in the cumulative impact analysis because there are no other known major activities which would result in loss of these biological resources.

Cumulative impact evaluation criteria for biological resources include direct effects to vegetation and wildlife and loss of wildlife habitat. With successful implementation of the reclamation and closure plans by YMC and the lack of any threatened or endangered species in the immediate vicinity of the project, project-specific and cumulative effects would be mitigated to a large degree. Mitigation measures for the desert tortoise, including compensation for habitat loss, would also ameliorate adverse effects. Reasonably foreseeable non-federal development in this area that could affect wildlife populations includes habitat loss, degradation and fragmentation, wildlife displacement and mortality associated with human population and community growth trends in Yavapai County and the Wickenburg area.

5.2.5 AIR RESOURCES

There are no other existing major industrial sources of air emissions in the immediate vicinity of the proposed project. The area is expected to remain relatively rural in nature and is not expected to change into land uses which would lead to major new sources of air emissions. The proposed project would be the primary source of impacts to existing air resources from the cumulative impact perspective.

Regionally, the growth and development trend would lead to additional impacts to air resources, primarily from mobile sources such as automobiles. These effects would be noticeable to some persons who prefer a less urban, lower traffic lifestyle. While some persons would perceive a cumulative adverse effect from the Yarnell Project and mobile sources from growth and development, air resources are expected to continue to be in compliance with state and federal standards and plans.

5.2.6 LAND USE

As noted above, historical land uses such as mining, open space and grazing in and around the proposed project area have tended to remain in effect over time, although the mining land use has not occurred in more than 50 years. Regionally, urbanization and growth have forced the modification and/or loss of previously undeveloped lands. The conversion of Yarnell Project lands to an active mining use would add to the loss of open space and wildlife habitat on both localized and regionalized cumulative bases.

Land ownership has evolved so that federal, state and county governments have become major decision-makers on land uses. Because of the proximity to Yarnell/Glen Ilah, the mining land use associated with the proposed action would be in conflict with existing residential land uses and future residential development around the project area, even though it would be consistent with BLM land use policies. The major source of cumulative impact to the environment is from the proposed action.

5.2.7 CULTURAL RESOURCES

There would be a cumulative loss of cultural resources as growth, urbanization and resource extraction activities occur throughout the region. In addition, growth in the region would continue to indirectly result in the loss of cultural resources from unauthorized collection and vandalism of sites. Effects to project-specific cultural resources would be mitigated through the implementation of a data recovery plan approved by the BLM.

5.2.8 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

The proposed action would bring a number of hazardous and other materials into the proposed project area. Additionally, project operations would result in a number of wastes which also require special handling and disposal. While YMC has made plans to handle these materials in an acceptable manner, the transportation, handling and disposal of materials implies some inherent level of risk to human and/or ecological welfare. Potential effects to the environment are primarily from the proposed action; however, effects are not considered significant.

5.2.9 NOISE

The proposed action would be the primary source of noise effects in the immediate vicinity of the mine site from the cumulative perspective. There are no existing or planned projects which would compare in noise impact magnitude or duration to the proposed action. Therefore, cumulative noise impacts would accrue primarily from the proposed action.

Regionally, the current growth and development trend would continue to create a more urban environment which, in turn, would lead to more noise adversely affecting more people in the area. The cumulative effect of noise on each individual would depend on the location (affecting exposure to noise), lifestyles, values and goals of these individuals and their ability to adapt to increasing noise.

5.2.10 VISUAL RESOURCES

As discussed in Chapter 3, Key Observation Points (KOPs) near the proposed project site were chosen to depict viewpoints which would show the types of effects on residents of the area surrounding the proposed project and users of the nearby road system (primarily State Highway 89 and Mina Road). The proposed action would dominate several of these views and not be in conformance with existing BLM visual quality objectives either in the short term or the long term. On a localized basis, the proposed action would be the major source of cumulative impacts to the environment.

The Alvarado Mine, a nearby boulder mining operation, is not visible from the MSA or from the communities of Yarnell, Glen Ilah or Congress. It is below and visible from the State Highway 89 overlook south of the proposed project area. From the valley, the Alvarado Mine is visible from the Parker Dairy and could be seen from portions of the water supply pipeline. Due to the local topography, it is unlikely that the Alvarado and Yarnell mines would be visible from the same vantage point. While there would be other visual effects associated with the general level of growth, development and urbanization in the region, the Yarnell Project would be a localized but dominant visual effect because of its proximity to State Highway 89, the major north-south access road between communities in the county and Phoenix.

5.2.11 TRANSPORTATION

The recent growth, development and urbanization trends throughout the county have added increased traffic to the local and regional road systems. Traffic levels, traffic flow and transportation-related hazards are increasing in association with this trend. The proposed action would add to these transportation changes through employee commuting and other project-related traffic to and from the proposed site.

ADOT has estimated that traffic on State Highway 89 would increase by a factor of 1.6 over the next 20 years. However, the project-related traffic on this road would be a relatively small part of the cumulative total during this time. The major cumulative concern associated with project-related traffic is related to the potential for increased accidents and other safety concerns. While additional traffic levels and the potential for increased accidents is an adverse effect which could be experienced by residents and visitors to the area, no major road improvements are planned or needed with current information. Therefore, cumulative effects are not expected to be significant.

Another transportation effect is the potential for blocked access to and from Yarnell along State Highway 89 when the road is closed for blasting purposes. The proposed action would be a major new source of traffic blockage and potentially prevent emergency access to/from the project area. However, the proposed blasting plan deals adequately with this potential, and cumulative effects due to road closures would not be significant.

5.2.12 SOCIOECONOMICS

As discussed in Chapter 4, YMC is expected to use existing residents of Yavapai and Maricopa counties for the vast majority of its project workforce. Direct and indirect employment, population, housing, community infrastructure/services and fiscal effects to affected local governments associated with the proposed action are not expected to be significant on either localized or regionalized bases.

Because of the major growth and urbanization underway in the region, cumulative employment, population, housing and other effects would be significant in many communities. While the Yarnell Project-related socioeconomic effects would add to regional growth trends, the project would contribute only a very small portion of growth to the total. Regional growth and urbanization trends would continue with or without the proposed action.

From a quality of life and social well-being perspective, many people in the project area, especially in Glen Ilah, do not consider the proposed mining operations to be consistent with their desired lifestyle and quality of life. On a localized basis (e.g., Yarnell/ Glen Ilah), the proposed action would be a major contributor to the effects on quality of life. Because of the likelihood for the existing regional growth and urbanization trends to continue and because of the direct cause/effect relationship of growth and urbanization on quality of life, regional cumulative effects to the socioeconomic environment are likely to be significant. However, these trends would continue with or without the proposed action.

CHAPTER 6

OTHER REQUIRED CONSIDERATIONS

6.0 OTHER REQUIRED CONSIDERATIONS

In addition to information and analysis contained in Chapters 1 through 5 of this EIS, NEPA requires several other EIS analyses and disclosures. These other required considerations include:

- unavoidable adverse impacts,
- relationship between short-term use of the human environment and long-term productivity and
- irreversible and irretrievable commitment of resources.

Each of these other required considerations is discussed below. For purposes of these discussions, short term is defined as the life of the proposed mining/processing operation through closure and reclamation. Long term is defined as the future after reclamation is completed.

6.1 UNAVOIDABLE ADVERSE IMPACTS

Many of the foreseeable impacts to the existing environment would be adequately mitigated by the elements incorporated by YMC into the proposed action and the mitigation measures identified in Chapter 4 of this EIS. However, development of the proposed action or action alternative would result in some unavoidable adverse impacts to some elements of the human and physical environment. These unavoidable adverse impacts are described in the "Residual Effects" sections in Chapter 4 of this EIS.

6.2 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE HUMAN ENVIRONMENT AND LONG-TERM PRODUCTIVITY

This section discusses the balance between the short-term use of the site for mining and the long-term productivity of the site without the proposed project. The proposed operations at the Yarnell Project site would result in short- and long-term impacts to the existing resources within the various resource study areas. Many of the impacts associated with the Yarnell Project would be mitigated through reclamation and other measures. Other impacts, however, could not be mitigated to any great degree.

6.2.1 TOPOGRAPHY, SOILS AND GEOLOGY

Potential impacts to earth resources would be primarily long term and concentrated within the disturbed area during the construction, operation and reclamation phases of all of the action alternatives. Soil erosion levels would increase above natural levels as a result of the construction of haul roads and removal and stockpiling of materials from the mine pit creating steep (50 percent) slopes. Soil productivity would be reduced over the long term. New and altered landforms would change the topography of the area for the long term. Effects to geological resources would be minimal.

6.2.2 WATER RESOURCES

Approximately 161 acre-feet per year of groundwater would be pumped from wells for the proposed project water supply. Over the short term, this water would not be available for other uses. No effects to other users is expected as a result of the proposed pumping. In the unlikely event that the proposed pit would intercept and dewater aquifers, local groundwater levels could be reduced over the long term. Mitigation has been suggested for affected wells should pumping or dewatering by the pit result in a lowering in groundwater levels that would adversely affects other users.

Leakage from the heap leach pad could adversely affect groundwater quality in a 91-acre area downgradient from the heap leach pad over the short term. Outside this area, dilution returns groundwater quality (TDS) to levels undetectable from baseline levels. This impact would be short term and levels would be expected to return to normal after rinsing and closure of the heap leach facility.

The potential for a catastrophic event that would cause failure of the heap leach facility is remote. Although highly unlikely, such a failure could significantly impact both surface and groundwater quality over the short term. Leach solution reaching surface waters would be diluted rapidly, and leach solution seeping into groundwater would likely be attenuated and diluted.

The proposal would permanently affect Waters of the U.S. Streams comprising Waters of the U.S. would be permanently buried by the NWRD and impacted over the short term by construction of the solution and stormwater ponds. Reclamation of the pond area would mitigate the impacts to that area. Alternative 2 would destroy a wetland, but in-kind mitigation would be required by COE.

6.2.3 VEGETATION RESOURCES

Under the proposed action, approximately 154 acres of vegetation would be lost for the short term. Vegetation resources comprising the 28-acre pit area would be permanently lost. Over the long term, these areas would not be fully returned to their pre-disturbance condition. Although proposed reclamation activities could lessen these effects and return portions of the disturbed areas to a chaparral vegetation-type over hundreds of years. Implementing either of the action alternatives would reduce disturbance of vegetation by about 20 acres.

6.2.4 WILDLIFE RESOURCES

There would be a short-term loss of wildlife resources due to the loss of habitat and subsequent displacement of wildlife and direct mortality. Over the long term, habitat would slowly return to its pre-disturbance values. Disturbance of wildlife habitat would be reduced by approximately 20 acres in both action alternatives. However, Alternative 2 would disturb wetland habitat.

6.2.5 AIR QUALITY

Potential impacts to air quality resulting from project-related emissions are short term in nature and directly associated with the construction and operation of the proposed mining and processing facilities. No long-term impacts to air quality are anticipated as a result of any of the alternative actions.

6.2.6 LAND USE AND ACCESS

Each of the action alternatives would have short- and long-term impacts to land use and access within and surrounding the proposed mining operation. Because the proposed operation is located in close proximity to residential areas, the proposed mining land use would be in conflict with nearby residential land uses. Changes in access to the area would be minimal, although proposed road closures could disrupt access to and from the Yarnell area from the south along State Highway 89 in the short term. Access to the open pit would be restricted for the long term by construction of a five-foot high berm and barb wire fence around its perimeter. Post-mining land uses of open space and wildlife habitat are proposed to occur after reclamation and closure activities, but the site would not be fully returned to pre-mining conditions.

6.2.7 VISUAL RESOURCES

Potential impacts related to the re-establishment of mining activities at the proposed site are long-term in nature and associated with the permanent modification of the existing landscape. Due to the lack of available mitigation measures and proximity of mining operations to residential areas and to State Highway 89, there would be major long-term effects to visual resources for all action alternatives.

6.2.8 CULTURAL RESOURCES

The Yarnell Overlook (a historic Native American site) and the Biedler Mine and Edgar Shaft, both historic mines, were considered eligible for the National Register of Historic Places. The Biedler Mine and Edgar Shaft would be disturbed by the SWRD and the open pit and have been fully recorded. The Yarnell Overlook would not be directly affected, but indirect adverse effects could occur due to increased accessibility, making the site more vulnerable to collecting or other disturbance. The potential effects to the Yarnell Overlook site would be mitigated through development and implementation of a data recovery plan.

Cultural resources that were unrecorded or undiscovered would be destroyed with the selection of any action alternative, thus foregoing long-term use of these resources. However, Alternative 2 would not disturb the Biedler Mine site. The recovery of archaeological information prior to re-establishment of mining would be a beneficial short-term use insofar as the results enhance understanding of the cultural history of the region. Any collected information would be preserved and available for re-analysis over the longer term, but these cultural resources sites would not be available for study in the future when archaeological data recovery techniques might have improved.

6.2.9 NOISE

Levels associated with the proposed mining activities are considered short-term and directly related to the construction and operation of the proposed mine and processing facilities. Because of the proximity of residential areas to the site, there would be major short-term noise impacts for all action alternatives. No long-term impacts are anticipated.

6.2.10 SOCIOECONOMICS

Selection of any action alternative would provide short-term benefits to local and regional economies and could potentially provide long-term benefits in the form of improved infrastructure, schools and other public facilities maintained through tax revenues. However, many lives would be disrupted by the proposed project and many residents of the area would perceive a degradation in their lifestyle and quality of life due to the presence and operation of the project.

6.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The irreversible commitment of resources is defined as the use of nonrenewable resources or start of a process, which once committed to the proposed project, would continue to be committed throughout the life of the proposed project and thereafter. Irretrievable commitment of resources includes those resources used, consumed, destroyed or degraded during construction, operation and reclamation of the proposed project which could not be retrieved or replaced for the life of the project or beyond. However, irretrievable commitments may be reversed in some cases. This is due in part to the use of mitigation measures as described in this EIS or the natural restoration of the site.

The proposed action would result in some irreversible and irretrievable commitments of minerals, soils, groundwater, biological and cultural resources. Any of the action alternatives would result in comparable levels of resource commitments. The major commitment is the removal of up to 19 million tons of material including seven million tons of ore from the open pit and approximately 180,000 troy ounces of gold entering the open market, thereby resulting in both an irreversible and irretrievable commitment of geologic and mineral resources.

The commitments of groundwater, surface water, soils, vegetation, wildlife habitat and other land uses are considered irretrievable. These resources would be disturbed or displaced during the project life of the mining operation, but the commitment is somewhat reversible to the extent that successful reclamation of the mine site would allow for the long-term replacement of these resources to some extent.

The waste rock dumps, heap leach and open pit would be committed to remain in place irretrievably affecting topography of the area. Approximately 182 acres of total surface area would be disturbed by project operations. This acreage represents an irretrievable commitment of soils and vegetation resources during the life of the project. Up to one-half of the in-place topsoil resources may be irreversibly lost because they are not salvageable due to steep slopes and boulders. After mining operations cease, reclamation efforts would take place as part of the proposed action, thereby reversing this commitment to some extent with the exception of the 28-acre open pit area.

The consumption of approximately 161 acre-feet per year of groundwater would be irretrievable during mine operation. The groundwater elevation levels measured at wells could decrease within the WRSA, but would be expected to return to pre-mining levels after mining is completed. In the unlikely event that the open pit would dewater aquifer(s), groundwater levels could be irreversibly lowered with the intercepted water being discharged to Fools Gulch.

Post-mining land uses, including wildlife habitat and open space, would resume following closure and reclamation of the disturbed lands. The commitment of these resources, as well as wildlife habitat and dispersed recreation that are supported by them, are therefore not irreversible. The exception would be the irreversible commitment of the 28-acre pit area to restricted land use of open space with limited use by wildlife.

Visual resource impacts would represent significant irretrievable and irreversible commitments.

Commitment of cultural resources would be irreversible, although the information content of the sites would be recovered.

Socioeconomic resource effects are described as the economic benefits and costs to the affected communities and state. These are irretrievable commitments for the life of the project and beyond to the extent that tax revenues are invested in enduring public facilities and programs. Adverse effects to one's sense of quality of life and lifestyle could be considered both irretrievable and irreversible for some persons. Persons who could not adjust to the changes brought on by the mining and processing operations would likely leave the area, thereby changing social structure and the makeup of the affected communities.

CHAPTER 7

LIST OF PREPARERS

7.0 LIST OF PREPARERS

This draft EIS was prepared by the Phoenix Field Office of the U.S. Bureau of Land Management (BLM). The BLM served as the lead federal agency for EIS preparation. The U.S. Environmental Protection Agency Region IX is serving as a cooperating agency in EIS preparation. The agencies are being supported by resource specialists from AGRA Earth & Environmental, Inc., formerly P.M. De Dycker & Associates, Inc., the third party EIS contractor. The EIS interdisciplinary team members are identified below.

Bureau of Land Management Interdisciplinary (ID) Team Members

Responsibility	Name	Qualifications
EIS Project Manager Cultural Resources Socioeconomics	Connie Stone Phoenix Field Office	Ph.D. Anthropology 22 years experience
Geology Mining Plan Review	Ron Smith Phoenix Field Office	B.S. Mechanical Engineering B.S. Geology 14 years DOI experience
Hazardous Materials Geology	Jeff Garrett Phoenix Field Office	B.S. Geology 20 years experience
Engineering Review Mining Plan Review	Ralph Costa Arizona State Office	B.S. Mining Engineering 17 years experience
Hydrology Water Quality	Steve Markman Arizona State Office/Phoenix Field Office	M.S. Watershed Management 11 years experience
Water Rights	Lin Fehlmann Phoenix Field Office	B.S. Secondary Education and Biology 17 years water rights experience
Wildlife, Vegetation T & E Species	Dave Hoerath Phoenix Field Office	B.S. Wildlife Biology 7 years experience
Land Use Vegetation	Russ Miller Phoenix Field Office	B.S. Natural Resources Management 20 years experience
Soils	Paul Hobbs Kingman Field Office	B.S. Soil Science 14 years experience
Land Use	Jim Andersen Phoenix Field Office	B.S. Natural Resources Management 20 years experience
Visual Resources	Kathryn Pedrick Phoenix Field Office	M.A. Anthropology 20 years experience
Public Affairs Editing	Wendell Peacock Phoenix Field Office	B.A. Mass Communications 11 years experience
Management Review	MarLynn Spears Phoenix Field Office	B.S. Wildlife Management 20 years experience

Environmental Protection Agency—Cooperating Agency Review

Responsibility	Name	Qualifications
CWA Section 402 Yarnell Project Manager	Laura L. Gentile Office of Clean Water Act Permits and Standards	B.S. Biology B.S. Chemistry 7 years experience
NEPA	Jeanne Geselbracht Federal Activities Office	B.A. Geography M.A. Geography 12 years experience
Geology Hydrology	Karl Kanbergs Federal Activities Office	B.S. Earth Sciences M.S. Economic Geology M.S. Hydrogeology 16 years experience
CWA Section 404 Hydrology Hydrogeology	Wendy Melgin	B.A. Geology M.S. Hydrology and Hydrogeology 15 years experience

AGRA Earth & Environmental, Inc.—Third Party Contractor

Responsibility	Name	Qualifications
EIS Project Director	Phillip De Dycker AGRA Earth & Environmental, Inc.	B.S. Environmental Engineering 24 years experience
Public Involvement Land Use Socioeconomics Visual Resources	Michael Stanwood AGRA Earth & Environmental, Inc.	B.S. Psychology M.S. Mineral Economics 18 years experience
Blasting Technical Project Manager	Melvin Granberg AGRA Earth & Environmental, Inc.	B.S. Geological Engineering B.S. Mining Engineering 23 years experience
Geochemistry Hydrogeology Groundwater Aquifer Testing	Roy Blickwedel Advanced GeoServices Corp.	B.A. Geology M.A. Geology 14 years experience
Vegetation	David Johnson Western Ecological Resource, Inc.	B.S. Mathematics M.S. Environmental Toxicology M.S. Plant Ecology 24 years experience
Biological Coordinator Wildlife	Richard Thompson Western Ecosystems, Inc.	B.S. Wildlife Research M.S. Zoology and Physiology 15 years experience
Air Quality/Climate Noise	Rodger Steen Air Sciences, Inc.	B.S. Engineering M.S. Geofluid Dynamics 21 years experience

Responsibility	Name	Qualifications
Air Quality/Climate	Dave Randall Air Sciences, Inc.	B.S. Land Resource Planning M.S. Progress, Civil Engineering 10 years expebience
Noise	Michael Hankard Air Sciences, Inc.	B.S. Electrical Engineering 8 years experience
Soils	David Buscher Soil & Environmental Consultant	B.S. Wildlife Management and Biology B.S. Geological Engineering M.S. Ecological Engineering 13 years experience
Geology Hazardous Materials	Michael Pappalardo Geologic and Water Resources Services	B.S. Geology 9 years experience
Cultural Resources	Marilyn Martorano Foothill Engineering Consultants, Inc.	B.A. Anthropology M.A. Anthropology 20 years experience
Cultural Resources	Ted Hoefer III Foothill Engineering Consultants, Inc.	B.A. Anthropology M.A. Anthropology Ph.D. currently enrolled in Graduate School of Public Affairs 18 years experience
Administrative Assistant	Janet Van Ackeren AGRA Earth & Environmental, Inc.	27 years assistant experience

CHAPTER 8

CONSULTATION AND COORDINATION

8.0 CONSULTATION AND COORDINATION

8.1 PUBLIC PARTICIPATION

As required by NEPA and CEQ regulations (40 CFR 1503), the general public, the business community, special interest groups and government agencies have been provided the opportunity to become informed and comment on the proposed Yarnell Project. The BLM accomplished its public participation goals for this draft EIS through agency and public scoping meetings; public mailings; publishing of a notice of intent to prepare an EIS in the Federal Register; preparing a Scoping Document; and responding to information requests (including Freedom of Information Act requests) from the public and other agencies. The BLM has considered verbal and written comments from all parties throughout this EIS process in helping to guide preparation of this EIS document.

The notice of intent to prepare an EIS for the Yarnell Project was published in the Federal Register on September 21, 1995. Meeting announcements were placed in the Federal Register and in newspapers, and a scoping document describing the proposed action and a meeting schedule was mailed to approximately 750 individuals, public officials and organizations. Public scoping meetings conducted in Wickenburg, Yarnell and Prescott on October 17, 18 and 19, 1995, respectively, were attended by approximately 400 people. The 60-day public comment period ended on November 20, 1995. While this 60-day period designated the formal scoping period required by NEPA and BLM policy, scoping is actually an ongoing process which will occur throughout the EIS process.

A total of 190 scoping letters/comment forms were received from the public during the formal comment period. Comments were received from the following organizations.

- Guardians of the Rural Environment,
- Weaver Mining District,
- Sierra Club Rincon Group,
- Sierra Club Palo Verde Group,
- Mineral Policy Center,
- Minerals Exploration Coalition and
- Escapees RV Club.

A total of nine letters/comment forms were received from the following governmental agencies.

- U.S. Army Corps of Engineers,
- Arizona Department of Environmental Quality,
- Arizona Department of Water Resources,
- Arizona Department of Mines and Mineral Resources,
- Arizona Game and Fish Department and
- U.S. Environmental Protection Agency (letter received December 14, 1995).

One letter was received from the Town of Wickenburg.

8.2 CONSULTATION WITH GOVERNMENTAL AGENCIES AND NATIVE AMERICAN TRIBES

Consultation with federal, state and local agencies is being conducted as a part of this EIS process. Agencies consulted include:

- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- U.S. Fish and Wildlife Service
- Arizona Department of Environmental Quality
  - Air Quality Division
  - Aquifer Protection Permit Unit
- Arizona Mine Inspector's Office
- Arizona Department of Transportation
- Arizona State Land Department
- Arizona Game and Fish Department
- Yavapai County Planning Department
- Arizona State Historic Preservation Office
- City of Wickenburg

Consultation activities include information/data gathering and discussions of significant issues, potential environmental effects and mitigation measures. Regulatory responsibilities for these agencies are discussed in Chapter 1.

Native American tribes contacted during the scoping process and later consultations include the Yavapai-Prescott Tribe, the Yavapai-Apache Tribe, the Fort McDowell Mohave-Apache Indian Community and the Hopi Tribe. The Yavapai inhabited the region historically, and the Hopi claim ancestral ties to the general region.

8.3 ENVIRONMENTAL JUSTICE

The BLM's mandate on Environmental Justice, Presidential Executive Order Number 12898, requires that all members of the public have the right to participate meaningfully in the BLM's processes and the activities affecting their health, welfare and other matters in the community. An integral part of scoping was to identify any environmental justice issues relating to the social, cultural, economic and health impacts on minorities and low income groups on BLM lands and in BLM activities.

The BLM has established a strategy to identify any minorities and low income groups that may be impacted by a proposed action. The strategy consists of using all available knowledge of the area and consulting with Native American tribes to determine if any interested groups exist. Socioeconomic profiles of the county and the surrounding communities are referenced in the EIS (see Section 3.10), and information on statewide alliance groups is researched and used where appropriate.

Through research and scoping, the general public was informed and invited to become involved in the EIS process. No significant minority or low income groups have been identified. The environmental justice analysis indicates that all segments of the population would be affected equally by the potential effects of the proposed action (see Section 4.1.17).

The BLM considers, in its land and resources management decisions, the health, social and economic impacts on any identified low income and minority groups and/or communities. The BLM has taken an active approach to outreach in and around minority and low income communities. The BLM is committed to equitable service to all communities.

8.4 EIS AVAILABILITY

8.4.1 PUBLIC REVIEW

Draft EISs will be available for public review at the BLM Phoenix Field Office, BLM Arizona State Office in Phoenix, Arizona State University Library in Tempe, the Prescott Public Library, Yarnell Public Library, Wickenburg Public Library and the Yarnell Mining Company in Yarnell.

8.4.2 LIST OF AGENCIES, ORGANIZATIONS AND INDIVIDUALS TO WHOM COPIES OF THIS EIS WERE SENT

ELECTED OFFICIALS

U.S. Senator John Kyl

U.S. Senator John McCain

U.S. Representative Bob Stump

Office of the Governor, State of Arizona

Sue Lynch, Arizona State House of Representatives

William Feldmeier, Yavapai County Board of Supervisors

Office of the Mayor, City of Wickenburg

AGENCIES

Arizona Department of Commerce, State Clearinghouse

Arizona Department of Environmental Quality

Arizona Department of Environmental Quality, Air Quality Division

Arizona Department of Environmental Quality, Mining APP Unit

Arizona Department of Mines and Mineral Resources

Arizona Department of Transportation

Arizona Department of Water Resources

Arizona Game and Fish Department

Arizona State Land Department

Arizona State Land Department, Natural Resources Division

Arizona State Land Department, Water Rights Division

Arizona State Mine Inspector's Office

Arizona State Parks, State Historic Preservation Office

Directorate of Environmental Quality, Civil Engineer HO USFS/CEVP

Office of Deputy A/S of the USAF

Prescott National Forest

Town of Wickenburg, City Manager

U.S. Army Corps. of Engineers

U.S. Department of Agriculture, National Agricultural Library

U.S. Department of Energy, Office of NEPA Oversight

U.S. Department of the Interior

- Bureau of Indian Affairs
- Bureau of Land Management, Director
- Bureau of Land Management, National Applied Resource Science Center
- Bureau of Reclamation
- Minerals Management Service
- National Park Service
- Natural Resources Library
- Office of Environmental Project Coordinator
- Office of Public Affairs
- Office of Surface Mining Recl. & Enforcement
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

U.S. Environmental Protection Agency, EIS Filing Section

U.S. Environmental Protection Agency, Region IX

U.S. Forest Service, Department of Agriculture

Yavapai County Planning Department

ORGANIZATIONS

Arizona Mining Association
Arizona State University Libraries
Arizona Wildlife Federation
ASARCO
Bio/West, Inc.
Center for Science in Public Participation
Dames & Moore
Escapees, Inc.
Fort McDowell Mohave-Apache Indian Community
GSA Resources Inc.
Guardians of the Rural Environment
Hassayampa River Preserve (The Nature Conservancy)
Hobday Enterprises
Hopi Tribe
Levy Trucking
Maricopa Mica Mines
Mineral Policy Center
Pebble Pickin Posse
People for the West
Prescott Courier
Prescott Public Library
Rayco Enterprises
Resource Advisory Council
Sierra Club, Palo Verde Group
Sierra Club, Rincon Group
South Branch Resources
Southwest Center for Biological Diversity
Southwestern Minerals Exploration Assoc.
The Harcuvar Company
Weaver Mining District
Western Mining Action Project
Western Resource Development
Wickenburg Public Library
Wickenburg Sun
Yarnell Public Library
Yavapai-Apache Indian Tribe
Yavapai-Prescott Indian Tribe

INDIVIDUALS

Joyce L. Ahearn
William & Carole Ashworth
David L. Baker
Paul Bauer
Leonard & Sandy Baumgarten
Julia Bengston
Otto Berthelsen
John & Delores Blizzard
Katie Booth
George Brown
Ross W. Bruner
Bob Burkhart
William & Nancy Cameron
Virgil Carson
Howard Chamberlain
Nola Cook
Nita & Ben Crane
George E. Daniels
David A. De Kok
Donald C. Drebing
Jim & Mary Edgin
Robert C. Euler
Robert Faires
Willace & Harriet Gesberg
Andy Groseta
Warren Haskin
Roc Indermill
Jack B. Jacks
Don & Maggie Jensen
O.G. Johnson
Gerard & Shirley Kneipp
Marie Koehler
John Koweil

Dorothy Kropp

Jim Kuipers

Lois M. Lancette

Ben Leach

Johanna L. Marks

P.K. Rana Medhi

Edwin W. Minch

Jane Ellen Moody

Jim Nagel

Don & Beverly Newhouse

Terri Palmberg

Harland Plattenberg

L.J. Polum

Robert J. Radesi

Joan Ridder

Jane M. Roper

Norma Scheall

Wayne Schlegel

Ray Schneider

James D. Sell

Robert L. Spude

J.W. Suchor

Rachel Thomas

Charles P. Van Epps

Jean Vance

John C. Voelker

Phil & Emma Waner

Gene Wendt

CHAPTER 9

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9.0 REFERENCES

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CHAPTER 10

ACRONYMS AND GLOSSARY

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ACRONYMS

A.A.S. Alluvial Aquifer System

ACEC. Area of Critical Environmental Concern

ACHP. Advisory Council on Historic Preservation.

ACOE. Army Corps of Engineers

ADEQ. Arizona Department of Environmental Quality

ADOT. Arizona Department of Transportation

ADR. Adsorption, Desorption and Refinery Plant

ADWR. Arizona Department of Water Resources

AEL. Acceptable Exposure Level

AGFD. Arizona Game and Fish Department

AID. Air Installation Permit

ANP/AGP. Acid Neutralization Potential/Acid Generation Potential

APE. Area of Potential Effect

APP. Aquifer Protection Permit, as regulated by the Arizona Department of Environmental Quality (ADEQ)

AQD. Air Quality Division

AQP. Air Quality Permit

ARD. Acid Rock Drainage

ARPA. Archaeological Resources Protection Act

ATV. All-Terrain Vehicle

BADCT. Best Available Demonstrated Control Technology

BAT. Best Available Technology Economically Achievable

BCAS. Bedrock Complex Aquifer System

BCT. Best Conventional Technology

BLM. Bureau of Land Management

BMP. Best Management Practice

CDC. Center for Disease Control

CEQ. Council on Environmental Quality

COE. Corps of Engineers

DIA. Discharge Impact Area

EIS. Environmental Impact Statement

ENP. Emergency Notification Plan

EPA. Environmental Protection Agency

ESA. Endangered Species Act

FLPMA. Federal Land Policy and Management Act

GPM. Gallons per minute

HAP. Hazardous Air Pollutants

HDPE. High Density Polyethylene

IT. Interdisciplinary Team

KOPs. Key Observation Points

L_{50}. Hourly medium noise level at a location

L_{90}. The noise level that is exceeded 90% of the time at a location; the background noise level

L_{EQS}. Hourly average noise level at a location

MCL. Maximum Containment Levels

RFP. Management Framework Plan

MMPA. Mining and Mineral Policy Act

MOU. Memorandum of Understanding

MPO. Mining Plan of Operation

MSA. Mine Site Study Area

MSHA. Mine Safety and Health Administration

MSL. Mean Sea Level

NAAQS. National Ambient Air Quality Standards

NEPA. National Environmental Policy Act of 1969

NHPA. National Historic Preservation Act

NOI. Notice of Intent

NPDES. National Pollution Discharge Elimination System

NRHP. National Register of Historic Places

NWRD. North Waste Rock Dump

OSHA. Occupational Safety and Health Administraction

OSM. Office of Surface Mining Reclamation and Enforcement

PM_{10}. A measurement of the amount of suspended particulate matter (i.e., those particles less than 10 microns in diameter) in the atmosphere

PPM. Parts Per Million

PPV. Peak Particle Velocity

PSD. Prevention of Significant Deterioration

QA. Quality Assurance

ROD. Record of Decision

ROW. Right-of-Way

SCS. Soil Conservation Service

SHPO. State Historic Preservation Office

SIP. State Implementation Plan

SPCC. Spill Prevention Control and Countermeasures

STEL. Short-term Exposure Limit

SVR. Standard Visual Range

SWPPP. Storm Water Pollution Prevention Plan

SWRD. South Waste Rock Dump

TDS. Total dissolved solids

TSV. Tertiary Sediments/Volcanic Aquifer System

USFWS. U.S. Fish and Wildlife Service

VRM. Visual Resource Management

VRMS. Visual Resource Management System

WAD. Weak Acid Dissociable

WRD. Waste Rock Dump

WRSA. Water Resource Study Area

YMC. Yarnell Mining Company

GLOSSARY

100-YEAR STORM. The most severe storm event likely to occur once every 100 years.

ACID DRAINAGE OR ACID ROCK DRAINAGE (WRD). Drainage with a pH of 2.0 to 4.5. It results from the oxidation of sulfides, which produces sulfuric acid and sulfate salts. The acid dissolves minerals in the rocks, further degrading the quality of the drainage water.

AESTHETICS. The appeal or beauty of objects, animals, plants, scenes, natural or improved areas to the viewer and his/her appreciation for such items.

AIRBASE. The airborne shock wave resulting from the detonation of explosives. Primarily caused by movement of the earth (burden) or the release of expanding gases into the air. It may or may not be audible.

ALTERNATIVE. A different method of reaching the same purpose and need as that of the proposed action.

AMBIENT AIR QUALITY STANDARD. A legal limit on the amount of a given pollutant that is permitted in the ambient air.

AMERICAN INDIAN RELIGIOUS FREEDOM ACT OF 1978. An Act which establishes a U.S. policy to protect and preserve the religious freedom of Native Americans by, among other things, allowing access to sites, use and possession of sacred objects and the freedom to worship through ceremonials and traditional rites. It also requires the President to direct federal agencies to evaluate their policies in consultation with native religious leaders to determine appropriate changes.

AQUIFER. A geological formation or structure that contains water in sufficient quantity to supply needs for water development.

ATTAINMENT AREA. An area which meets ambient air quality standards.

BACKFILL. 1) Waste rock, sand or tailings used to fill a mined-out pit or support an underground mine opening after removal of ore. 2) The process of re-filling a mined-out pit with waste rock.

BAGHOUSE. An air pollution abatement device used to trap particulates by filtering gas streams through large fabric bags, usually made of glass fibers.

BARREN SOLUTION. Non-precious metals-bearing dilute cyanide solution.

BASELINE CONDITION. That condition of environmental or other resources prior to disturbance.

BASELINE DATA. That data collected in an area prior to disturbance to describe baseline conditions.

BENCH. A vertical lift of ore or waste material to be mined. The combination of a number of benches (or sometimes a single bench) forms the highball. The relatively level terrace left between mined lifts may also be referred to as a bench or safety bench. These combine to form the overall angle of the highball.

BIOTA. The flora and fauna of a region.

BUREAU OF LAND MANAGEMENT. The agency of the U.S. Government, under the Department of Interior, responsible for administering some of the public lands of the U.S.

CANDIDATE SPECIES. Classification by the Fish and Wildlife Service (U.S. Department of the Interior) of taxonomic groups or species of plants or animals being considered for listing as either threatened or endangered under the Endangered Species Act of 1973, as amended.

COMPLIANCE. Compliance with legislation or regulations issued pursuant thereto. Also, compliance with a schedule or plan ordered or approved by a court of competent jurisdiction, the Environmental Protection Agency or an environmental pollution control agency.

CONCENTRATE. The valuable fraction of an ore that is left after worthless material is removed in processing.

CONDUIT. A passage filled with water under hydrostatic pressure.

CORRIDOR. A linear strip of land identified for the present or future location of transportation or utility rights-of-way.

COUNCIL ON ENVIRONMENTAL QUALITY (CEQ). An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies and advises the President on environmental matters.

COVER. The proportion of ground surface under live aerial parts of plants or the combined aerial parts of plants and mulch. Also describes vegetation or terrain used by wildlife for protection from predators and adverse weather conditions, and is a major component of wildlife habitat.

CRITICAL HABITAT. Habitat on which a species depends for survival because there are no alternative ranges or habitats available.

CULTURAL RESOURCE. The remains of sites, structures or objects used by humans in the historic or prehistoric past.

CULVERT. A conduit, especially a drain, under a road, through an embankment, etc.

CUMULATIVE EFFECTS OR IMPACTS. The impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

CYANIDE. A solid chemical compound (sodium or calcium cyanide) dissolved in water to form a solution suitable for the extraction of precious metals from ore using a leaching process.

DATA RECOVERY PROGRAM. The systematic investigation of cultural features or artifacts at a site.

DECIBEL. A unit of air pressure (or sound) commonly used to measure airbase from explosives. The decibel scale is logarithmic.

DEVELOPMENT ROCK. Rock removed in the process of reaching the ore to be mined that is discarded without being crushed and milled.

DIRECT IMPACTS. Impacts caused by the action and occurring at the same time and place (40 CAR 1508.7). Synonymous with direct effects.

DIVERSITY. The variety of species within a given association of organisms. Areas of high diversity are characterized by a great variety of species; usually relatively few individuals represent any one species. Areas with low diversity are characterized by a few species; often relatively large numbers of individuals represent each species.

DRAWDOWN. A lowering of the water table of an unconfined aquifer or the potentiometric surface of a confined aquifer caused by pumping of groundwater from wells.

ECOSYSTEM. An interacting system of organisms considered together with their environment (e.g., marsh, watershed and lake ecosystems).

EFFECTIVE POROSITY. The ratio (percentage) of water that a saturated aquifer will yield in relation to its total volume.

EFFECTS. See IMPACTS.

ELECTROWINNING. The process of electrolytically depositing metals or separating them from their ores or alloys.

EMISSION. A substance released into the air.

ENDANGERED SPECIES. Any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range; plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act.

ENVIRONMENTAL IMPACT STATEMENT (EIS). A statement of the environmental effects of a proposed action and alternatives to it. It is required for major federal actions under Section 102 of the National Environmental Policy Act (NEPA), and released to the public and other agencies for comment and review. It is a formal document that must follow the requirements of NEPA, the Council on Environmental Quality (SEQ.) guidelines and directives of the agency responsible for the project proposal.

FAULT. The plane of movement where one section of earth has moved with respect to an adjacent section of earth. Fault zones are often comprised of broken rock and may contain mineralization.

FAUNA. The animal life of a region.

FLOODPLAIN. Nearly level land on either or both sides of a channel that is subject to overflow flooding.

FLORA. The sum total of the kinds of plants in an area at one time.

FLOTATION. Method of mineral separation whereby a froth created in water by a variety of reagents floats some finely crushed minerals whereas others sink.

FLYROCK. Rock that is thrown through the air from detonation of explosives. Flyrock is normally the result of a poorly designed blast, error or weak zones in the material being blasted.

FOOT WALL. The foot wall is the material below a fault or ore zone. If a tunnel was driven into the ore or fault, it would be the material underfoot.

FORMATION. A body of rock strata that consists dominantly of a certain lithologic type or combination of types. Formations may be combined into groups or subdivided into members.

FUGITIVE DUST. Wind-borne soil particles which are the result of development activities (e.g., construction equipment, etc.). This dust can be very limited locally or quite extensive in distribution.

GEOCHEMISTRY. The study of the distribution and amounts of the chemical elements in minerals, ores, rocks, soils, water and the atmosphere, and their circulation in nature, on the basis of the properties of their atoms and ions.

GEOTECHNICAL. A branch of engineering concerned with the engineering design aspects of slope stability, settlement, earth pressures, bearing capacity, seepage control and erosion.

GRADE. The relative quantity or percentage of metal content in an ore body.

HABITAT. The place where a plant or animal naturally or normally lives or grows.

HANGING WALL. The hanging wall is the rock above the fault or ore zone looking in cross section. If a tunnel was driven into the ore or fault, it would be the material hanging overhead.

HARD ROCK. Rock that requires drilling and blasting for its economical removal.

HEAP LEACH PAD. A facility lined by impermeable material to collect the leach solutions which are slowly applied to a pile of ore placed in several layers onto the pad.

HERPETOFAUNA. The reptiles and amphibians of a specified region or time.

HERTZ (Hz). One hertz is one cycle per second. The term is used to express the frequency of ground vibration and airbase.

HIGHBALL. The highball is the face of rock from the ore or pit bottom to the surface.

HYDRAULIC CONDUCTIVITY. The rate at which water is transmitted under a unit hydraulic head. The hydraulic conductivity of an aquifer is its transmissivity divided by the aquifer thickness.

HYDRAULIC CONNECTION. The condition when two aquifers are in communication with one another in a manner that allows mixing of water between the two aquifers. The mixing can occur through fractures, physical contact of the aquifers and open holes penetrating both aquifers.

HYDRAULIC GRADIENT. Pressure gradient, or rate of change in the head pressure per unit of distance of flow, at a given point and in a given direction. It is the driving force for movement of water through an aquifer.

IMPACT AREA. That area affected by a development project.

IMPACTS. Environmental changes resulting from a proposed action. Included are direct impacts, which are caused by the action and occur at the same time and place, and indirect impacts, which are caused by the action and are later in time or further removed in distance, but which are still reasonably foreseeable. Indirect impacts may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems. Impacts and effects as used in the EIS are synonymous. Impacts include ecological (such as the effects on natural resources and on the components, structures and functioning of affected ecosystems), aesthetic quality, historic, cultural, economic, social or health effects, whether direct, indirect or cumulative. Impacts may also include those resulting from actions that may have both beneficial and detrimental effects, even if on the balance the agency believes that the effects will be beneficial.

INDIRECT IMPACTS. Impacts that are caused by the action and are later in time or farther removed in distance, but still reasonably foreseeable (40 CAR 1508.8). Synonymous with indirect effects.

INFRASTRUCTURE. The foundation underlying a nation's, region's or community's economy (e.g., transportation and communications systems, power facilities, schools, hospitals, etc.).

INTERDISCIPLINARY TEAM (IT). A group of individuals with different training assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad to adequately solve the problem.

ISSUE OF CONCERN. A point, matter or question of public discussion or interest to be considered through the environmental analysis.

JOINT. A fracture in rock, more or less vertical or transverse to bedding, along which no appreciable movement has taken place.

KEY OBSERVATION POINTS. Points selected as representative of the possible views of a project.

LANDLORD. An area defined by its particular combination of bedrock and soils, erosion processes and climatic influences.

LAND USE. The primary or primary and secondary use(s) of land, such as Copeland, woodland, pastureland, etc.

LEACHATE. Solution of soluble materials formed from percolation of water through strata.

LEACHING. The removal of the more soluble materials by percolating waters.

LINED POND. A water storage facility with an amended soil layer or other type of material covering the bottom and slopes to prevent leakage of fluids.

LOAMY. Soils intermediate in texture and properties between fine-textured and coarse-textured soils.

METEOROLOGICAL. Of, or pertaining to, weather or climate.

MINE DEVELOPMENT. The operations involved in preparing a mine for ore extraction, including tunneling, sinking, crosscutting, drifting and raising.

MINE WATER. Groundwater collected in a mine and drainage from the associated tailings.

MINERALIZATION. The process by which valuable mineral or minerals are introduced into a rock, resulting in a potential or actual ore deposit.

MINING PLAN OF OPERATION (MPO). A document required from any person proposing to conduct mineral-related activities on federal lands.

MITIGATION. Mitigation includes: (a) avoiding the impact altogether by not taking a certain action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action and (e) replacing or providing substitute resources or environments.

MODEL. A representative of reality used to describe, analyze or understand a particular concept. A "model" may be a relatively simple qualitative description of a system or organization, or a highly abstract set of mathematical equations.

MONITORING. Efforts to systematically watch, observe or measure environmental conditions to track changes.

NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 (NEPA). Public Law 91-190. Establishes environmental policy for the nation. Among other items, NEPA requires federal agencies to consider environmental values in the decision-making process.

NATIONAL HISTORIC PRESERVATION ACT OF 1966. An Act which declares a national policy of historic preservation (defined in the Act as "the protection, rehabilitation, restoration and reconstruction of districts, sites, building, structures, and objects significant in American history, architecture, archaeology, or culture"), including the encouragement of preservation on the state and private levels.

NATIONAL REGISTER OF HISTORIC PLACES (RHP). A listing (maintained by the National Park Service) of areas designated as being of historical significance. The Register includes places of local and state significance as well as those of value to the nation.

NO ACTION ALTERNATIVE. Required by the National Environmental Policy Act, this alternative analyzes the effects of continuing management under existing direction in approved management plans.

OREBODY. A continuous, well-defined mass of material containing enough ore to make extraction economically feasible.

PATENTED LAND. A mining claim for which the U.S. government has conveyed the fee simple interest in the surface and minerals into private ownership.

PERENNIAL STREAM. A stream with year-round surface flow.

PERMEABILITY. A qualitative description of the ability of material such as rock to transmit fluid. Similar to but not the same as hydraulic conductivity.

pH. A measure of the acidity or basicity of a solution.

PLANT COMMUNITY. An assemblage Charateariest by certain plant species which are inconspicuous or unrepresented in other assemblages, and wherever areas of equivalent environment are encountered, whether continuous or detached, essentially the same plant assemblage reappears.

POTABLE WATER. Water suitable for drinking or cooking, from both health and aesthetic considerations.

PREDATOR. Any animal that kills and consumes another animal.

PREGNANT SOLUTION. A precious metals-bearing cyanide solution which contains sufficient quantities of gold that can be sent to the precious metal recovery plant to remove the gold from the solution.

PROCESS WATER. Water used in the mill and associated facilities during ore processing.

PROPOSED ACTION. A description of the project as proposed by the project proponent in the mining plan of operations.

PSEUDOSTATIC SAFETY FACTOR. The numerical result of dividing the forces resisting movement of an earthmass or structure by the forces compelling movement of the same. The calculation takes into consideration the seismic forces that could be applied to an earthmass or structure. A force is included in the calculations for the acceleration that would be likely from a seismic event. This force increases the forces compelling motion of an earthmass or structure and results in a lowered factor of safety. The greater the safety factor, the more stable the structure. A safety factor of less than one indicates a structure is unstable.

PUMPING TEST. A test made by pumping groundwater from a well for a period of time and observing the change in hydraulic head in the aquifer. A pumping test is commonly used to determine the yield of the well and the hydraulic characteristics of the aquifer. Also called aquifer test.

RAPTOR. A predatory bird, such as an eagle, hawk, falcon, owl or vulture.

REAGENT. A substance used to chemically react with another substance to create or maintain a desired product or process condition.

RECLAMATION. Returning disturbed lands to the form and productivity that is ecologically balanced and in conformity with BLM and/or state guidelines or regulations.

RECORD OF DECISION. A document separate from, but associated with, an environmental impact statement which states the decision, identifies all alternatives, specifying which were environmentally preferable, and states whether all practicable means to avoid environmental harm from the alternative have been adopted, and if not, why not.

RUN-OF-MINE. Ore which is not crushed prior to processing.

SANDY. Soils which are more than 35 percent, by volume, coarser than two mm, with enough fines to fill interstices larger that one mm.

SCALED DISTANCE FACTOR. A ratio used to estimate and control ground vibrations. As commonly used, the scaled distance is the distance from the blast to the point of concern, divided by the square root of the weight of explosives detonated per delay. The delay period must be at least eight milliseconds.

SCAT. A feces or dropping, especially of a mammal or carnivorous bird.

SCOPING PROCESS. A part of the National Environmental Policy Act (NEPA) process; early and open activities used to determine the scope and significance of the issues and the range of actions, alternatives and impacts to be considered in an environmental impact statement (EIS).

SEISMIC. Pertaining to an earthquake or earth vibration, including those that are artificially induced.

SENSITIVE SPECIES. Plant or animal species which are susceptible or vulnerable to activity impacts or habitat alterations; a plant or animal species recognized as needing special management to prevent placement on federal or state lists.

SIGNIFICANT ENVIRONMENTAL IMPACT. A substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the proposed action including land, air, water, minerals, flora, fauna, ambient noise, the socioeconomic environment and objects of historic or aesthetic value.

SLUG TEST. Use of water level measurements taken at a single well to calculate water transmission and storage where a volume of water has been instantaneously added to or removed from the well. The calculation of aquifer represent-time of the region very close to the well.

SLURRY. A highly fluid mixture of water and finely divided material (e.g., tailings) for movement by pipeline.

SOCIOECONOMIC. Pertaining to, or signifying, the characteristics or interaction of social and economic factors.

SOIL HORIZON. A layer of soil or soil material approximately parallel to the land surface and differing from adjacent, genetically related layers in physical, chemical and biological properties or characteristics, such as color, structure, texture, consistency, kinds and numbers of organisms present, degree of acidity or alkalinity, etc.

SOIL MAPPING UNIT. A kind of soil or miscellaneous area or a combination of soils or of soil(s) and miscellaneous area(s) that can be shown at the scale of mapping for the defined purposes and objectives of the survey. Soil mapping units are the basis for the delineations of a soil survey map, and are generally designed to reflect significant differences in use and management.

SOIL STOCKPILE. Location within the mine and process area where excavated soils are stockpiled for future revegetation purposes.

STANDARDS AND GUIDELINES. Principles specifying conditions or levels of environmental quality to be achieved.

STATIC SAFETY FACTOR. The static safety factor is the numerical result of dividing the forces resisting movement of an earthmass or structure by the forces compelling movement of the same. At a safety factor of one, these forces are equal. The greater the safety factor, the more stable the structure. A safety factor of less than one indicates a structure is unstable. See PSEUDOSTATIC SAFETY FACTOR.

STEMMING. The material used to fill a blast hole from the top of the explosives to the surface. The amount of stemming (length of the blast hole filled with stemming) is important in the confinement of the blast and the control of airblast.

STORAGE COEFFICIENT. The volume of water released from storage in each vertical column on the aquifer having a base of one foot square when the water table or other piezometric surface declines one foot.

TAILINGS. Those portions of washed or milled ore that are regarded as too poor to be treated further, as distinguished from the concentrates, or material of value.

TAKE. Action which results in the killing of an animal.

THREATENED SPECIES. Those plant or animal species likely to become endangered species throughout all or a significant portion of their range within the foreseeable future.

TOPOGRAPHY. The configuration of a surface including its relief, elevation and the position of its natural and human-created features.

TRANSMISSIVITY. The rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. Transfix-solvates greater than 100,000 gpd/ft of drawdown represent good aquifers.

UNDERGROUND MINE WORKINGS. The entire collection of adits, declines and scoping making up an underground mine.

UNNECESSARY OR UNDUE. In conjunction with the degradation of lands, describes activities which would cause environmental impacts greater than what would normally occur for specific activities, or would be necessary to conduct specific activities.

UNPATENTED LAND. A mining claim for which the U.S. government has not conveyed the fee simple interest in the surface and minerals into private ownership; these lands are managed by federal governmental agencies, such as the BLM, but can be used by private parties for mining purposes.

VEGETATION TYPE. A plant community with distinguishable characteristics.

VISUAL RESOURCE MANAGEMENT SYSTEM (VRMS). A system of managing visual resources that establishes visual quality objectives and evaluates the capability of various landscapes to accept modification or alteration.

VISUAL RESOURCE. The composite of basic terrain, geologic features, water features, vegetative patterns and land use effects that typify a land unit and influence the visual appeal the unit may have for visitors.

WASTE ROCK DUMP. Location within the mine and process area where excavated waste rock (e.g., rock having no value as ore) is stockpiled or permanently disposed.

WATERS OF THE U.S. A jurisdictional term from Section 404 of the Clean Water Act referring to water bodies such as lakes, rivers, streams (including ephemeral and/or intermittent streams, drainages, streambeds, washes, water-courses), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes or natural ponds. The use, degradation or destruction of these waters could affect interstate or foreign commerce.

WETLANDS. Areas that have a predominance of hydric soils inundated or saturated by surface or ground water at a frequency and duration sufficient to support (and under normal circumstances do or would support) a prevalence of hydrophytic vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

CHAPTER 11

INDEX OF KEY WORDS

11.0 INDEX OF KEY WORDS

APPENDIX A

AQUIFER TEST RESULTS

TABLE A-1
Aquifer Test Results

Well Identification	Date Tested	Company	Test Method	Host Rock	Hydrogeologic Unit	Saturated Thickness (feet)	Transmissivity (gpd/ft)	Hydraulic Conductivity (feet/day)	Analysis Method	Estimated Long-term Yield (gpm)
SUL	4/96	GWRC	Pumping	Meta-sediments	BCAS	313	96	0.041	Cooper and Jacob (1946)	Not Evaluated
TW-1	3/96	GWRC	Pumping	Meta-volcanics	BCAS	340	800	0.31	Cooper and Jacob (1946)	6-9
YMC-01	4/95	SMI	Slug	Granitics	BCAS	69	360	0.69	Bouwer and Rice (1976)	Not Evaluated
YMC-02	4/95	SMI	Slug	Granitics (Yarnell fault)	BCAS	72	8.8	0.017	Cooper et al. (1967)	Not Evaluated
YMC-03	4/95	SMI	Slug	Granitics	BCAS	70	4.6	0.0088	Cooper et al. (1967)	Not Evaluated
YMC-04	4/96	GWRC	Pumping	Granitics	BCAS	109	260 (drawdown) 1,160 (recovery)	0.32 (drawdown) 1.5 (recovery)	Cooper and Jacob (1946)	20
YMC-05	12/97	GWRC	Pumping	Granitics	BCAS		9.7	85	Cooper and Jacob (1946)	Not Evaluated
YMC-06	1/97	GWRC	Pumping	Granitics	BCAS		13.3	200	Cooper and Jacob (1946)	Not Evaluated
2BCD	6/96	GWRC	Pumping	Basalt and Alluvium	AAS	275	500	0.24	Cooper and Jacob (1946)	50
Section 28 Well Field (Wells 1, 4, 5)	8/96	GWRC	Pumping	Cemented Conglomerate	AAS	400	2,000	0.67	Cooper and Jacob (1946)	60

Notes: SMI = Shepherd Miller, Inc.
GWRC = Groundwater Resources Consultants, Inc.
gpd/ft - gallons per day per foot
Slug tests and pumping tests are standard methods used in hydrologic analysis.
Pumping Test - use of water level measurements from observation wells to calculate the water transmission and storage properties of an aquifer. The calculation is averaged over a large aquifer volume.
Slug Test - use of water level measurements taken at a single well to calculate water transmission and storage where a volume of water has been instantaneously added to or removed from the well. The calculation of aquifer properties is representative of the region very close to the well.
Transmissivity - rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. Transmissivities greater than 100,000 gpd/ft of drawdown represent good aquifers.
Hydraulic Conductivity - rate at which water is transmitted under a unit hydraulic head. The hydraulic conductivity of an aquifer is its transmissivity divided by the aquifer thickness. The values for the BCAS are typical of unfractured to fractured igneous and metamorphic rocks, while those of the AAS are typical of cemented sediment.

APPENDIX B

GROUNDWATER ELEVATION DATA

TABLE B-1
Groundwater Elevation Data

Well Identification	Measuring Point* Elevation (ft)	Date Measured	Depth to Groundwater (ft)	Water Level* Elevation (ft)
YMC-01	4594.75	4/13/95	14.53	4580.22
	4594.75	5/22/95	0.54	4594.21
	4594.75	6/29/95	15.10	4579.65
	4594.75	7/17/95	14.95	4579.80
	4594.75	8/14/95	14.80	4579.95
	4594.75	9/19-20/95	14.90	4579.85
	4594.75	3/15/96	14.75	4580.00
	4594.75	3/30/96	14.93	4579.82
	4594.75	4/15/96	14.96	4579.79
	4594.75	1/30/97	14.72	4580.00
	4594.75	4/30/97	15.18	4579.60
	4594.75	7/30/97	17.04	4577.70
	4594.75	10/30/97	15.40	4579.40
	4594.75	1/12/98	14.28	4580.47
	4594.75	2/11/98	13.49	4581.26
	4594.75	3/19/98	14.75	4580.00
YMC-02	4597.11	4/13/95	4.21	4592.90
	4597.11	5/22/95	7.10	4590.01
	4597.11	6/29/95	14.25	4582.86
	4597.11	7/17/95	13.15	4583.96
	4597.11	8/14/95	15.47	4581.64
	4597.11	9/19-20/95	15.90	4581.21
	4597.11	3/14/96	19.27	4577.84
	4597.11	3/30/96	18.90	4578.21
	4597.11	4/15/96	19.23	4577.88
	4597.11	1/30/97	24.85	4572.26
	4597.11	4/30/97	20.92	4576.20
	4597.11	7/30/97	24.99	4572.10
	4597.11	10/30/97	21.77	4575.30
	4597.11	1/12/98	18.93	4578.18
	4597.11	2/11/98	15.26	4581.85

TABLE B-1 (Continued)
Groundwater Elevation Data

Well Identification	Measuring Point* Elevation (ft)	Date Measured	Depth to Groundwater (ft)	Water Level* Elevation (ft)
YMC-03	4647.75	4/13/95	40.17	4607.58
	4647.75	5/22/95	44.00	4603.75
	4647.75	6/29/95	50.45	4597.30
	4647.75	7/17/95	54.20	4593.55
	4647.75	8/14/95	58.20	4589.55
	4647.75	9/19-20/95	61.25	4586.50
	4647.75	3/15/96	71.96	4575.79
	4647.75	3/30/96	72.64	4575.11
	4647.75	4/15/96	73.26	4574.49
	4647.75	1/30/97	81.97	4565.78
	4647.75	4/30/97	83.37	4564.40
	4647.75	7/30/97	83.41	4564.30
	4647.75	10/30/97	83.50	4564.30
	4647.75	1/12/98	83.45	4564.30
	4647.75	2/11/98	82.71	4565.04
YMC-04	4687.83	4/13/95	20.50	4667.33
	4687.83	5/22/95	27.52	4660.31
	4687.83	6/29/95	31.35	4656.48
	4687.83	7/17/95	33.05	4654.78
	4687.83	8/14/95	34.65	4653.18
	4687.83	9/19-20/95	35.75	4652.08
	4687.83	3/15/96	39.55	4648.28
	4687.83	3/30/96	40.15	4647.68
	4687.83	4/3/96	40.33	4647.50
	4687.83	1/30/97	48.95	4638.88
	4687.83	4/30/97	49.94	4637.90
	4687.83	7/30/97	52.05	4635.80
	4687.83	10/30/97	51.68	4636.20
	4687.83	1/12/98	51.87	4635.96
	4687.83	2/11/98	48.61	4639.22
	4687.83	3/19/98	33.44	4654.39
TW-1	4060.00	3/20/96	19.31	4040.69
	4060.00	7/3/96	23.14	4036.86
	4060.00	10/2/96	24.67	4035.33
	4060.00	12/16/96	24.38	4035.62

Well Identification	Measuring Point* Elevation (ft)	Date Measured	Depth to Groundwater (ft)	Water Level* Elevation (ft)
TW-2	4065.00	3/15/96	43.01	4021.99
	4065.00	3/30/96	43.37	4021.63
	4065.00	4/15/96	43.47	4021.53
TW-3	3920.00	3/15/96	18.01	3901.99
	3920.00	3/30/96	17.78	3902.22
	3920.00	4/15/96	17.61	3902.39
WILHITE	4765.00	3/30/96	11.98	4753.02
	4765.00	4/15/96	12.39	4752.61
	4765.00	5/1/96	12.82	4752.18
ANDERSON	4860.00	3/30/96	19.57	4840.43
	4860.00	4/15/96	19.64	4840.36
WASSON	4770.00	3/30/96	23.94	4746.06
	4770.00	4/15/96	24.09	4745.91
UPPER GLEN ILAH	4925.00	3/30/96	19.67	4905.33
	4925.00	4/15/96	19.82	4905.18
SUL	3845.00	3/15/96	15.79	3829.21
	3845.00	3/30/96	16.37	3828.63
	3845.00	4/17/96	20.97	3824.03
MICHAEL (active)	3790.00	3/15/96	48.73	3741.27
	3790.00	4/17/96	49.00	3741.00
MICHAEL (inactive)	3798.00	3/15/96	57.23	3740.77
	3798.00	4/17/96	57.39	3740.61
STOCK	4860.00	3/12/96	22.87	4837.13
	4860.00	4/17/96	22.37	4837.63
WHITE SHED	3660.00	4/15/96	53.98	3606.02
RICH HILL CLAIM	3570.00	4/15/96	47.74	3522.26
STANTON WINDMILL	3460.00	4/15/96	35.55	3424.45
SPRING	4440.00	4/15/96	6.48	4433.52
PARKER WINDMILL	3300.00	4/16/96	96.69	3203.31
PARKER	3200.00	4/17/96	468.79	2731.21
OLD CITY WATER	4830.00	4/17/96	9.31	4820.69
HARVEY	4833.00	4/18/96	12.89	4820.11
ALVARADO MINE	3370.00	4/16/96	0.00	3370.00
ADIT	3610.00	4/16/96	10.00	3600.00

* Elevation in feet above mean sea level.

APPENDIX C

WATER QUALITY TABLES

TABLE C-1
Water Quality Analytical Results for Well YMC-01

Well ID Date Sampled Client ID Lab ID	AWQS*	YMC-01 4-11-95 YMC-01-01 504768-02	YMC-01 6-15-95 YMC-95-06-14-01 506874-01	YMC-01 8-15-95 YMC-15-08-95-01 508795-01	YMC-01 9-20-95 YMC-20-09-95-01 509804-02	YMC-01 1-3-96 YMC1-3-96-1 601527-04	YMC-01 4/25/96 YMC-25-4-96-1 601527-04	YMC-01 6/26/96 YMC-26-6-96-1 606963-02	YMC-01 12/12/96 YMC 12/12/96 - 1 612722-04
ANALYTE									
Field pH	[6.5 - 8.5]	6.68	7.05	7.02	6.08	7.04	7.01	6.54	6.85
Field conductivity (mS/cm)		675	700	684	722	726	760	713	818
Field temperature (°C)		21.4	18.5	18.5	18	15.6	17.7	18.8	17.8
Lab pH	[6.5 - 8.5]	6.9	7.3	7	7.4	7.2	7.1	7.1	7.5
Lab conductivity (mS/cm)		665	668	670	655	681	684	669	691
Total dissolved solids (mg/l)	[500]	460	440	470	470	450	480	490	470
Sulfate (mg/l)	[250]	81	80	96	85	93	94	100	90
Chloride (mg/l)	[250]	32	34	31	30	32	33	31	30
Fluoride (mg/l)	4.0	0.53	0.51	0.53	0.51	0.51	0.51	0.48	0.54
Carbonate (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Bicarbonate (mg/l $CaCO_3$)		223	218	229	230	228	238	219	242
Hydroxide (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Total alkalinity (mg/l $CaCO_3$)		223	218	229	230	228	238	219	242
NO_2/NO_3 - N, Total (mg/l as N)	10.0	2.6	2.8	2.5	2.6	2.8	2.5	2.6	2.6
Calcium (mg/l)		110	108	106	100	101	101	95.4	106
Magnesium (mg/l)		12.9	12.7	13	11.5	12.1	11.5	10.8	12
Potassium (mg/l)		1.8	1.2	2	1.5	1.5	1.2	1.4	1.8
Sodium (mg/l)		33.4	34.2	30	32.4	31.4	32.5	30.7	32.4
Antimony (mg/l)	0.006	0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Arsenic (mg/l)	0.05	0.01	0.013	0.012	0.013	0.013	0.011	0.011	0.011
Barium (mg/l)	2.0	0.019	0.021	-0.1	0.015	0.016	0.016	0.015	0.015
Beryllium (mg/l)	0.004	-0.004	-0.004	-0.005	-0.005	-0.004	NA	-0.004	NA
Cadmium (mg/l)	0.005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
Chromium (mg/l)	0.1	-0.01	-0.01	-0.01	-0.005	-0.01	NA	0.017	NA
Copper (mg/l)	[1.0]	-0.01	-0.01	-0.01	-0.005	0.014	NA	-0.01	NA
Iron (mg/l)	[0.3]	-0.05	-0.05	-0.05	-0.005	-0.05	-0.05	0.082	-0.05
Lead (mg/l)	0.05	0.008	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Manganese (mg/l)	[0.05]	-0.01	0.01	NA	-0.005	-0.01	-0.01	-0.01	-0.01
Mercury (mg/l)	0.002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
Nickel (mg/l)	0.1	-0.02	-0.02	-0.02	-0.005	-0.02	NA	-0.02	NA
Selenium (mg/l)	0.05	-0.005	-0.005	-0.005	-0.005	-0.005	NA	-0.005	NA
Silver (mg/l)	[0.1]	-0.01	-0.01	-0.01	-0.005	-0.01	NA	-0.01	NA
Thallium (mg/l)	0.002	-0.002	-0.002	-0.002	-0.002	-0.002	NA	-0.005	NA
Zinc (mg/l)	[5.0]	0.277	-0.05	-0.02	-0.025	-0.05	-0.05	0.063	-0.05
Gross alpha (pCi/L)	15	-11	NA	NA	NA	NA	-4.4	9.1	NA
Gross beta (pCi/L)	50	-5.7	NA	NA	NA	NA	-12	-5.3	NA
Cyanide, total (mg/l)	0.2	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cyanide, free (mg/l)		NA	NA	NA	NA	NA	NA	-0.01	NA

NA = Not analyzed
Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
* Aquifer water quality standards; numbers in brackets are federal secondary water quality standards.
# Concentration exceeds drinking water standard or secondary maximum contaminant level.

mS/cm = millimhos per centimeter; mho is the reciprocal ohm.
°C = Degrees Centigrade
mg/l = Milligrams (one thousandth of a gram) per liter.
pCi/L = Picocurries per liter.
N = Nitrogen

TABLE C-2
Water Quality Analytical Results for Well YMC-02

Well ID Date Sampled Client ID Lab ID	AWQS*	YMC-02 4-10-95 YMC-02-01 504768-01	YMC-02 6-14-95 YMC-95-06-14-02 506874-02	YMC-02 8-14-95 YMC-14-08-95-02 508797-02	YMC-02 9-19-95 YMC-19-09-95-02 509806-01	YMC-02 1-2-96 YMC1-2-96-2 601527-01	YMC-02 4-24-96 YMC-24-04-96-2 604925-03	YMC-02 8/21/96 YMC-21-08-96-2 608850-02	YMC-02 12/11/96 YMC-12/11/96-2 612722-01
ANALYTE									
Field pH	[6.5 - 8.5]	6.74	7.02	6.50	6.60	6.96	5.56	7.00	6.95
Field conductivity (mS/cm)		843	821	800	857	851	830	973	1172
Field temperature (°C)		15.8	22.7	25	20.5	18.0	21.1	23	18.4
Lab pH	[6.5 - 8.5]	6.9	7.3	7.4	7.4	7.3	7.2	7.4	7.9
Lab conductivity (mS/cm)		789	783	759	794	782	797	790	796
Total dissolved solids (mg/l)	[500]	490	480	**510#**	**510#**	480	**510#**	490	**510#**
Sulfate (mg/l)	[250]	56	50	59	54	51	55	56	50
Chloride (mg/l)	[250]	29	29	27	26	28	28	26	25
Fluoride (mg/l)	4.0	1.22	1.21	1.12	1.29	1.31	1.22	1.46	1.44
Carbonate (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Bicarbonate (mg/l $CaCO_3$)		354	368	373	369	373	370	371	384
Hydroxide (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Total alkalinity (mg/l $CaCO_3$)		354	368	373	369	373	370	371	384
NO_2/NO_3 - N, Total (mg/l as N)	10.0	0.55	0.57	0.53	0.48	0.57	0.59	0.62	0.63
Calcium (mg/l)		106	105	111	90.8	100	93.5	90.8	107
Magnesium (mg/l)		28.2	27	26	22.2	25.1	22.8	20.4	24.2
Potassium (mg/l)		1.4	1.1	2	1.6	1.8	1	1	1.8
Sodium (mg/l)		51.8	51.3	47	44.4	55.7	47.9	50	57.1
Antimony (mg/l)	0.006	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Arsenic (mg/l)	0.05	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	0.003	-0.003
Barium (mg/l)	2.0	0.046	0.188	0.2	0.257	0.167	0.108	0.2	0.131
Beryllium (mg/l)	0.004	-0.004	-0.004	-0.005	-0.005	-0.004	NA	NA	NA
Cadmium (mg/l)	0.005	-0.0005	-0.0005	-0.005	-0.0005	-0.0005	-0.00005	-0.0005	-0.0005
Chromium (mg/l)	0.1	-0.01	-0.01	-0.01	-0.005	-0.01	NA	NA	NA
Copper (mg/l)	[1.0]	-0.01	-0.01	-0.01	-0.005	0.012	NA	NA	NA
Iron (mg/l)	[0.3]	-0.05	-0.05	-0.1	**0.324#**	0.065	0.058	0.03	-0.05
Lead (mg/l)	0.05	0.008	-0.002	-0.002	-0.002	-0.002	-0.002	0.003	-0.002
Manganese (mg/l)	[0.05]	**0.21#**	**0.871#**	NA	**0.893#**	**0.45#**	**0.105#**	**0.15#**	**0.065#**
Mercury (mg/l)	0.002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
Nickel (mg/l)	0.1	-0.02	-0.02	-0.02	-0.005	-0.02	NA	NA	NA
Selenium (mg/l)	0.05	-0.005	-0.005	-0.005	-0.005	-0.005	NA	NA	NA
Silver (mg/l)	[0.1]	-0.01	-0.01	-0.01	-0.005	-0.01	NA	NA	NA
Thallium (mg/l)	0.002	-0.002	-0.002	-0.002	-0.002	-0.002	NA	NA	NA
Zinc (mg/l)	[5.0]	0.142	-0.05	-0.02	-0.025	-0.05	0.059	0.07	0.09
Gross alpha (pCi/L)	15	-15	NA	NA	NA	NA	7.3	NA	NA
Gross beta (pCi/L)	50	-6.5	NA	NA	NA	NA	-15	NA	NA
Cyanide, total (mg/l)	0.2	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cyanide, free (mg/l)		NA	NA	NA	NA	NA	NA	NA	NA

NA = Not analyzed
Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
* Aquifer water quality standards; numbers in brackets are federal secondary water quality standards.
# Concentration exceeds drinking water standard or secondary maximum contaminant level.

mS/cm = millimhos per centimeter; mho is the reciprocal ohm.
°C = Degrees Centigrade
mg/l = Milligrams (one thousandth of a gram) per liter.
pCi/L = Picocurries per liter.
N = Nitrogen

TABLE C-3
Water Quality Analytical Results for Well YMC-03

Well ID / Date Sampled / Client ID / Lab ID	AWQS*	YMC-03 4-12-95 YMC-03-01 504768-03	YMC-03 6-15-95 YMC-95-06-14-03 506874-03	YMC-03 8-14-95 YMC-14-08-95-03 506874-04	YMC-03 9-19-95 YMC-19-09-95-03 509806-02	YMC-03 1-2-96 YMC1-2-96-3 601527-02	YMC-03 4-24-96 YMC-24-4-96-3 604925-02	YMC-03 8-21-96 YMC-21-8-96-3 608850-05	YMC-03 12-11-96 YMC-12-11-96-3 612722-02
ANALYTE									
Field pH	[6.5 - 8.5]	6.57	7.01	6.79	6.76	6.99	6.95	6.84	6.95
Field conductivity (mS/cm)		1021	1040	1022	1042	1043	1070	1038	1172
Field temperature (°C)		19.4	20.8	23.7	23.0	18.2	22.9	25.9	18.4
Lab pH	[6.5 - 8.5]	7	7.9	7.5	NA	7.2	7.1	7.3	7.4
Lab conductivity (mS/cm)		977	970	946	NA	949	979	976	994
Total dissolved solids (mg/l)	[500]	**640#**	**610#**	**620#**	**610#**	**600#**	**620#**	**610#**	**620#**
Sulfate (mg/l)	[250]	81	70	78	73	67	73	84	80
Chloride (mg/l)	[250]	69	72	65	67	66	66	59	90
Fluoride (mg/l)	4.0	2.41	2.37	2.27	2.34	2.34	2.38	2.6	2.13
Carbonate (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Bicarbonate (mg/l $CaCO_3$)		363	374	389	380	378	377	385	412
Hydroxide (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Total alkalinity (mg/l $CaCO_3$)		363	374	389	380	378	377	385	412
NO_2/NO_3 - N, Total (mg/l as N)	10.0	0.8	0.56	0.48	0.59	0.64	0.62	0.37	0.11
Calcium (mg/l)		111	103	111	88.1	99.5	95.4	93	110
Magnesium (mg/l)		25.9	25.4	24	21.6	23.6	20.8	19	23.5
Potassium (mg/l)		3.1	3.4	6	3.2	3.3	2.9	3	4.1
Sodium (mg/l)		96.1	89.8	94	80.7	102	93.4	80	94.6
Antimony (mg/l)	0.006	-0.005	-0.005	-0.005	-0.025	-0.005	-0.005	-0.005	-0.005
Arsenic (mg/l)	0.05	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
Barium (mg/l)	2.0	0.051	0.406	-0.1	0.403	0.478	0.489	0.4	0.345
Beryllium (mg/l)	0.004	-0.004	-0.004	-0.005	-0.005	-0.004	NA	NA	NA
Cadmium (mg/l)	0.005	0.0008	-0.0005	-0.005	-0.0005	-0.0005	-0.0005	0.0006	-0.0005
Chromium (mg/l)	0.1	-0.01	-0.01	-0.01	-0.005	0.011	NA	NA	NA
Copper (mg/l)	[1.0]	-0.01	-0.01	-0.01	-0.005	0.015	NA	NA	NA
Iron (mg/l)	[0.3]	-0.05	**2.65#**	**4.05#**	**2.29#**	**2.6#**	**3.65#**	**7.28#**	**8.7#**
Lead (mg/l)	0.05	0.026	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Manganese (mg/l)	[0.05]	**0.239#**	**6.5#**	NA	**5.73#**	**5.87#**	**4.56#**	**3.65#**	**4.26#**
Mercury (mg/l)	0.002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
Nickel (mg/l)	0.1	-0.02	-0.02	-0.02	-0.005	-0.02	NA	NA	NA
Selenium (mg/l)	0.05	-0.005	-0.005	-0.005	-0.005	-0.005	NA	NA	NA
Silver (mg/l)	[0.1]	-0.01	-0.01	-0.01	-0.005	-0.01	NA	NA	NA
Thallium (mg/l)	0.002	-0.002	-0.002	-0.002	-0.002	-0.002	NA	NA	NA
Zinc (mg/l)	[5.0]	0.365	-0.05	-0.02	-0.025	-0.05	-0.05	-0.01	-0.05
Gross alpha (pCi/L)	15	-17	NA	NA	NA	NA	**19.8#**	NA	NA
Gross beta (pCi/L)	50	12.9	NA	NA	NA	NA	-19	NA	NA
Cyanide, total (mg/l)	0.2	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Cyanide, free (mg/l)		NA	NA	NA	NA	NA	NA	NA	NA

NA = Not analyzed
Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
* Aquifer water quality standards; numbers in brackets are federal secondary water quality standards.
# Concentration exceeds drinking water standard or secondary maximum contaminant level.

mS/cm = millimhos per centimeter; mho is the reciprocal ohm.
°C = Degrees Centigrade
mg/l = Milligrams (one thousandth of a gram) per liter.
pCi/L = Picocurries per liter.
N = Nitrogen

TABLE C-4
Water Quality Analytical Results for Well YMC-04

Well ID / Date Sampled / Client ID / Lab ID	AWQS*	YMC-04 11-16-94 -- --	YMC-04 4-13-95 OCW-01-01 504775-03	YMC-04 6-15-95 YMC-95-06-14-04 506874-04	YMC-04 8-15-95 YMC-15-08-15-04 508797-03	YMC-04 9-20-95 YMC-20-09-95-04 509804-03	YMC-04 1-3-96 YMC-1-3-96-4 601542-01	YMC-04 8-20-96 YMC-20-8-96-4 608850-04	YMC-04 12-12-96 YMC-12-12-96-4 612722-05
ANALYTE									
Field pH	[6.5 - 8.5]	--	**6.14#**	**6.40#**	**6.32#**	**5.85#**	**6.52#**	**6.47#**	6.53
Field conductivity (mS/cm)		--	910	909	952	1086	1143	1406	1422
Field temperature (°C)		--	17.9	18.7	21.6	20.5	17.1	22	19.7
Lab pH	[6.5 - 8.5]	6.7	6.6	7.0	6.8	6.8	7.0	6.7	6.8
Lab conductivity (mS/cm)		1800	874	902	920	979	1060	1340	1350
Total dissolved solids (mg/l)	[500]	**1200#**	**640#**	**650#**	**720#**	**780#**	**870#**	**1100#**	**1100#**
Sulfate (mg/l)	[250]	**510#**	**290#**	**280#**	**350#**	**370#**	**430#**	**560#**	**720#**
Chloride (mg/l)	[250]	29	32	30	25	25	25	27	27
Fluoride (mg/l)	4.0	0.70	0.78	0.78	0.77	0.79	0.83	0.76	0.64
Carbonate (mg/l $CaCO_3$)		-5	-1	-1	-1	-1	-1	-1	-1
Bicarbonate (mg/l $CaCO_3$)		180	128	132	143	141	143	147	156
Hydroxide (mg/l $CaCO_3$)		-1	-1	-1	-1	-1	-1	-1	-1
Total alkalinity (mg/l $CaCO_3$)		180	128	132	143	141	143	147	156
NO_2/NO_3 - N, Total (mg/l as N)	10.0	7.1	5.9	7.3	4.7	4.8	5.1	6.1	5.7
Calcium (mg/l)		240	115	127	141	142	156	185	217
Magnesium (mg/l)		42.0	26.0	25.2	26.0	27.5	30.6	31.2	38.0
Potassium (mg/l)		2.8	2.5	2.2	3.0	2.3	2.3	2.0	3.0
Sodium (mg/l)		50.0	50.0	46.1	46.0	46.6	56.9	53.0	62.0
Antimony (mg/l)	0.006	NA	0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Arsenic (mg/l)	0.05	-0.005	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003
Barium (mg/l)	2.0	-0.05	0.014	0.012	-0.10	0.016	0.018	-0.1	0.023
Beryllium (mg/l)	0.004	NA	-0.004	-0.004	-0.005	-0.005	-0.004	NA	NA
Cadmium (mg/l)	0.005	0.0002	-0.0005	-0.0005	-0.005	-0.0005	-0.0005	-0.0005	-0.0005
Chromium (mg/l)	0.1	-0.005	-0.01	-0.010	-0.010	-0.005	-0.010	NA	NA
Copper (mg/l)	[1.0]	-0.005	-0.010	-0.010	-0.010	-0.005	0.017	NA	NA
Iron (mg/l)	[0.3]	0.02	-0.05	-0.05	-0.1	0.068	0.286	-0.02	-0.05
Lead (mg/l)	0.05	-0.005	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Manganese (mg/l)	[0.05]	0.018	0.026	0.024	NA	0.018	0.026	0.02	0.019
Mercury (mg/l)	0.002	-0.0001	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
Nickel (mg/l)	0.1	NA	-0.020	-0.020	-0.020	-0.005	-0.020	NA	NA
Selenium (mg/l)	0.05	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	NA	NA
Silver (mg/l)	[0.1]	-0.0002	-0.010	-0.010	-0.010	-0.005	0.015	NA	NA
Thallium (mg/l)	0.002	NA	-0.002	-0.002	-0.002	-0.002	-0.002	NA	NA
Zinc (mg/l)	[5.0]	1.100	1.780	1.090	1.160	1.030	0.890	0.580	0.654
Gross alpha (pCi/L)	15	NA	-14	NA	NA	NA	NA	NA	NA
Gross beta (pCi/L)	50	NA	-6.1	NA	NA	NA	NA	NA	NA
Cyanide, total (mg/l)	0.2	NA	0.04	0.01	-0.01	-0.01	0.01	-0.01	-0.01
Cyanide, free (mg/l)		NA	0.02	-0.01	-0.01	NA	-0.01	NA	NA

NA = Not analyzed
Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
* Aquifer water quality standards; numbers in brackets are federal secondary water quality standards.
\# Concentration exceeds drinking water standard or secondary maximum contaminant level.

mS/cm = millimhos per centimeter; mho is the reciprocal ohm.
°C = Degrees Centigrade
mg/l = Milligrams (one thousandth of a gram) per liter.
pCi/L = Picocurries per liter. mg/l = Milligrams (one thousandth of a gram) per liter.
N = Nitrogen

TABLE C-5
Analytical Results for Springs Sampled in March 1996

Parameter (milligrams per liter)	Sampling location								
	Antelope Spring	Juniper Spring	Yarnell Spring	Fools Gulch Spring	Cottonwood Spring	Cox Spring	Cox Spring*	White Spring	Bovine Spring
Calcium	61.3	48.2	48.8	110	110	89.6	88.4	51.4	83.9
Magnesium	41.8	43.7	41.3	32.1	16.7	32.0	31.6	15.8	37.1
Potassium	4.3	2.1	1.9	-1.0	-1.0	2.9	1.9	1.3	1.7
Sodium	22.4	9.0	9.4	74.4	37.0	55.7	55.6	20.8	28.6
Carbonate ($CaCO_3$)	-1	-1	-1	-1	-1	-1	-1	-1	-1
Bicarbonate (as HCO_3)	395.0	336.4	337.7	445	295.0	436.4	427.9	204.8	454.7
Hydroxide ($CaCO_3$)	-1	-1	-1	-1	-1	-1	-1	-1	-1
Total alkalinity ($CaCO_3$)	324	276	277	365	242	358	351	168	373
Chloride	15	10.2	7.3	59	31	39	39	16	17
Fluoride	0.40	0.24	0.18	1.24	0.73	0.51	0.52	2.49	0.35
Sulfate	5	8	6	76	95	23	24	25	8
Nitrate (as N)	-0.06	1.09	-0.06	-0.06	0.09	-0.06	-0.06	-0.06	-0.06
Cyanide (total)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Total suspended solids	---	---	---	-10	---	---	---	---	---
Total dissolved solids	430	360	340	**630#**	490	500	500	260	460
Conductivity (lab) (umhos/cm)	585	407	486	924	681	750	747	409	675
pH (lab)	8.3	8.0	8.4	8.1	7.7	7.6	7.6	7.6	7.9
Antimony	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Arsenic	0.003	-0.003	-0.003	-0.003	0.004	0.012	0.010	-0.003	0.003
Barium	0.011	0.013	-0.010	0.084	0.080	0.029	0.028	0.046	0.042
Beryllium	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004	-0.004
Cadmium	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
Chromium (total)	0.019	0.021	0.020	0.012	-0.010	0.017	0.017	-0.010	0.019
Copper	0.013	-0.010	0.011	0.013	0.020	0.016	0.016	0.013	0.015
Iron	-0.050	-0.050	-0.050	-0.050	0.116	0.096	0.097	-0.050	-0.050
Lead	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Manganese	-0.010	-0.010	-0.010	0.047	**0.553#**	**0.137#**	**0.136#**	0.013	**0.424#**
Mercury	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002	-0.0002
Nickel	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020	-0.020
Selenium	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005	-0.005
Silver	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010	-0.010
Thallium	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
Zinc	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050	-0.050
Sample date	03-13-96	03-13-96	03-13-96	03-26-96	03-13-96	03-13-96	03-13-96	03-13-96	03-13-96

NA = Not analyzed

Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.

* Designates duplicate sample.

Concentration exceeds drinking water standard or secondary maximum contaminant level

Milligram = One thousandth of a gram.

$CaCO_3$ = Calcium Carbonate

N = Nitrogen

umhos/cm = Micromhos per centimeter, a measure of electrical conductivity. A mho is the reciprocal ohm. Micro = one millionth.

TABLE C-6
Analytical Results for Creeks Sampled in March/April 1996

Parameter (milligrams per liter)	Sampling location			
	Lower Antelope Creek	Upper Antelope Creek	East Antelope Creek	Yarnell Creek
Calcium	51.6	48.2	55.2	56.6
Magnesium	46.6	44.1	41.2	48.7
Potassium	1.9	2.9	2.1	-1.0
Sodium	25.4	12.6	23.3	94.1
Carbonate ($CaCO_3$)	-1	-1	6	-1
Bicarbonate (as HCO_3)	374	362	355	456
Hydroxide ($CaCO_3$)	-1	-1	-1	-1
Total alkalinity ($CaCO_3$)	307	297	297	374
Chloride	16	8.4	15	47
Fluoride	0.44	0.25	0.50	0.78
Sulfate	15	9	9	64
Nitrate (as N)	-0.06	0.07	-0.06	-0.06
Cyanide (total)	-0.01	-0.01	-0.01	-0.01
Total suspended solids	—	-10	—	-10
Total dissolved solids	390	370	360	570
Conductivity (lab) (umhos/cm)	581	537	535	890
pH (lab)	8.3	8.3	8.4	8.2
Antimony	-0.005	-0.005	-0.005	-0.005
Arsenic	0.004	-0.003	-0.003	-0.003
Barium	0.041	-0.010	0.117	0.058
Beryllium	-0.004	-0.004	-0.004	-0.004
Cadmium	-0.0005	-0.0005	-0.0005	-0.0005
Chromium (total)	0.021	0.028	0.020	0.039
Copper	0.012	-0.010	0.012	-0.010
Iron	-0.050	-0.050	-0.050	-0.050
Lead	-0.002	-0.002	-0.002	-0.002
Manganese	-0.010	-0.010	-0.010	-0.010
Mercury	-0.0002	-0.0002	-0.0002	-0.0002
Nickel	-0.020	-0.020	-0.020	-0.020
Selenium	-0.005	-0.005	-0.005	-0.005
Silver	-0.010	-0.010	-0.010	-0.010
Thallium	-0.002	-0.002	-0.002	-0.005
Zinc	-0.050	-0.050	-0.050	-0.050
Sample date	03-13-96	03-26-96	03-13-96	04-19-96

NA = Not analyzed
Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
* Designates duplicate sample.
# Concentration exceeds drinking water standard or secondary maximum contaminant level
Milligram = One thousandth of a gram.
$CaCO_3$ = Calcium Carbonate
N = Nitrogen
umhos/cm = Micromhos per centimeter, a measure of electrical conductivity. A mho is the reciprocal ohm. Micro = one millionth.

TABLE C-7
Water Quality Results for Water Resource Study Area
Wells Sampled in April 1996

Parameter (milligrams per liter)	Well sampling location					
	AWQS*	TW-1	Sul	Michael	Wilhite	Harvey
Calcium		87.2	107	82.1	170	97.4
Magnesium		20.2	31.0	57.5	27.9	19.2
Potassium		2.1	1.5	1.8	1.6	-1.0
Sodium		49.2	49.0	110	84.8	40.0
Carbonate ($CaCO_3$)		-1	-1	-1	-1	-1
Bicarbonate (as HCO_3)		353	445	524	391	268
Hydroxide ($CaCO_3$)		-1	-1	-1	-1	-1
Total alkalinity ($CaCO_3$)		290	365	430	321	220
Chloride	[250]	34	30	100	210	75
Fluoride	4.0	1.07	**2.35#**	0.86	1.08	0.58
Sulfate	[250]	63	86	33	80	64
Nitrate (as N)	10.0	0.11	0.28	13	0.12	3.4
Physical cyanide (total)	0.2	-0.01	-0.01	-0.1	-0.01	-0.01
Total suspended solids		---	---	---	---	---
Total dissolved solids	[500]	490	**590#**	**730#**	**870#**	490
Conductivity (lab) (umhos/cm)		716	864	1150	1310	749
pH (lab)	[6.5 - 8.5]	7.5	7.2	7.6	7.2	7.5
Antimony	0.006	-0.005	-0.005	-0.005	-0.005	-0.005
Arsenic	0.05	-0.003	-0.003	-0.003	-0.003	-0.003
Barium	2.0	0.052	0.039	0.018	0.128	0.103
Beryllium	0.004	-0.004	-0.004	-0.004	-0.004	-0.004
Cadmium	0.005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
Chromium (total)	0.1	0.016	0.021	0.043	0.031	0.023
Copper	[1.0]	-0.010	-0.010	-0.010	-0.010	-0.010
Iron	[0.3]	0.075	-0.050	-0.050	-0.050	-0.050
Lead	0.05	-0.002	-0.002	-0.002	-0.002	-0.002
Manganese	[0.05]	**0.051#**	-0.010	-0.010	-0.010	-0.010
Mercury	0.002	-0.0002	-0.0002	-0.0002	-0.0002	-0.002
Nickel	0.1	-0.020	-0.020	-0.020	-0.020	-0.020
Selenium	0.05	-0.005	-0.005	-0.005	-0.005	-0.005
Silver	[0.1]	-0.010	-0.010	-0.010	-0.010	-0.010
Thallium	0.002	-0.002	-0.002	-0.005	-0.005	-0.005
Zinc	[5.0]	0.253	0.048	0.050	0.066	-0.050
Sample date		04-02-96	04-02-96	04-19-96	04-19-96	04-19-96

NA = Not analyzed
Note: A negative sign indicates a result is below detectable limits. Numerical value is detection limit.
* Aquifer water quality standards; numbers in brackets are federal secondary water quality standards.
# Concentration exceeds drinking water standard or secondary maximum contaminant level
Milligram = One thousandth of a gram.
$CaCO_3$ = Calcium Carbonate
N = Nitrogen
umhos/cm = Micromhos per centimeter, a measure of electrical conductivity. A mho is the reciprocal ohm. Micro = one millionth.

APPENDIX D

GEOCHEMICAL CHARACTERISTICS

APPENDIX D

GEOCHEMICAL CHARACTERISTICS OF EXISTING MILL TAILINGS AND WASTE ROCK

The geochemical characterization for the proposed Yarnell Project included an evaluation of historic mill tailings (deposited from 1936 to 1943) and an investigation of the rock types found within the area of the proposed mine pit. A detailed study of the geochemical characteristics of the ore, waste rock and mine pit walls was conducted by Shepherd Miller, Inc. (1995) in accordance with ADEQ's BADCT and BLM guidance documents. A plan for geochemical characterization was approved by ADEQ prior to sampling and testing. A second stage of tailings sampling was conducted by YMC in December 1996, and geochemical results were evaluated by Shepherd Miller, Inc. (July 1997). The results of the study were submitted to ADEQ as a supporting technical document as part of the Aquifer Protection Permit application.

Materials tested for the geochemical analysis included:

- ***Existing mill tailings piles*** - collection of three grab samples (surface) from fresh pits excavated in the upper tailings terrace (above the gully) and the southwest and northwest ends of the lower tailings terrace. Samples were collected from seven backhole pits. One bulk sample from the bottom of each trench and one composite sample from each trench were collected. One trench, in the crushed ore pile area, was excavated into tailings and tailings samples (not crushed ore) collected. Two trenches were in the upper tailings terrace, and four trenches were in the lower tailings terrace.
- ***Mine rock*** - selection of 42 representative drill core samples from two sample events (nine samples collected during the initial sampling event and 33 samples during an additional sampling event reflected in Table 4-2).

A map showing the core locations and the existing tailings pile sample sites is presented as Figure D-1.

The core sampling program was designed to obtain samples representative of the major structural, alteration and mineralization zones in the proposed mine. Specifically, samples were selected based on the variations of: weathering, alteration, oxidation/reduction state (reduced), mineralogy, depth and structural position (hanging wall, foot wall, ore zone) of the mineable materials. In addition, samples were selected to obtain a reasonably representative proportion of the rock types that will be excavated or exposed during mining (see Table D-1).

The geochemical testing program for the proposed mineable materials consisted of static predicative testing for acid-producing potential on 41 samples and batch leach testing on 12 samples. Static testing was also conducted on all three of the existing mill tailings samples, and batch testing was conducted on one of the tailings samples. In addition, the three existing tailings samples were analyzed for residual cyanide content.

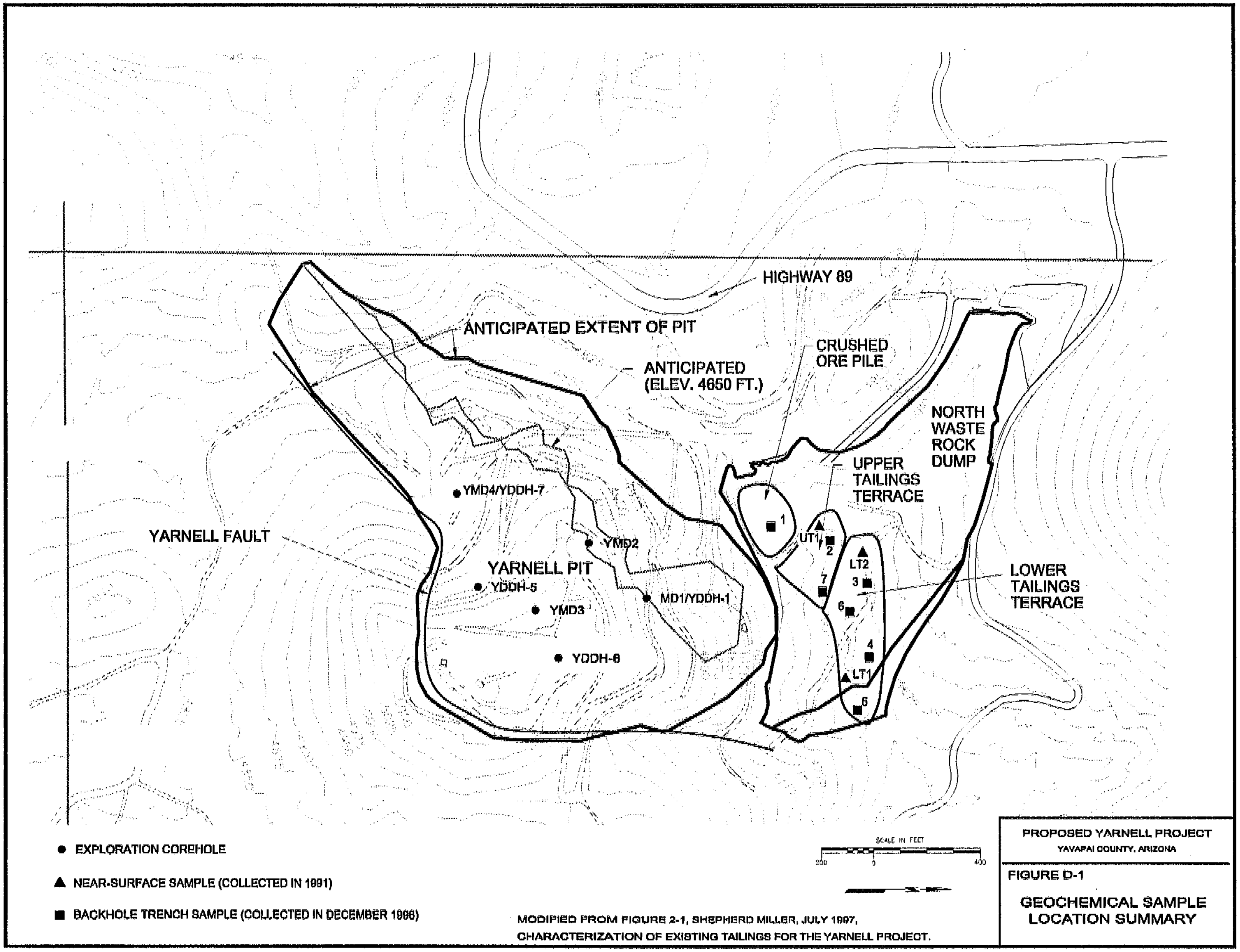

HIGHWAY 89
ANTICIPATED EXTENT OF PIT
ANTICIPATED (ELEV. 4650 FT.)
CRUSHED ORE PILE
NORTH WASTE ROCK DUMP
UPPER TAILINGS TERRACE
LOWER TAILINGS TERRACE
YARNELL FAULT
YARNELL PIT
YMD4/YDDH-7
YMD2
YDDH-5
YMD3
MD1/YDDH-1
YDDH-6
UT1
LT2
LT1
1
2
3
4
5
6
7
SCALE IN FEET
200
0
400
● EXPLORATION COREHOLE
▲ NEAR-SURFACE SAMPLE (COLLECTED IN 1991)
■ BACKHOLE TRENCH SAMPLE (COLLECTED IN DECEMBER 1996)
MODIFIED FROM FIGURE 2-1, SHEPHERD MILLER, JULY 1997, CHARACTERIZATION OF EXISTING TAILINGS FOR THE YARNELL PROJECT.
PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA
FIGURE D-1
GEOCHEMICAL SAMPLE LOCATION SUMMARY

TABLE D-1
Drill Core - Geochemical Sample Distribution Summary

SAMPLE DESCRIPTION	STRUCTURAL ZONE[1]			
	Hanging Wall	Ore Zone	Foot Wall	Totals
Alteration				
Propylitic	10	0	6	16
Sericitic	7	4	7	18
Potassic	7	1	0	8
Totals	**24**	**5**	**13**	**42**
Mineralogy and Physical Description[2]				
Iron oxide	5	6	4	--
Pyrite	3	0	2	--
Weathered	3	0	0	--
Broken rock	1	4	5	--
Reduced	0	0	3	--

[1] Approximately 80 percent of the mined rock is expected to be hanging wall material, 5 percent ore zone material and 15 percent foot wall material.

[2] Mineralogical and physical types may coexist in combination(s), may not be present or may not be identifiable in association with a specific altered rock type and are, therefore, not directly applicable to the total number of altered samples collected.

An explanation of the analytical testing procedures used for sample characterization is presented below.

<u>Static Predicative Testing for Acid Producing Potential.</u> Some types of waste rock, leached ore or fresh ore can acidify contacting water when exposed to the atmosphere and/or groundwater. This ability is characterized as a rock's "acid potential." Generally, rock with a high acid potential contains minerals which can react with water and atmospheric oxygen to produce sulfuric acid. The generated acid may then leach potentially toxic metals and other constituents from these materials. Other waste rock, leached ore or fresh ore may be acid-neutralizing under the same conditions. This is a rock's "neutralization potential." Waste rock materials with low acid potential and high neutralizing potential are generally environmentally benign. A high potential for production of acidic materials would be considered a significant effect.

Static test procedures include the measurement of the percentage of total sulfur, acid- generating potential (AGP) and acid-neutralization potential (ANP) of the sample. Specifically, these "acid-base" accounting methods estimate the amount of acid that could possibly be generated by weathering of sulfide minerals in the sample and the amount of acid that can be neutralized by other minerals in the sample. By convention, both AGP and ANP are reported in units of tons $CaCO_3$/1,000 tons rock. The results of this analysis are presented as a ratio of the ANP to AGP. A ratio greater than one indicates that, based solely on the quantity of minerals in the sample, there is a net potential to neutralize acid and, therefore, acidic runoff conditions would not be expected.

Because the rate of acid production and neutralization reactions is not considered in static testing, results are interpreted conservatively by comparing the AGP and the ANP. This evaluation, consistent with ADEQ and BLM guidance, uses two comparisons. First, one may look at the ratio of ANP to AGP; the greater this ratio, the more likely it is that the neutralization potential of the rock can neutralize any acidity that may be generated. Second, the net neutralization potential (NNP) may be defined as the difference between the ANP and the AGP (i.e., ANP-AGP). A positive value indicates that the ANP is greater than the AGP and the greater the absolute difference, the more likely it is that the neutralization potential of the rock can neutralize any acidity that may be generated. An ANP:AGP ratio of about three is generally accepted as a conservative indication that net acid generation will not occur. This is especially true in arid environments. The BLM criteria for non-acid-generating materials is an ANP:AGP ratio of three or more and a net neutralization potential greater than 20.

EPA Method 1312 Batch Leach Testing for Determination of Metals Leachability. This method simulates the leaching of ore and waste rock by rainwater. Metals evaluated by this procedure include arsenic, antimony, barium, beryllium, cadmium, chromium, copper, iron, lead, mercury, manganese, selenium, silver and zinc. Other parameters tested include specific conductivity, total dissolved solids, sulfate, calcium, magnesium, potassium and sodium. Test results are compared to ADEQ groundwater quality standards to determine if metals leaching from ore, waste rock or existing mill tailings have the potential to affect groundwater quality.

Analysis of Residual Cyanide Content. Previous milling activities may have included the use of cyanide in the gold extraction process. An analysis of total cyanide content was conducted on the seven samples collected from the existing tailings piles. The test was conducted to determine if cyanide is present in measurable concentrations and included measurement of total cyanide and free cyanide concentrations.

Cyanide is a general chemical term for compounds containing carbon bound to nitrogen (CN). Cyanidation, the use of solutions containing dissolved cyanide, has been used to extract gold from ores since 1898. Under most conditions, gold is very insoluble, so it is difficult to separate from ores. However, under oxidizing conditions, gold reacts with cyanide in solution to form gold-cyanide complexes that increase the solubility of gold, allowing the gold to be recovered in economic quantities. In the metallurgical process, a cyanide solution is formed by dissolving a solid cyanide compound, such as sodium cyanide (NaCN), in water. When sodium cyanide dissolves into solution, ions of sodium (Na^+) and cyanide (CN^-) exist in the solution; these may react with other ions or molecules to form more complicated chemical species called "complexes." These chemical complexes include molecules of cyanide with gold, but also of cyanide with other elements.

The forms of cyanide most often discussed with respect to monitoring and compliance include "free cyanide" and "total cyanide." "Free cyanide" includes molecular hydrogen cyanide (HCN) and its aqueous ion (CN^-). Based on extensive toxicological investigations, these forms are considered by the U.S. Environmental Protection Agency, ADEQ and most other authorities to have the greatest potential toxicity. "Total cyanide" is an analytical term that refers to the cyanide concentration that is calculated for a compound or solution when the matter is (a) treated with a strong acid in the presence of a catalyst to make the reactions proceed quickly and (b) all the cyanide is converted to volatile HCN gas and collected during distillation. The "total cyanide" concentration includes, of course, all "free cyanide," but it also includes all the cyanide that was combined ("complexed") with other chemical elements in less soluble (and less toxic) forms. The most common forms for insoluble cyanides are as complexes and compounds of iron and cyanide. The "total cyanide" concentrations always should be as high or higher than the "free cyanide" concentration. In samples of old tailings, "free cyanide" is usually low or absent, but "total cyanide," representing insoluble iron-cyanide compounds, often is observed at concentrations of a few parts per million (mg/kg) for years or decades after mineral processing occurred. Such tailings samples typically cannot leach cyanide into surface or groundwaters at detectable levels (or the "total cyanide" would already be gone) and the demonstration that "free cyanide" is not detectable indicates that such old tailings are not significantly toxic due to cyanide compounds.

Results of the Geochemical Evaluation for Existing Mill Tailings. The geochemical characterization test results for the existing mill tailings are presented in Table D-2 and summarized below.

TABLE D-2
Existing Tailings - Static and Batch Test Results

Area	Sample No.[1]	Total Sulfur (%)	ANP[2] (tons $CaCO_3$/kT)	ANP:AGP[3]	Total Cyanide (mg/kg)	Free Cyanide (mg/l)	Leached Metals[4]
Leached Ore (tailings)	1B	0.71	1.8	0.8	<0.01	NA	Cd, Cu, Fe, Pb, Mg, Mn, Ni, Zn
	1C	1.03	<0.1	<0.20	<0.02	NA	Cd, Cu, Fe, Pb, Mn, Mg, Zn
Upper Tailings Terrace	2B	0.03	8.4	10.5	0.41	NA	As
	7C	0.06	48.5	44.1	NA	NA	NA
	UT1	0.02	3.9	6.5	NA	NA	—
Lower Tailings Terrace	3B	0.04	<0.1	<0.13	0.38	NA	As, Cu, Fe
	4B	0.04	12.8	12.8	NA	NA	NA
	5C	0.41	1.8	0.4	<0.02	NA	Ba, Cd, Fe, Pb, Mg, Mn, Zn
	6B	0.19	0.8	0.5	NA	NA	NA
	LT1	0.06	2.5	1.3	<0.05	<0.02	Ba, Zn
	LT2	<0.01	1.0	---	1.7	<0.02	---

(1) Samples LT1, LT2 and UT1 are surface samples collected in 1991. The remaining samples are backhoe trenches sampled in December 1996, with B indicating bottom sample, and C indicating a composite sample.
(2) Acid neutralization potential in equivalent tons of calcium carbonate per 1,000 tons of material.
(3) Acid generation potential calculated from total sulfur.
(4) Only those metals with concentrations at or above the laboratory detection limits are listed.
NA = Not Available

- ***Total Sulfur.*** The concentration of total sulfur detected within the existing mill tailings ranged from 1.03 percent to below detection limits.
- ***Acid Neutralization Potential (ANP).*** ANP values range from <0.1 to 48.5 tons equivalent calcium carbonate per 1,000 tons of material ($CaCO_3$/kT).
- ***ANP:AGP.*** ANP:AGP ratios range from <0.13 to 44.1. Six samples showed an ANP:AGP of less than three.
- ***Batch Leach Test Results.*** A limited suite of metals including arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver and zinc was analyzed using EPA Method 1312. The batch leach tests indicate the presence of arsenic, barium, cadmium, copper, iron, lead, manganese, magnesium nickel and zinc. Concentrations meet ADEQ groundwater standards except for the secondary standards for copper in one sample, manganese in three samples and zinc in two samples. Cadmium concentration exceeded the groundwater standard in one sample. Two samples exceeded the ADEQ groundwater secondary standards for total dissolved solids and sulfate. Of the 12 exceedances of the groundwater standards, 10 were from the bottom and composite sample of Hole 1 in the leached ore area of the tailings. The other two exceedances were from Hole 5 in the lower tailings terrace.
- ***Cyanide Analysis.*** Residual cyanide analysis indicated measurable concentrations of total cyanide ranging from 1.7 mg/kg to below detection limits. The presence of free cyanide was not measurable above laboratory detection limits. These results are consistent with observations in many old mining districts and indicate that the most toxic "free cyanide" concentrations are negligible in the old tailings at the Yarnell site.

The geochemical test results indicate that the existing mill tailings are not likely to promote the degradation of groundwater or surface water resources. The proposed Yarnell Project would bury the existing mill tailings (and the area of surface disturbance from previous mining) within the NWRD. The tailings and other historic disturbances would be removed from the erosional and leaching effects of surface water.

Results of the Geochemical Evaluation on Waste Rock and Ore Samples. The geochemical characterization test results from the ore and waste rock core samples are listed in Table D-3 and summarized below.

- ***Total Sulfur.*** Total sulfur was measured above laboratory detection limits in only 12 of the 41 core samples analyzed. Overall, the values for the 12 samples containing detectable sulfur are very low, with eight samples at 0.01 percent and the remaining four samples ranging from 0.02 to 0.04 percent.
  Analytical results showed less than 0.01 percent total sulfur (below detection limits) in 29 of the 41 samples analyzed. The mean AGP is conservatively estimated to be about 0.35 tons $CaCO_3$/kT. When all 41 samples are considered, detection limits are equivalent to 0.01 percent total sulfur or an AGP value of 0.3 tons $CaCO_3$/kT.
- ***Acid Neutralization Potential (ANP).*** Acid neutralization potential values range from approximately three to 139 $CaCO_3$/kT. The mean net ANP for all 41 samples is conservatively estimated at approximately eight $CaCO_3$/kT.
- ***ANP:AGP.*** The ANP:AGP ratio for all of the samples range from 6.7 to 126.4. Acid generation potential (AGP) values (measured as total sulfur) ranged from less than 0.3 to 1.1 $CaCO_3$/kT. These values represent extremely low levels of acid generation potential. Most of the core samples show low (less than 10 tons $CaCO_3$/kT) to moderate (10 to 30 tons $CaCO_3$/kT) acid-neutralization potentials (ANP). This range of ANP values is characteristic of granitic rocks that do not have secondary carbonates in abundance. These levels indicate a consistent capacity of the granitic host rocks to neutralize small amounts of acidity, should it be generated.
- ***Batch Leach Test Results.*** Table D-4 shows the range of concentration of metals above detection limits from the batch leach test results. Batch leach test results indicate that metals concentrations meet ADEQ Water Quality Standards (WQS) for all parameters, except for antimony in two samples. Secondary water quality standards (derived from EPA Drinking Water Standards) are exceeded for iron in two samples and manganese in one sample (Table D-5). The leach test extract also shows relatively low total dissolved solids (TDS) values (28 to 55 mg/l) and sulfate concentrations were not observed above detection limits.

TABLE D-3
Drill Core Sample -- Static and Batch Test Results

Core Location	Depth (ft) and Structural Zone[1]		Total Sulfur (%)	AGP[2] ($CaCO_3$/kT)	ANP[3] ($CaCO_3$/kT)	ANP:AGP	Leached Metals[4]
	10-15	HW	0.04	1.1	139.0	126.4	As, Ba, Fe, Mn, Zn
	50-55	HW	<0.01	<0.3	4.4	>14.7	
YMD4/	140-145	HW	<0.01	<0.3	3.0	>10.0	
YDDH-7	150-155	OZ	<0.01	<0.3	3.3	>11.0	
	160-165	FW	<0.01	<0.3	5.9	>19.0	
	180-185	FW	<0.01	<0.3	12.0	>40.0	As,Ba,Fe,Zn
	10-15	HW	<0.01	<0.3	6.6	>22.0	
	40-45	HW	<0.01	<0.3	6.3	>21.0	Ba,Fe, Mn, Hg, Zn
YDDH-5	75-80	HW	<0.01	<0.3	6.8	>22.7	
	85-90	OZ	<0.01	<0.3	7.7	>25.7	Sb,As,Ba,Fe,Mn,Zn
	90-95	FW	<0.01	<0.3	6.3	>21.0	Sb,As,Ba,,Fe,PbMn,
	140-145	FW	<0.01	--	--	--	Zn
	20-25	HW	<0.01	<0.3	5.2	>17.3	
	120-125	HW	<0.01	<0.3	9.2	>30.7	
YMD2	225-230	HW	<0.01	<0.3	3.0	>10.0	
	295-300	HW	<0.01	<0.3	6.1	>20.3	As,Ba,Fe,Mn,Zn
	310-315	OZ	0.02	0.5	5.4	10.8	As,Ba,Fe,Mn,Zn
	320-325	FW	<0.01	<0.3	5.0	>16.7	
	375-380	FW	<0.01	<0.3	6.8	>22.7	
	15-20	HW	<0.01	<0.3	9.6	>32.0	
	95-100	HW	<0.01	<0.3	7.6	>25.3	Ba,Fe, Mn, Ni,Zn
YMD3	130-135	HW	<0.01	<0.3	5.9	>19.7	
	235-240	FW	<0.01	<0.3	4.3	>14.3	
	255-260	FW	<0.01	<0.3	15.6	>52.0	
	5-10	HW	<0.01	<0.3	8.0	>26.7	
	100-105	HW	<0.01	<0.3	11.6	>38.7	
YDDH-6	135-140	HW	0.01	<0.4	6.6	16.5	As,Ba,Fe,Pb,Zn
	145-150	OZ	<0.01	<0.3	3.1	>10.3	
	150-155	FW	<0.01	<0.3	5.7	>19.0	
	22-25	HW	0.01	0.3	13.3	44.3	
	25-28	HW	0.02	0.6	5.7	9.5	Ba,Fe,Mn,Zn
	28-31	HW	0.01	0.3	2.7	9.0	
	140-145	HW	<0.01	<0.3	8.5	>28.3	
	190-195	HW	0.01	0.4	9.2	23.0	
YMD1/	250-253	OZ/HW	0.01	0.3	5.5	18.3	
YDDH-1	253-256	OZ/HW	0.03	0.9	6.0	6.7	Ba,Fe
	256-260	OZ/HW	0.01	0.3	2.7	9.0	
	270-275	OZ	<0.01	<0.3	5.7	>19.0	
	287-290	FW	0.01	0.3	4.5	15.0	
	290-292	FW	0.01	0.3	25.2	84.0	Ba
	292-295	FW	<0.01	<0.3	21.6	>72.0	
	310-315	FW	<0.01	<0.3	13.4	>44.7	

[1] Structural zones: HW - hanging wall, OZ - ore zone, FW - foot wall.

[2] Acid generation potential calculated from total sulfur.

[3] Acid neutralizing potential in equivalent tons of calcium carbonate.

[4] Only those metals with concentrations observed above the laboratory analytical detection are listed.

TABLE D-4
Batch Leach Test Results (EPA Method 1312)
Range of Metals Concentrations Above Detection Limits

Parameter	Concentration Range (mg/l)	WQS*
Antimony	0.005 to 0.020	0.006
Arsenic	0.05 to 0.035	0.05
Barium	0.004 to 0.050	2.0
Iron	0.06 to 1.15	[0.3]
Lead	0.003 to <0.05	0.05
Manganese	0.001 to 0.09	[0.05]
Mercury	0.0002 to 0.0005	0.002
Nickel	<0.005 to 0.006	0.1
Zinc	0.016 to 0.060	[5.0]

* ADEQ ground water quality standards, secondary standards are shown in brackets.

TABLE D-5
Batch Leach Tests Results

Parameter (mg/l)	Sample and Depth (ft)				WQS[1]
	YDDH-1		YDDH-5		
	25-28	253-256	80-90	90-95	
Antimony	--	--	0.008	0.020	0.006
Iron	1.15	0.32	--	--	[0.3]
Manganese	0.09	--	--	--	[0.05]

[1] ADEQ Ground Water Quality Standards; secondary standards (derived from EPA Drinking Water Standards) in brackets.

The samples collected are representative of the mineralization and alteration types found within the respective structural zones of the proposed mine site. Consequently, based on the similarity of the test results, the geochemical characterization conclusions for the waste rock, mine pit walls and construction materials can be discussed together. These general conclusions are:

- the acid generation potential measured within these samples is very low (<0.30 to 1.1 tons $CaCO_3$/kT);
- the net neutralization potential is greater than two $CaCO_3$/kT; the conservative average of the net neutralization potential is approximately eight $CaCO_3$/kT and
- the minimum ANP:AGP ratio for all samples is 2.7 $CaCO_3$/kT; 95 percent of the samples led an ANP:AGP ratio of three or greater.

The BLM criteria for non-acid generating materials are an ANP:AGP ratio of three or more and net ANP greater than 20 tons $CaCO_3$/kT. The test results do not strictly meet both BLM criteria because of the low ANP values for the rocks. However, the samples do not appear to constitute acid-generating materials because of the extremely low AGP values.

Batch leach testing conducted on two core samples collected from drill hole YDDH-5 indicate the presence of rock with leachable concentrations of antimony above the ADEQ-WQS (Table 4-5). YDDH-5 core hole logs indicate that samples with elevated concentrations of antimony were collected from 85 and 95 feet below surface. Samples collected from this area were designated as coming from the ore zone and foot wall areas of the pit. They were described as coming from a sericitic alteration zone with high silica and iron oxide content, characteristic of the Yarnell Fault zone. Consequently, this material may actually represent ore grade material. If this is the case, then rock mined from this zone would be treated as ore and placed within the heap. This would preclude the need for mitigating measures because the heap leach is being designed as a zero discharge facility and leachate from rock placed within this facility would not impact surface and groundwater. Furthermore, the samples represent a very minor fraction of the total waste rock under the proposed mine plan, and when the leachate quality from all waste rock materials is considered, the water quality that would exit the dumps should not exceed ADEQ-WQS for antimony.

With regard to exceedances for iron and manganese in the batch leaching extracts, it is important to consider that the natural concentrations of iron and manganese in the aquifer exceed the ADEQ-WQS. Many rock types commonly release iron and manganese into percolating solutions; the extent to which this occurs is dependent upon the Eh-pH condition of the system. For the BCAS aquifer in the proposed projected site, iron and manganese concentrations were as great as 8.7 mg/l and 6.5 mg/l, respectively (Appendix C, Table C-3). The maximum concentrations of iron and manganese in the extracts were 1.15 mg/l and 0.09 mg/l, respectively.

APPENDIX E

WATER RIGHTS

APPENDIX E

Surface Water Rights

Surface water rights and claims are available to the public in a database managed by the Arizona Department of Water Resources (ADWR). Table E-2 is a compilation of surface water rights and claimed rights within the WRSA. Figure E-1 shows the location of each sixteenth of the section (40 acres) claimed as a water right or claim. The location identification on the map for each right or claim is in the second column of this table. Water rights or claims that are greater than one acre-foot/year are shaded, and those greater than 10 acre-feet/year are shaded and outlined by a bold square on the map.

Since 1919, a person seeking a surface water for public water has been required to file an application with the state for a permit to appropriate the water. If granted, the permitee receives a certificate of water right (CWR). The application or registration numbers for these water rights are filed under the prefixes "33" or "4A."

The Water Rights Registration Act, enacted in 1974, required most persons claiming surface water rights established prior to the effective date of surface water code (1919) to file a statement of claim. This Act did not provide a process by which to determine the validity of the claims. The statements of claim under this Act are filed under the prefix "36."

Lastly, in 1977, the Legislature enacted the Stockponds Registration Act which provided a method for registering those stock ponds built between 1919 and 1977 which do not have a "33" application permit or certificate applicable to the pond. The Act applies only to ponds used solely for watering livestock or wildlife and with a storage capacity or no more than 15 acre-feet. Stockpond claims are filed under the prefix "38."

TABLE E-1
ARIZONA DEPARTMENT OF WATER RESOURCES
WELL REGISTRY CONSTRUCTION DATA

Qtr.	Town-ship North	Range West	Well Desig.	Regis. No.	Owner	Compl. Date	Depth Drilled (ft bls)	Depth to Water at Well Completion (ft bls)	Casing			Reported Pumping Rate (gpm)	Well Use	Lithology Logs	Comments
									Dia. (in)	Depth (ft)	Perforated Int. (ft bls)				
B	9	4	5BBA	506418	Weaver Mining Prop.	11-23-83	500	90	6	500	100-140, 420-460	---	I	Yes	
B	9		5BBB	504396	Modesitt	02-17-83	490	70	7	490	60-80, 420-490	60	D	Yes	
B	9	4	6DAD	518823	Burns	10-02-87	680	600	7	20	---	7	I	Yes	
B	9	4	6DDB	643420	Grantham	?-?-55	80	40	8	80	---	25	J	---	
B	9	4	6DDD	602420	Winner Golel Octave	?-?-35	2,500	---	3	900	---	50	JDA	---	
B	9	5	1AB	504535	Brinkley	01-08-83	660	280	7	660	---	---	I	---	
B	9	5	1BAB	800425	Breslin	?-?-26	167	120	---	---	---	35	DI	---	
B	9	5	1BBA	506521	Rich Hill Mining	10-26-83	450	Dry	---	---	---	---	I	Yes	
B	9	5	1BBD	643463	Grantham	?-?-37	180	155	8	100	---	6	J	---	
B	9	5	2BBC	643462	Grantham	3-?-73	1,330	580	10	1,330	---	25	DJ	---	
B	9	5	2BCD	804048	AZ State Land Dept.	?-?-77	1,500	---	10	---	---	35	JD	---	
B	9	5	2BDB	641378	Coughlin	?-?-77	1,330	1,000	8	1,330	1000-1200	---		Yes	
B	9	5	5BDB	643465	Grantham	12-31-47	820	680	10	500	---	---	J	---	
B	10	4	19CAC	518269	AZ State Land Dept.	10-?-81	400	---	6	400	---	35	DI	---	Formerly mislocated and misnamed 19CBC
B	10	4	19CDC	518287	AZ State Land Dept.	12-31-81	400	---	6	400	---	35	ID	---	Formerly mislocated and misnamed 19CCB
B	10	4	29CAC	514105	Tucker	05-08-86	800	155	6	---	---	15	F	Yes	Well was deepened from 200 to 800 ft
B	10	4	29DCC	514102	Tucker	05-25-86	1,000	380	8/6	553	323.5-463.5	35	I	Yes	
B	10	4	31	606586	Schmitt	07-15-70	630	44	7	100	---	55	DI	---	Not plotted on map

See last page of Table E-1 for footnotes and explanations.

TABLE E-1
ARIZONA DEPARTMENT OF WATER RESOURCES
WELL REGISTRY CONSTRUCTION DATA

Qtr.	Town-ship North	Range West	Well Desig.	Regis. No.	Owner	Compl. Date	Depth Drilled (ft bls)	Depth to Water at Well Completion (ft bls)	Casing			Reported Pumping Rate (gpm)	Well Use	Lithology Logs	Comments
									Dia. (in)	Depth (ft)	Perforated Int. (ft bls)				
B	10	4	32ABB1	514104	Tucker	07-02-86	950	150	8/6	650	110.5-267/569-629.6	50	F	Yes	
B	10	4	32ABB2	616459	AZ State Land Dept.	07-02-86	950	150	8	650	---	---	JI	---	
B	10	4	32BAD1	616465	AZ State Land Dept.	12-31-71	518	28	8	516	---	---	IJ	---	
B	10	4	32BAD2	514103	Tucker	06-03-86	1,025	**Dry**	---	---	---	---	I	Yes	
B	10	4	32BAD3	514945	Tucker	07-29-86	518	28	8	516	33-74, 114-134, 436-496.5	50	I	Yes	
B	10	4	32BDD	616455	AZ State Land Dept.	12-31-80	8	2	8	8	---	---	DI	---	
B	10	4	32CCA1	616457	AZ State Land Dept.	07-01-81	165	8	6	16	12-16	20	DI	Yes	
B	10	4	32CCA2	616458	AZ State Land Dept.	12-31-79	12	8	72	12	---	---	---	---	
B	10	4	32CCA3	500116	Modesitt	07-?-81	165	Flowing	6	16	---	35	D	---	
B	10	4	32DBB	616456	AZ State Land Dept.	01-01-11	12	1	72	---	---	---	DJI	---	
B	10	4	32DCC	614616	AZ State Land Dept.	12-31-49	6	5	72	---	---	---	DJI	---	
B	10	5	1ABB	506920	Grantham	11-01-83	450	200	15	500	280-500	18		Yes	
B	10	5	1BCC		Coughlin	?-?-24	120	80	8	---	---	12	D	---	
B	10	5	2CDD	515621	Andrea	10-10-86	165	42	6/4.5	160	65-165	1-2	I	Yes	
B	10	5	4DBB	614619	Az State Land Dept.	06-15-61	41	20	4	---	---	10	J	---	
B	10	5	10AAA	500848	Paulic	09-?-81	120	95	7/5	120	60-120	5	I	Yes	
B	10	5	10ABD1	648519	Father Wasson	?-?-50	---	11	---	---	---	2	D	---	
B	10	5	10ABD2	648520	Father Wasson	?-?-50	---	---	---	---	---	---	D	---	
B	10	5	10ABD3	648521	Father Wasson	12-31-50	---	---	---	---	---	---	D	---	
B	10	5	10CDD	514890	Meagher	07-16-86	100	15	7/5	100	40-100	<0.5	1	Yes	
B	10	5	10DBA1	643111	Schlegel, W	?-?-50	100	20	8	---	---	10	D	---	
B	10	5	10DBA2	643112	Schlegel, W	?-?-58	196	30	8	---	---	20	D	---	

See last page of Table E-1 for footnotes and explanations.

TABLE E-1
ARIZONA DEPARTMENT OF WATER RESOURCES
WELL REGISTRY CONSTRUCTION DATA

Qtr.	Town-ship North	Range West	Well Desig.	Regis. No.	Owner	Compl. Date	Depth Drilled (ft bls)	Depth to Water at Well Completion (ft bls)	Casing			Reported Pumping Rate (gpm)	Well Use	Lithology Logs	Comments
									Dia. (in)	Depth (ft)	Perforated Int. (ft bls)				
B	10	5	10DCC	602553	Booth	?-?-69	85	---	---	---	---	---	D	---	
B	10	5	10DDD1	514889	Lynch	07-14-86	180	40	7/5	180	40-80, 140-180	35	I	Yes	
B	10	5	10DDD2	643097	Abbott, W	?-?-73	40	20	8	40	---	10	AD	---	
B	10	5	10DDD3	643098	Abbott, W	?-?-73	310	80	8	100	---	15	D	---	
B	10	5	11AA1	630812	Byrd	07-07-71	200	189	1	200	---	---	D	---	
B	10	5	11AA2	632826	Young	04-?-50	100	---	---	---	---	35	D	---	
B	10	5	11AAA	618157	Cheatwood	?-?-68	---	45	6	---	---	100	DAJ	---	
B	10	5	11ABB	806444	Crane	12-31-58	---	---	---	---	---	---	D	---	
B	10	5	11ABC	647401	Verna	?-?-63	161	---	4	160	---	---	D	---	
B	10	5	11AC	606812	Oldham	?-?-76	85	50	10	40	---	65	D	---	
B	10	5	11ACC	644680	Wagner	12-08-61	180	---	---	---	---	20	D	---	
B	10	5	11BBC	509007	Friends	10-02-84	250	25	7	---	---	5	D	Yes	
B	10	5	11BCD1	650463	Moore	?-?-52	13	7	72	13	---	10	D	---	
B	10	5	11BCD2	643103	Garrett	?-?-70	80	60	6	20	---	2	A	---	
B	10	5	11BD	643480	Volkman	07-?-58	99	---	8	99	---	8	D	---	
B	10	5	11BDC1	643117	Cook	?-?-55	20	---	---	---	---	20	A	---	
B	10	5	11BDC2	647418	Lee	?-?-20	15	6	2	15	---	30	A	---	
B	10	5	11C	642840	Majka	?-?-58	105	---	88	---	---	---	D	---	Not plotted on map
B	10	5	11CAD	647575	Kahle	?-?-60	100	42	8	---	---	---	D	---	
B	10	5	11CBA	650460	Hindman	?-?-71	105	85	6	---	---	---	A	---	
B	10	5	14-1	531061	Bema Gold	10-03-91	185	---	---	---	---	---	N	---	Water not detected
B	10	5	14-2	523897	Asarco	06-03-89	---	---	---	---	---	---	N	---	

See last page of Table E-1 for footnotes and explanations.

TABLE E-1
ARIZONA DEPARTMENT OF WATER RESOURCES
WELL REGISTRY CONSTRUCTION DATA

Qtr.	Town-ship North	Range West	Well Desig.	Regis. No.	Owner	Compl. Date	Depth Drilled (ft bls)	Depth to Water at Well Completion (ft bls)	Casing			Reported Pumping Rate (gpm)	Well Use	Lithology Logs	Comments
									Dia. (in)	Depth (ft)	Perforated Int. (ft bls)				
B	10	5	14-3	524750	Asarco	06-07-89	---	**Dry**	---	---	---	---	N	---	
B	10	5	14BCD		Yarnell Mining							10-30	ID	---	YMC-04
B	10	5	14BDD	548397	Yarnell Mining	06-01-95	150	120	6	145	---	---	M	Yes	YMC-01
B	10	5	15DDA	548396	Yarnell Mining								M	Yes	YMC-02
B	10	5	15AAB1	510883	Wood	04-29-85	205	115	7	205	55-75 & 155-205	8	D	Yes	
B	10	5	15AAB2	504051	Rue Trust	12-03-82	400	20	7	400	---	3	D	Yes	
B	10	5	15AAC	515877	Bonebrake	10-25-86	245	155	6	240	140-240	5	D	Yes	
B	10	5	15AB	500989	Beattie	09-?-81	195	100	6	---	---	1	D	Yes	
B	10	5	15ACC	516248	Jendrisak	04-10-87	360	---	---	20	---	---	D	Yes	
B	10	5	15CAA	509184	Lee & Casebolt	09-13-84	400	**Dry**	7	20	---	---	D	---	
B	10	5	17CC	803792	Ferra, Manual & Luis	?-?-30	200	140	4	180	---	6	D	---	
B	10	5	21	533443	Conquistador Gold	11-05-91	---	---	---	---	---	---	N	---	Not plotted on map
B	10	5	21BBB	609604	Coughlin	?-?-62	210	180	8	---	---	4	J	---	
B	10	5	21CBD	524691	Parker	07-18-89	1,140	530	8	1,097	497-1097	12	M	Yes	
B	10	5	21CCC	519853	Parker Dairy Farms	12-26-87	1,400	800?	8	1,400	---	5	JD	Yes	"Capped" well
B	10	5	21D	626306	Conquistador Gold	?-?-00	50	10	6	50	---	20	D	---	
B	10	5	22ABA	648941	Vakanovich	07-?-27	40	20	6	40	---	5	D	---	
B	10	5	22BCB1	804046	AZ State Land Dept.	07-20-81	229	105	8	---	---	35	J	---	
B	10	5	22BCB2	803843	AZ State Land Dept.	07-20-81	229	105	8	---	---	35	---	---	
B	10	5	22C	626305	Scarth Oil & Gas Co.	?-?-00	80	8	---	---	---	100	ID	---	
B	10	5	23AAA	550684	Yarnell Mining	11-17-95	400	19	8 6	0-20 20-400	79-379	30-73	10	Yes	TW-01 drilled on BLM land under ROW

See last page of Table E-1 for footnotes and explanations.

TABLE E-1
ARIZONA DEPARTMENT OF WATER RESOURCES
WELL REGISTRY CONSTRUCTION DATA

Qtr.	Town-ship North	Range West	Well Desig.	Regis. No.	Owner	Compl. Date	Depth Drilled (ft bls)	Depth to Water at Well Completion (ft bls)	Casing			Reported Pumping Rate (gpm)	Well Use	Lithology Logs	Comments
									Dia. (in)	Depth (ft)	Perforated Int. (ft bls)				
B	10	5	23ACB	55-548395	Yarnell Mining								M	Yes	YMC-03
B	10	5	23BCC	643461	Grantham	?-?-72	620	520	8	620	---	8	J	---	
B	10	5	24ADD	506430	Sul, Kenneth	09-24-83	300	190	7	300	200-300	30	DI	Yes	
B	10	5	24BAB	550685	Yarnell Mining	12-01-95	560	43	8	0-20	20-560 (open)	---	M	Yes	TW-02 drilled on BLM land under ROW
B	10	5	24BDA	550682	Yarnell Mining	12-07-95	520	18	8	0-20	20-520 (open)	---	M	Yes	TW-03 drilled on BLM land under ROW
B	10	5	24DAA	505947	Sul, Kenneth	08-24-83	400	50	6	400	300-400	20	DI	Yes	
B	10	5	25ABD	627419	Shelton	?-?-68	90	12	6	90	---	15	ID	---	
B	10	5	25CAC	087232	Proaz Resources Corp.	04-?-81	175	125	7	175	95-175	25	I	Yes	
B	10	5	25DBA	643460	Grantham	?-?-45	80	18	8	50	---	15	J	---	
B	10	5	25DBD	087544	Proaz Resources Corp.	04-?-81	200	150	7/5	200	120-200	12	I	Yes	
B	10	5	25DDA	522209	Culp	09-24-88	105	56	5	70	---	20	D	Yes	
B	10	5	25DDD	602479	Thompson	09-29-79	200	140	7/4	200	120-180	7	D	Yes	
B	10	5	28BAD	520743	Parker Dairy Farms	04-14-88	1,050	Dry	---	---	---	---	DJ	Yes	
B	10	5	28CAC1	520462	Parker Dairy Farms	03-09-88	800	465	6	790	440-790	11	DJ	Yes	
B	10	5	28CAC2	526206	Parker Dairy Farms	11-01-89	2,513	670	16	1,376	956-996 & 1036-1376	---	J	Yes	
B	10	5	28CAC3	519929	Parker Dairy Farms	02-17-88	1,376	640	16	1,376	---	30	DJ	---	
B	10	5	28CAC4	525333	Parker Dairy Farms	09-28-89	1,100	520	7	1,022	422-1022	7	F	Yes	
B	10	5	28CAC5	525334	Parker Dairy Farms	09-08-89	865	530	10	40	420-835	20	F	Yes	
B	10	5	28CAD	525922	Parker Dairy Farms	10-10-89	838	440	8	40	---	---	F	---	
B	10	5	28CBB	525982	Parker Dairy Farms	10-31-89	1,400	440	12	1,235	455-1215	10	J	Yes	

See last page of Table E-1 for footnotes and explanations.

TABLE E-1
ARIZONA DEPARTMENT OF WATER RESOURCES
WELL REGISTRY CONSTRUCTION DATA

Qtr.	Town-ship North	Range West	Well Desig.	Regis. No.	Owner	Compl. Date	Depth Drilled (ft bls)	Depth to Water at Well Completion (ft bls)	Casing			Reported Pumping Rate (gpm)	Well Use	Lithology Logs	Comments
									Dia. (in)	Depth (ft)	Perforated Int. (ft bls)				
B	10	5	28CBC1	525983	Parker Dairy Farms	10-10-89	1,246	**Dry**	12	25	---	---	J	---	
B	10	5	28CBC2	524690	Parker, Jim	06-15-89	4,000	750	7	20	---	---	M	---	
B	10	5	28DAD	525876	Parker Dairy Farms	09-18-89	1,400	**Dry**	10	20	---	---	F	---	
B	10	5	28DBC	526515	Parker Dairy Farms	12-05-89	1,710	526	12	1,280	398-1168	---	DJ	Yes	
B	10	5	29BAD	518813	Red Tail Mining	08-29-87	700	**Dry**	7	20	---	---	IF	Yes	
B	10	5	36CAB	642215	Froelich	12-28-77	125	95	6	15	---	25	D	Yes	
B	10	5	36CB	622866	Makela	?-?-1890	100	60	---	---	---	47	DJA	---	
B	10	5	36DDD	671241	Lyall	12-21-78	300	---	6	20	---	0.5-1	D	Yes	

A = Irrigation
D = Domestic
F = Industrial
I = Mine
J = Stock
M = Monitor
N = Test

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
33-0086575	33-1	BLM Phoenix	01/12/81	BLM	Antelope Creek	Mining	10,798,702.0	20.55	**33.17**	NW NE 25 10.0N 5.0W	CWR issued	
33-0087081	33-2	Thompson, RM	03/26/81	BLM	Antelope Creek	Mining	36,000.0	0.07	0.11	SE SW 25 10.0N 5.0W	CWR issued	
33-0087158	33-3	Sul, KJ	06/23/81	BLM	Rich Gulch Seep	Total Domestic Stock Mining	16,293,600.0 525,600.0 2,628,000.0 13,140,000.0	31.00 1.00 5.00 25.00	**50.04** 1.61 8.07 40.36	SE SE 24 10.0N 5.0W	**Legal Action Hold (non-hearing) 06/30/94**	
33-0087164	33-4	Evans, B	07/20/81	BLM	Antelope Creek	Total Domestic Mining	1,140,208.0 325,581.0 814,627.0	2.17 0.62 1.55	**3.50** 1.00 2.50	NE NW 36 10.0N 5.0W	**Legal Action Hold (non-hearing) 11/17/94**	
33-0087169	33-5	BLM Phoenix	08/06/81	BLM	Antelope Creek	Total Mining Recreation	487,777.0 325,581.0 162,196.0	0.93 0.62 0.31	**1.50** 1.00 0.50	NE SW 36 10.0N 5.0W	Permit fee due 03/24/95	
33-0087292	---	Lyall, RM	03/12/82	Private	Antelope Creek	Irrigation	16,279,050.0	30.97	**50.00**	SW SW 36 10.0N 5.0W	**Application rejected**	
33-0087110	---	Jones, JF	05/19/81	BLM	Antelope Creek	Mining	162,926.0	0.31	0.50	SE SE 24 10.0N 5.0W	**Permit cancelled**	
33-0087273	*33-6	Telfer, RJ	03/03/82	Private	Weaver Creek	Mining	977,700.0	1.86	**3.0**	SE NW 29 10N 4W	**Protest received; will schedule hearing**	
33-0090515	---	LaPAZ Mining Inc.	03/27/86	State	Weaver Creek	Mining	70,080,000.0	133.3	**215.0**	NE NW 32 10N 4W	**Application withdrawn**	
33-0092293	33-7	Pecen, Edward M.	01/20/87	State	Millsite Creek	Mining	<3,259.0	<0.006	<0.01	NE SW 32 10N 4W	**Appeal submittal; will schedule hearing**	
4A-0000058	4A-1	Coughlin, JJ	05/01/20		Cox Spring	Stock	35,849,320.0	68.21	**110.11**	SE SW 13 10.0N 5.0W	CWR issued	
4A-0002273	4A-2	Kelley, Z	05/09/40	BLM	Citizens Spring	Stock	365,000.0	0.69	**1.12**	SW SW 16 10.0N 4.0W	CWR issued	
4A-0002500	4A-3	Michael, RM	08/21/41	BLM	Antelope Creek	Stock	730,000.0	1.39	**2.24**	SW SE 24 10.0N 5.0W	CWR issued	

See last page of Table E-2 for footnotes and explanations.

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
4A-0002501	4A-4	Michael, RM	08/21/41	BLM	Antelope Creek	Total Domestic Stock	930,750.0 912,500.0 18,250.0	1.77 1.74 0.03	**2.86** 2.80 0.06	NW SE 24 10.0N 5.OW	CWR issued	
4A-0003010	4A-5	Grantham, W	10/28/49	BLM	Cotton-wood Wash	Stock	150,000.0	0.29	0.46	SE SE 14 10.0N 5.0W	CWR issued	
4A-0003011	4A-6	Grantham, W	10/28/49	State Agency	Bathtub Wash	Stock	75,000.0	0.14	0.23	SW NW 14 10.0N 5.0W	CWR issued	
38-0062572	38-1	Grantham, W	05/14/58		Indian Creek	Stock	35,813.9	0.07	0.11	NE NW 23 10.0N 5.0W	Certificate to be issued	
38-0062576	38-2	Grantham, W	05/10/58		Indian Creek	Stock	52,093.0	0.10	0.16	SW NW 23 10.0N 5.0W	Certificate to be issued	
38-0062569	38-3	Grantham, W	05/01/60	Corpo-ration	Unnamed Creek	Stock	58,662.0	0.11	0.18	SE SW 31 10.0N 5.0W	Certificate to be issued	
38-0062571	38-4	Grantham, W	05/15/60	State	Unnamed Creek	Stock	58,662.0	0.11	0.18	NE SW 30 10.0N 5.0W	Certificate to be issued	
38-0062574	38-5	Ramsey, TP	10/01/59	BLM	Unnamed Creek	Stock	35,849.0	0.07	0.11	SE NW 6 10.0N 4.0W	Certificate to be issued	
38-0072307	---	Medd, GC	03/08/58	State	Lion Canyon	Stock	651,800.0	1.24	**2.0**	NE NE 21 10.0N 4.0W	Statement of continuing use	Same as 36-23
38-0075083	---	Michael, RM	03/08/58	State	Headwa-ter Lion Canyon	Stock	651,800.0	1.24	**2.0**	NE NE 21 10.0N 4.0W	Statement of continuing use	Same as 36-23
38-0091581	---	BLM	12/31/77	BLM	Weaver Creek	Stock Wildlife	149,914.0	0.29	0.46	NE NW 32 10.0N 4.0W	Claim withdrawn	Same as 36-26
38-0092608	---	AZ State Land Dept.	03/08/58	State	Lion Canyon	Stock Wildlife	136,878.0	0.26	0.42	NE NE 21 10.0N 4.0W	Certificate to be issued	Same as 36-23
38-0092609	---	AZ State Land Dept.	12/31/69	State	Fall Line Draw	Stock Wildlife	492,109.0	0.94	**1.51**	SE NE 8 10.0N 5.0W	Certificate to be issued	Same as 36-29
38-0092610	---	AZ State Land Dept.	12/31/68	State	Elephant Rill	Stock Wildlife	492,109.0	0.94	**1.51**	NE NW 16 10.0N 5.0W	Certificate to be issued	Same as 36-30

See last page of Table E-2 for footnotes and explanations.

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
38-0092611	---	AZ State Land Dept.	05/15/60	State	North Corner Tank Wash	Stock Wildlife	117,324.0	0.22	0.36	NW SE 30 10.0N 5.0W	Potential conflict	Same as 36-31
38-0094752	---	AZ State Land Dept.	05/31/60	State	South Corner Wash	Stock Wildlife	<3,259.0	<0.006	<.01	SW SE 31 10.0N 5.0W	Certificate to be issued	Same as 36-43
36-0003151	---	AZ State Land Dept.	12/31/18 83	State Agency	Antelope Creek	Stock Wildlife	42,325.5	0.08	0.13	19 10.0N 4.0W	On file	Not plotted on map
36-0003162	---	AZ State Land Dept.	12/31/18 83	State Agency	Peccary Spring	Stock Wildlife	117,209.2	0.22	0.36	SE SW 13 10.0N 5.0W	On file	**Same as 4A-1**
36-0003163	36-1	AZ State Land Dept.	12/31/18 83	State Agency	Corner Spring	Stock Wildlife	117,209.2	0.22	0.36	NW NE 13 10.0N 5.0W	On file	
36-0003164	---	AZ State Land Dept.	12/31/18 83	State Agency	Cox Rill	Stock Wildlife	117,209.2	0.22	0.36	SE SW 13 10.0N 5.0W	On file	**Same as 4A-1**
36-0003165	---	AZ State Land Dept.	12/31/18 83	State Agency	Cox Spring	Stock Wildlife	113,953.4	0.22	0.36	SE SW 13 10.0N 5.0W	On file	**Same as 4A-1**
36-0003166	36-2	AZ State Land Dept.	12/31/18 83	State Agency	Deer Seep	Stock Wildlife	117,209.2	0.22	0.36	SW SE 13 10.0N 5.0W	On file	
36-0003167	36-3	AZ State Land Dept.	12/31/18 83	State Agency	Road Seep	Stock Wildlife	117,209.2	0.22	0.36	NE SE 13 10.0N 5.0W	On file	
36-0003168	36-4	AZ State Land Dept.	12/31/18 83	State Agency	Yarnell Creek	Stock Wildlife	117,209.2	0.22	0.36	SE 14 10.0N 5.0W	On file	Not plotted on map
36-0020765	36-5	BLM	04/17/26	Federal Gov't	Unidenti-fied Spring	Recreation Stock Wildlife	None	None	None	NE 18 10.0N 4.0W	On file	Not plotted on map
36-0020766	36-6	BLM	04/17/26	Federal Gov't	Unidenti-fied Spring	Recreation Stock Wildlife	None	None	None	NW 17 10.0N 4.0W	On file	Not plotted on map
36-0020767	36-7	BLM	04/17/26	Federal Gov't	Unidenti-fied Spring	Recreation Stock Wildlife	None	None	None	SW 17 10.0N 4.0W	On file	Not plotted on map

See last page of Table E-2 for footnotes and explanations.

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
36-0020768	36-8	BLM	04/17/26	Federal Gov't	Unidenti-fied Spring	Recreation Stock Wildlife	None	None	None	NW 16 10.0N 4.0W	On file	Not plotted on map
36-0020785	36-9	BLM	04/17/26	Federal Gov't	Unidenti-fied Spring	Recreation Stock Wildlife	None	None	None	NE 25 10.0N 5.0W	On file	Not plotted on map
36-0062581	36-10	Grantham, WJ	02/01/13	Private	Indian Creek	Stock	13,023.2	0.02	0.04	NW SW 25 10.0N 5.0W	On file	
36-0062582	36-11	Grantham, WJ	02/01/13	Private	Antelope Creek	Stock	52,093.0	0.10	0.16	SE NW 36 10.0N 5.0W	On file	
36-0062583	---	Grantham, WJ	02/01/13	Private	Antelope Creek	Stock	52,093.0	0.10	0.16	NE SW 36 10.0N 5.0W	On file	Same as 33-5
36-0071378	36-12	M&D of Stanton Inc.	10/30/1895	Corporation	Genung Millsite	Irrigation Stock Mining	36,761,350.7	**69.94**	**112.91**	NW SW 9 10.0N 4.0W	On file	
36-0071380	---	Devault, J	07/01/70	Private	Drilled well	Mining Domestic	None	None	None	NW NE 25 10.0N 5.0W	On file	Same as 33-1
36-0072308	36-13	Medd, GC	01/01/00	Private	Antelope Creek	Stock	599,069.0	**1.14**	**1.84**	NE NW 17 10.0N 4.0W	On file	
36-0072309	36-14	Medd, GC	01/01/00	Private	Antelope Spring	Stock	250,697.4	0.48	0.77	NE NE 18 10.0N 4.0W	On file	
36-0072310	36-15	Medd, GC	01/01/00	Private	Antelope Spring	Stock	250,697.4	0.48	0.77	NE SW 25 10.0N 5.0W	On file	
36-0072312	36-16	Medd, GC	01/01/00	Private	Yarnell Creek	Stock	198,604.4	0.38	0.61	SE NW 24 10.0 5.0W	On file	
36-0072316	36-17	Medd, GC	01/01/00	Private	East Antelope Creek	Stock	250,697.4	0.48	0.77	NE NW 20 10.0N 4.0W	On file	
36-0072317	36-18	Medd, GC	01/01/00	Private	White Spring	Stock Domestic	400,464.6	0.76	**1.23**	NE NW 30 10.0N 4.0W	On file	
36-0072318	36-19	Medd, GC	01/01/00	Private	Kane Spring	Stock	198,604.4	0.38	0.61	SW NE 19 10.0N 4.0W	On file	

See last page of Table E-2 for footnotes and explanations.

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
36-0072319	36-20	Medd, GC	01/01/00	Private	Mesa Spring	Stock	149,767.3	0.28	0.46	SW NE 20 10.0N 4.0W	On file	
36-0072320	36-21	Medd, GC	01/01/00	Private	Juniper Spring	Stock	299,534.5	0.57	0.92	NE SW 17 10.0N 4.0W	On file	
36-0072321	36-22	Medd, GC	01/01/00	Private	Beech Spring	Stock	149,767.3	0.28	0.46	SE NW 16 10.0N 4.0W	On file	
36-0075084	---	Michael, RM	01/01/00	Private	Antelope Creek	Stock	599,069.0	1.14	1.84	NE NW 17 10.0N 4.0W	On file	Same as 36.13
36-0075085	---	Michael, RM	01/01/00	Private	Antelope Spring	Stock	247,441.6	0.47	0.76	NW SW 25 10.0N 5.0W	On file	Same as 36-14
36-0075086	---	Michael, RM	01/01/00	Private	Antelope Creek	Stock	247,441.6	0.47	0.76	NE SW 25 10.0N 5.0W	On file	Same as 36-15
36-0075088	---	Michael, RM	01/01/00	Private	Yarnell Creek	Stock	198,604.4	0.38	0.61	SE NW 24 10.0N 5.0W	On file	Same as 36-16
36-0075092	---	Michael, RM	01/01/00	Private	East Antelope Creek	Stock	247,441.6	0.47	0.76	NE NW 20 10.0N 4.0W	On file	Same as 36-17
36-0075093	---	Michael, RM	01/01/00	Private	White Spring	Stock	397,208.8	0.76	1.22	NE NW 30 10.0N 4.0W	On file	Same as 36-18
36-0075094	---	Michael, RM	01/01/00	Private	Kane Spring	Stock	198,604.4	0.38	0.61	SW NE 19 10.0N 4.0W	On file	Same as 36-19
36-0075095	---	Michael, RM	01/01/00	Private	Mesa Spring	Stock	149,767.3	0.28	0.46	SW NE 20 10.0N 4.0W	On file	Same as 36-20
36-0075096	---	Michael, RM	01/01/00	Private	Juniper Spring	Stock	299,534.5	0.57	0.92	NE SW 17 10.0N 4.0W	On file	Same as 36-21
36-0075097	---	Michael, RM	01/01/00	Private	Beech Spring	Stock	149,767.3	0.28	0.46	SE NW 16 10.0N 4.0W	On file	Same as 36-22
36-0003152	36-23	AZ State Land Dept	12/31/83	State	Lion Canyon	Stock Wildlife	136,878	0.26	0.42	NE NE 21 10.0N 4.0W	On file	
36-0003153	36-24	AZ State Land Dept	12/31/83	State	Barrel Spring	Stock Wildlife	42,367	0.08	0.13	NE SW 21 10.0N 4.0W	On file	

See last page of Table E-2 for footnotes and explanations.

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
36-0003154	36-25	AZ State Land Dept	12/31/83	State	Lion Canyon	Stock Wildlife	42,367	0.08	0.13	NE 21 10.0N 4.0W SW SE 21 10.0N 4.0W SE 21 10.0N 4.0W SW NE 28 10.0N 4.0W NE 28 10.0N 4.0W SW SW 28 10.0N 4.0W SW 28 10.0N 4.0W NE 32 10.0N 4.0W NW NW 33 10.0N 4.0W	On file	
36-0003155	36-26	AZ State Land Dept	12/31/83	State	Weaver Creek	Stock Wildlife	9,998,612	19.02	**30.08**	NE NW 32 10.0N 4.0W	On file	
36-0003156	---	AZ State Land Dept	12/31/83	State	Weaver Creek	Stock Wildlife	42,367	0.08	0.13	NW 32 10.0N 4.0W SW SW 32 10.0N 4.0W SW 32 10.0N 4.0W	On file	Sections already allocated water rights
36-0003157	36-27	AZ State Land Dept	12/31/83	State	Weaver Creek	Stock Wildlife	97,770	0.19	0.3	SE NW 32 10.0N 4.0W	On file	
36-0003158	36-28	AZ State Land Dept	12/31/1883	State	Weaver Creek	Stock Wildlife	19,554,000	37.20	**60.0**	SW SW 32 10.0N 4.0W	On file	
36-0003159	---	AZ State Land Dept	12/31/1883	State	GMH Gulch	Stock Wildlife	<3,259	<0.006	<0.01	NW SE 32 10.0 N 4.0W	On file	No water use
36-0003160	---	AZ State Land Dept	12/31/1883	State	Senator Canyon	Stock Wildlife	492,109	0.94	**1.51**	6 10.0N 5.0 W	On file	No location given
36-0003161	36-29	AZ State Land Dept	12/31/1883	State	Fall Line Draw	Stock Wildlife	492,109	0.94	**1.51**	SE NE 8 10.0N 5.0W	On file	
36-0003169	36-30	AZ State Land Dept	12/31/1883	State	Elephant Rill	Stock Wildlife	492,109	0.94	**1.51**	NE NW 16 10.0N 5.0W	On file	
36-0003170	36-31	AZ State Land Dept	12/31/1883	State	North Corner Wash	Stock Wildlife	117,324	0.22	0.36	NW SE 30 10.0N 5.0W	On file	
36-0003171	36-32	AZ State Land Dept	12/31/1883	State	#32 Wash	Stock Wildlife	5,540,300	10.5	**17.00**	SW NW 32 10.0N 5.0W	On file	

See last page of Table E-2 for footnotes and explanations.

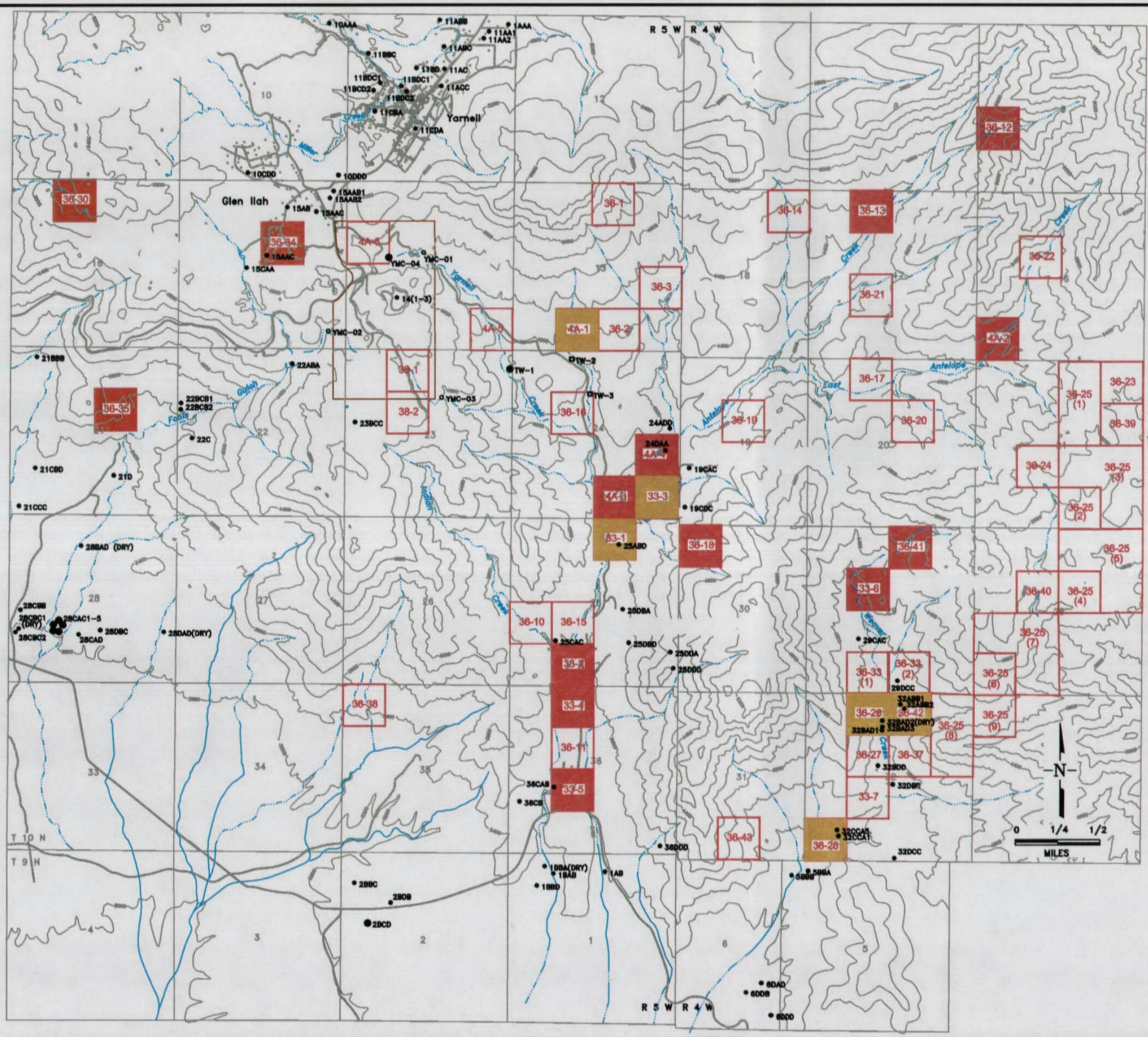
TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
36-0012123	36-33	Brinkley Dr	12/31/1883	State	Underground Stream Underground Channel	Mining	325,900	0.62	1.00	SE SW 29 10.0N 4.0W SW SE 29 10.0N 4.0W SE NW 32 10.0N 4.0W	On file	#3 same as 36-27
36-0020173	---	BLM	04/17/26	Federal	Unidentified Spring	Wildlife	<3,259	<0.006	<0.01	NW 7 10.0N 4.0W	On file	No water used/ No location given
36-0024915	---	Goodwin, DA	00/00/1865	?	Weaver Creek	Mining Domestic	19,554,000	37.20	**60.00**	SW SW 32 10.0N 4.0W	On file	Same as 36-28
36-0034780	36-34	Munz, WS	07/12/27	Private	Su Draw	Domestic	365,008	0.69	**1.12**	SW NE 15 10.0N 5.0W	On file	
36-0034781	36-35	Munz, WS	06/09/1900	Private	Su Ravine	Mining Domestic	730,016	1.39	**2.24**	SW NE 21 10.0N 5.0W	On file	
36-0061819	36-36	Hays, H	06/01/1912	Private	Riggs Place Spring	Stock	293,310	0.56	0.9	SW NE 4 10.0N 5.0W	On file	
36-0062579	---	Michael, RM	02/01/13	Private	Johnson Spring	Stock	13,036	0.02	0.04	SW SW 32 10.0N 4.0N	On file	Same as 36-28
36-0062580	36-37	Michael, RM	02/01/13	Private	Beehive Spring	Stock	182,504	0.35	0.56	SW NE 32 10.0N 4.0N	On file	
36-0062585	36-38	Grantham, WJ	02/01/13	Private	Mine shaft subflow	Stock	6,518	0.01	0.02	NW NW 35 10.0N 5.0N	On file	
36-0068284	---	Meitz, RL	01/29/1900	Private	Beehive Mine Tunnel Subflow	Stock Mining	9,777,000	18.60	**30.00**	33 10.0N 4.0W	On file	No location given
36-0072311	36-39	Medd, GC	01/01/1900	Private	Barrel Spring	Stock	198,799	0.38	0.61	SE NE 21 10.0N 4.0W	On file	
36-0072313	36-40	Medd, GC	01/01/1900	Private	Middle-water Lion Canyon	Stock	198,799	0.38	0.61	SE NW 28 10.0N 4.0W	On file	

TABLE E-2
Arizona Department of Water Resources
Surface Water Rights and Claimed Rights

Appl./ Regis. No.	Location ID Map	Appl./Regis. Holder	Priority Date	Land Owner	Water Source	Water Use	Water Use Amount			Point of Diversion	Last Action Taken	Comments
							gals/yr	gpm	ac-ft/yr			
36-0072314	---	Medd, GC	01/01/1900	Private	Weaver Creek	Stock	348,713	0.66	**1.07**	NE NW 32 10.0N 4.0W	On file	Same as 36-26
36-0072315	36-41	Medd, GC	01/01/1900	Private	Johnson Spring	Stock	400,857	0.76	**1.23**	NW NE 29 10.0N 4.0W	On file	
36-0075087	---	Michael, RM	01/01/1900	Private	Barrel Spring	Stock	198,799	0.38	0.61	SE NE 21 10.0N 4.0W	On file	Same as 36-39
36-0075089	---	Michael, RM	01/01/1900	Private	Middle Water Lion Canyon	Stock	198,799	0.38	0.61	SE NW 28 10.0N 4.0W	On file	Same as 36-40
36-0075090	---	Michael, RM	01/01/1900	Private	Weaver Creek	Stock	348,713	0.66	**1.07**	NE NW 32 10.0N 4.0W	On file	Same as 36-26
36-0075091	---	Michael, RM	01/01/1900	Private	Johnson Spring	Stock	397,598	0.76	**1.22**	NW NE 29 10.0N 4.0W	On file	Same as 36-41
36-0076274	36-42	Buckridge, PR	01/01/17	State	Weaver Creek	Mining	4,999,306	9.51	**15.34**	NW NE 32 10.0N 4.0W	On file	
36-0076275	---	Buckridge, PR	01/01/17	State	Weaver Creek	Mining	4,999,306	9.51	**15.34**	NE NW 32 10.0N 4.0W	On file	Same as 36-26
36-0100290	36-43	AZ State Land Dept	12/31/1883	State	South Corner Wash	Stock Wildlife	117,324	0.22	0.36	SW SE 31 10.0N 4.0W	On file	
36-0100561	36-44	AZ State Land Dept	12/31/1883	State	Cattail Spring	Stock Wildlife	394,339	0.75	**1.21**	SE NW 4 10.0N 4.0W	On file	
36-0100562	36-45	AZ State Land Dept	12/31/1883	State	Riggs Place Spring	Stock Wildlife	394,339	0.75	**1.21**	NW SE 4 10.0N 4.0W	On file	

(---) = Map location is the same as another water right or the location is not given in the database, as specified in the "Comments" column.
Public Water Rights are designated by "33" or "4A" Application Numbers.
Claimed Water Rights are designated by "36" Registration Numbers.
Stockpond Rights are designated by "38" Registration Numbers.
Water Rights or Claims for >1 acre-ft/year are highlighted.



EXPLANATION

• 24ADD PRIVATE WELL

○ YMC-01 YARNELL MINE MONITOR WELL

● TW1 YARNELL MINE WATER SUPPLY WELL
(TW-1, YMC-04, 2BCD AND SEC. 28 WELL FIELD)

□ TW-2 YARNELL MINE OBSERVATION WELL

4A-__ PUBLIC WATER SURFACE WATER RIGHT

33-__ CLAIMED SURFACE WATER RIGHT

36-__ STOCK POND SURFACE WATER RIGHT

38-__

RIGHT OR CLAIM THAT IS > 1.0 ACRE - FT/YR

RIGHT OR CLAIM THAT IS > 10.0 ACRE - FT/YR

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE E-1

LOCATION OF SURFACE WATER RIGHTS AND WELL PERMITS

APPENDIX F

SUMMARY OF FIELD MEASUREMENTS AT SPRINGS AND STREAM STATIONS

TABLE F-1
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Lower Antelope Creek	12/20/95	09:30	128.3	610	6.90	8.0	--
	12/26/95	13:20	144.0	650	8.40	10.0	---
	12/27/95	10:00	144.0	650	8.30	7.0	---
	02/21/96	10:40	136.0	600	7.90	13.5	---
	03/12/96	18:10	113.5	500	8.30	15.0	
	03/13/96	10:00	198.3	475	8.30	11.8	9.44
		15:45	299.4	---	---	---	---
	03/14/96	14:10	382.2	620	8.00	11.1	10.80
		17:35	399.6	---	---	---	---
	03/15/96	07:40	218.8	660	8.00	8.6	11.20
		12:30	198.3	---	---	---	---
	03/16/96	07:30	208.4	660	7.90	8.7	10.94
		12:25	188.6	---	---	---	---
		16:26	169.6	---	---	---	---
	03/17/96	07:20	188.6	650	7.80	9.0	10.12
		12:25	161.0	---	---	---	10.04
		16:10	144.1	---	---	---	---
	03/18/96	07:50	152.4	660	7.60	10.6	9.60
		13:15	136.0	---	---	---	---
		17:15	120.8	---	---	---	---
	03/19/96	07:50	144.1	655	7.80	10.5	9.60
		14:25	136.0	---	---	---	---
		17:10	128.3	---	---	---	---
	03/20/96	07:30	136.0	660	7.80	10.9	9.28
		13:40	144.1	---	---	---	---
		18:40	128.3	---	---	---	---
	03/21/96	09:30	144.1	680	7.40	12.9	9.50
		14:00	136.0	---	---	---	---
		17:10	128.3	---	---	---	---

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Lower Antelope Creek (continued)	03/22/96	07:50	136.0	620	7.60	11.4	8.50
		13:24	128.3	---	---	---	---
		17:23	128.3	---	---	---	---
	03/23/96	08:57	144.1	670	8.20	11.4	8.90
		13:36	128.3	---	---	---	---
		17:36	136.0	---	---	---	---
	03/24/96	08:17	136.0	630	8.15	9.2	9.35
	04/02/96	12:11	120.8	---	---	---	---
	04/11/96	12:11	106.6	---	---	---	---
	04/15/96	15:45	75.63	---	---	---	---
	04/18/96	17:05	81.31	625	8.25	17.2	7.46
	05/01/96	17:50	28.47	---	---	---	---
	06/06/96	17:28	0.63	---	---	---	---
	10/02/96	10:20	Dry[1/]	1075	7.45	22.5	2.70
	12/17/96	13:55	6.8	680	8.20	12.0	---
Upper Antelope Creek	03/13/96	12:30	30.2	---	---	---	---
	03/14/96	14:15	33.6	---	---	---	---
	03/15/96	10:00	37.3	560	7.80	14.2	7.20
	03/16/96	10:00	30.2	550	7.70	14.6	7.18
	03/17/96	10:05	30.2	540	7.60	14.8	7.18
	03/18/96	10:30	30.2	550	7.60	14.9	7.15
	03/19/96	11:30	30.2	520	7.40	15.4	7.25
	03/20/96	10:45	30.2	520	7.40	15.1	7.39
	03/21/96	11:35	30.2	540	7.30	15.3	8.19
	03/22/96	10:20	30.2	510	7.40	14.9	7.20
	03/24/96	11:43	33.6	520	8.05	15.0	7.33
	03/26/96	08:00	35.5	575	---	12.0	---
	04/06/96	11:45	37.3	680	7.60	15.7	7.54
	04/18/96	11:43	49.3	585	7.80	15.2	7.47

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Upper Antelope Creek (continued)	06/06/96	14:34	5.96	500	7.20	17.3	5.48
	10/02/96	15:30	5.43[2/]	600	7.50	16.9	3.36
	12/20/95	14:50	30.0	550	8.15	9.0	---
	12/26/95	16:10	33.3	640	8.20	11.0	---
	12/27/95	13:30	37.5	640	8.40	9.0	---
	02/21/96	09:30	33.3	580	8.00	12.0	---
	03/12/96	14:00	31.6	450	8.00	18.0	---
	03/13/96	12:50	42.9	470	8.55	12.3	11.23
	03/15/96	11:20	50.0	580	8.40	12.6	10.82
	03/16/96	11:20	46.2	580	8.40	14.8	9.62
	03/17/96	11:10	42.9	570	8.30	16.2	9.12
	03/18/96	11:50	40.0	570	8.30	16.7	8.80
	03/19/96	12:50	37.5	530	8.10	18.4	9.09
	03/20/96	11:55	37.5	540	8.00	16.6	8.80
	03/21/96	13:00	37.5	530	8.00	17.4	9.90
	03/22/96	11:20	37.5	520	7.60	15.2	9.0
	03/24/96	13:20	30.0	530	8.30	16.9	9.50
	03/27/96	11:45	33.3	550	7.25	15.0	---
	04/06/96	14:10	25.0	580	8.40	20.8	8.90
	04/18/96	11:12	25.0	625	8.10	15.1	9.85
	06/06/96	15:30	0.0	---	---	---	---
	10/02/96	14:55	0.0	---	---	---	---
Antelope Spring	12/17/96	12:45	0.5	500	8.20	9.5	---
	12/20/95	11:50	3.75	550	8.20	9.0	---
	12/26/95	14:45	4.30	600	8.20	9.0	---
	12/27/95	11:25	3.75	600	8.40	9.0	---
	02/21/96	08:15	4.50	590	7.80	12.0	---
	03/12/96	17:06	4.11	450	8.35	12.0	---
	03/13/96	11:45	7.50	480	8.40	10.7	10.53

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Antelope Spring (continued)	03/14/96	17:05	9.00	600	8.20	10.9	10.88
	03/15/96	09:50	7.50	620	8.20	9.2	11.06
		14:50	6.43	---	---	---	---
	03/16/96	09:50	6.93	620	8.10	10.6	10.88
		14:45	6.00	---	---	---	---
	03/17/96	09:50	5.63	620	8.10	11.8	10.44
		15:00	5.29	---	---	---	---
	03/18/96	10:20	5.00	620	8.10	12.0	10.20
		16:40	4.50	---	---	---	---
	03/19/96	11:00	5.00	540	7.60	13.3	9.85
		16:20	4.50	---	---	---	---
	03/20/96	10:30	5.00	580	7.90	12.9	9.94
		17:20	4.30	---	---	---	---
	03/21/96	11:20	4.70	600	7.80	12.8	9.92
	03/22/96	10:08	5.30	570	7.70	12.2	9.35
	03/23/96	12:57	4.70	640	8.30	13.7	9.23
	03/24/96	11:27	5.00	575	8.20	12.1	8.95
	04/06/96	11:25	4.10	660	8.30	14.8	8.50
	04/18/96	10:22	4.30	635	8.20	13.4	8.05
	06/06/96	16:30	0.0	---	---	---	---
	10/02/96	12:50	1.36	675	8.20	23.0	3.19
	12/17/96	10:10	3.2	600	8.00	10.5	---
Bovine Spring	12/20/95	11:30	1.30	650	7.60	13.0	---
	12/26/95	14:30	1.25	740	8.00	10.0	---
	12/27/95	11:05	1.25	740	8.00	12.5	---
	02/21/96	07:50	0.94	740	7.80	13.0	---
	03/13/96	11:15	1.25	590	7.85	17.0	5.28
	03/14/96	16:55	1.88	680	7.80	16.2	6.55
	03/15/96	09:40	1.50	720	7.80	15.7	6.60

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Bovine Spring (continued)		14:30	1.50	---	---	---	---
	03/16/96	09:30	1.50	710	7.70	17.8	6.42
	03/16/96	14:20	1.36	---	---	---	---
	03/17/96	09:30	1.36	710	7.70	18.0	6.33
		14:40	1.36	---	---	---	---
	03/18/96	10:05	1.36	710	7.70	18.1	6.24
		16:30	1.36	---	---	---	---
	03/19/96	10:30	1.36	670	7.60	20.0	5.54
		16:10	1.36	---	---	---	---
	03/20/96	10:10	1.36	680	7.30	19.3	5.64
	03/21/96	11:00	1.36	700	7.40	16.1	5.92
	03/22/96	09:50	1.36	680	7.20	17.4	4.34
	03/23/96	12:40	1.36	760	7.60	17.0	6.83
	03/24/96	10:54	1.25	700	7.70	16.9	4.27
	04/18/96	10:01	1.11	750	7.75	15.6	4.30
	06/06/96	14:04	0.0	---	---	---	---
	10/02/96	12:15	0.0	---	---	---	---
	12/17/96	09:55	0.0	---	---	---	---
Cottonwood Spring	12/20/95	11:10	2.73	680	7.45	8.0	---
	12/26/95	17:20	2.86	780	7.60	7.0	---
	12/27/95	15:00	2.83	780	7.60	7.0	---
	02/20/96	16:50	2.33	720	7.40	12.0	---
	03/12/96	17:45	2.45	580	8.20	12	---
	03/13/96	08:30	3.16	580	7.55	8.4	10.08
	03/14/96	12:30	5.00	830	7.20	8.7	10.90
	03/15/96	09:05	3.33	780	7.80	8.3	11.00
		14:00	3.06	---	---	---	---
	03/16/96	09:00	2.66	780	7.60	9.2	10.86
		13:55	2.39	---	---	---	---

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Cottonwood Spring (continued)	03/17/96	09:05	2.15	770	7.60	10.1	10.74
		14:05	1.88	---	---	---	---
	03/18/96	09:30	1.67	780	7.50	10.7	10.80
		16:10	1.88	---	---	---	---
	03/19/96	10:00	2.50	760	7.40	10.9	10.14
		15:40	2.15	---	---	---	---
	03/20/96	10:50	2.50	560	7.40	11.3	10.00
		14:30	2.14	---	---	---	---
		16:00	2.14	---	---	---	---
		17:50	2.14	---	---	---	---
	03/21/96	08:00	2.50	---	---	---	---
		16:15	2.14	640	7.30	13.6	7.70
	03/22/96	07:20	2.30	770	7.00	10.3	8.10
		17:52	2.14				
	03/23/96	08:07	2.50	790	7.60	8.8	8.89
		17:28	2.30				
	03/24/96	07:07	2.50	730	7.20	6.0	8.70
	03/27/96	07:40	2.50	750	7.00	8.0	---
		15:13	2.14	725	6.90	15.5	---
	03/28/96	07:52	2.50	735	7.40	8.5	---
		15:51	2.14	725	7.70	14.0	---
	03/29/96	07:51	2.50	730	7.55	8.5	---
		15:03	2.14	725	7.70	14.5	---
	03/30/96	08:06	2.30	735	7.00	8.5	---
		15:25	2.14	---	7.90	15.0	---
	03/31/96	08:59	2.30	---	7.55	11.0	---
		14:55	2.14	---	7.45	17.0	---
	04/01/96	07:50	2.50	---	7.20	9.0	---
		15:13	2.14	---	7.30	17.0	---

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Cottonwood Spring (continued)	04/02/96	07:46	2.50	---	7.10	10.0	---
		16:55	2.14	---	---	---	---
	04/03/96	09:15	2.50	760	7.20	9.6	9.12
		15:05	2.14	---	---	---	---
	04/04/96	08:40	2.14	800	7.60	9.9	9.20
		12:40	1.88	---	---	---	---
		15:00	1.88	---	---	---	---
	04/05/96	08:55	2.14	800	7.60	10.1	9.32
		15:05	1.88	---	---	---	---
	04/06/96	09:40	2.14	780	7.60	11.6	9.61
		15:50	1.88	---	---	---	---
	04/07/96	09:50	2.14	800	7.50	10.8	9.42
		15:10	1.88	---	---	---	---
	04/08/96	11:05	2.14	800	7.60	11.6	9.28
		14:05	1.88	---	---	---	---
	04/09/96	09:40	1.88	780	7.60	11.4	9.34
		16:20	1.88	---	---	---	---
	04/10/96	08:35	1.88	800	7.50	11.8	9.43
		16:30	1.88	---	---	---	---
	04/11/96	11:23	1.88	850	7.70	13.5	8.80
		15:56	1.88	---	---	---	---
	04/12/96	08:09	2.14	820	7.20	10.2	9.43
		17:12	1.88	---	---	---	---
	04/13/96	08:31	1.88	840	7.40	10.8	9.21
		17:34	1.67	---	---	---	---
	04/14/96	07:17	2.14	870	7.80	8.1	8.43
	04/15/96	11:18	1.76	785	7.70	14.4	9.47
	04/17/96	10:44	1.76	750	7.75	15.0	9.09
	04/18/96	18:10	1.76	815	7.55	17.6	7.26

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Cottonwood Spring (continued)	05/01/96	17:20	0.36	---	---	---	---
	06/06/96	07:35	0.0	---	---	---	---
	10/02/96	14:35	0.0	---	---	---	---
	12/17/96	09:35	0.31	850	7.70	10.5	---
Cox Spring	12/20/95	10:50	0.64	770	7.00	9.0	---
	12/26/95	14:00	0.71	840	7.70	10.0	---
	12/27/95	10:40	1.54	860	7.80	8.5	---
	02/20/96	16:30	1.67	840	7.20	13.0	---
	03/13/96	09:20	2.36	625	7.70	9.7	7.33
	03/14/96	15:25	2.46	810	7.60	9.2	7.44
	03/15/96	09:20	2.46	820	7.70	8.6	7.83
		14:15	1.90	---	---	---	---
	03/16/96	09:15	1.83	810	7.60	9.8	6.34
		14:05	1.76	810	7.60	10.2	6.02
	03/17/96	09:02	1.77	800	7.60	10.0	6.46
		15:40	1.67	---	---	---	---
	03/18/96	09:45	1.54	800	7.40	10.7	5.60
		17:05	1.58	---	---	---	---
	03/19/96	10:10	2.03	760	7.50	13.2	7.82
		17:00	1.79	---	---	---	---
	03/20/96	14:10	1.82	780	7.00	15.9	6.52
		16:30	1.83	---	---	---	---
		18:30	1.82	---	---	---	---
	03/21/96	10:18	2.00	660	7.20	12.4	7.86
		16:45	1.82	---	---	---	---
	03/22/96	09:10	2.07	680	7.20	10.8	7.24
		17:00	2.13				
	03/23/96	08:27	1.87	850	7.50	10.0	7.13
		17:08	2.00				

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Cox Spring (continued)	03/24/96	07:38	1.90	790	7.95	8.0	7.20
	03/27/96	07:18	2.21	810	7.20	9.0	
		14:45	1.79	780	7.05	14.0	
	03/28/96	07:33	2.15	790	6.75	9.5	---
		15:33	1.76	785	7.80	13.5	---
	03/29/96	07:30	2.13	790	7.95	9.5	---
		14:38	1.90	760	7.80	13.0	---
	03/30/96	07:40	2.13	780	---	8.0	---
		15:02	1.92	780	6.75	14.5	---
	03/31/96	08:41	2.21	---	6.90	10.0	---
		15:08	1.82	---	7.45	15.0	---
	04/01/96	07:31	2.16	---	7.60	9.5	---
		14:48	1.79	---	6.95	15.0	---
	04/02/96	07:27	2.21	---	7.30	10.5	---
		16:45	1.82	790	7.40	15.0	7.05
	04/03/96	08:50	2.13	780	7.30	9.6	7.14
		14:45	1.82	---	---	---	---
	04/04/96	08:25	2.08	780	7.30	9.4	7.08
		14:50	2.08	---	---	---	---
	04/05/96	08:30	2.08	870	7.40	10.0	7.40
	04/06/96	10:50	1.99	880	7.40	10.6	7.24
	04/07/96	10:05	1.99	880	7.50	10.4	7.11
	04/08/96	11:30	1.95	880	7.40	10.7	7.02
	04/09/96	11:15	1.99	860	7.50	11.2	7.33
	04/10/96	08:50	2.04	850	7.40	11.0	7.62
	04/11/96	11:49	1.99	860	7.60	15.0	7.31
	04/12/96	11:38	1.90	860	7.30	15.1	7.29
	04/13/96	11:24	1.95	860	7.60	14.0	7.39
	04/14/96	11:24	1.90	865	7.10	13.8	7.68

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Cox Spring (continued)	04/15/96	11:56	1.82	820	7.65	14.8	6.90
	04/17/96	14:42	1.72	825	7.55	15.4	6.58
	04/18/96	17:53	1.76	850	7.35	13.8	7.21
	05/01/96	17:40	1.03	---	---	---	---
	06/06/96	17:15	0.58	---	---	---	---
	10/02/96	11:45	0.50	690[3/]	7.60[3/]	25.9[3/]	2.78[3/]
	12/17/96	13:35	0.58	850	7.40	11.5	---
Fools Gulch Spring	03/25/96	17:30	1.36	---	---	---	---
	03/26/96	14:35	1.36	950	6.60	19.5	---
	03/27/96	10:22	1.50	900	6.95	12.5	---
		17:05	1.30	950	7.10	13.0	---
	03/28/96	12:04	1.36	890	7.50	17.0	---
		17:00	0.91	950	7.80	13.0	---
	03/29/96	10:33	1.15	925	7.80	11.0	---
		17:37	1.20	950	7.90	11.5	---
	03/30/96	10:30	1.11	890	7.10	13.0	---
		16:23	1.36	---	---	--	---
	03/31/96	12:10	1.36	---	7.35	18.5	---
		16:37	1.30	---	7.45	16.5	---
	04/01/96	12:03	1.36	---	7.10	13.0	---
		16:47	1.20	---	7.20	15.5	---
	04/02/96	09:17	1.36	---	7.10	12.0	---
		17:30	1.15	---	---	---	---
	04/03/96	09:45	1.36	900	7.20	11.4	7.53
		15:45	1.15	---	---	---	---
	04/04/96	09:15	1.36	900	7.20	11.2	7.48
		15:30	1.25	---	---	---	---
	04/05/96	10:00	1.36	1000	7.60	11.2	7.67
	04/06/96	17:45	1.15	950	7.50	14.4	7.33

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Fools Gulch Spring (continued)	04/07/96	08:45	1.25	950	7.60	11.1	7.44
	04/08/96	07:35	1.25	900	7.50	11.0	7.29
	04/09/96	10:40	1.15	900	7.40	11.8	7.48
	04/10/96	10:30	1.15	950	7.70	13.5	6.80
	04/11/96	15:25	1.15	950	7.70	18.0	10.85
	04/12/96	16:53	1.15	940	7.00	16.8	9.73
	04/13/96	16:56	0.94	1000	7.10	17.8	8.14
	04/15/96	09:28	1.25	980	7.00	10.9	8.19
	04/16/96	07:55	1.25	1000	7.60	9.2	6.40
	04/18/96	08:01	1.00	1000	7.70	11.2	5.53
	05/01/96	18:40	0.75	---	---	---	---
	06/07/96	08:00	0.64	950	8.00	---	---
	10/02/96	17:15	0.0	940	7.85	19.8	3.85
	12/17/96	08:55	0.0	1000	7.90	11.5	---
Juniper Spring	12/20/95	15:35	6.00	500	8.00	19.0	---
	12/26/95	15:50	6.25	540	8.00	17.0	---
	12/27/95	13:00	6.12	530	8.20	19.0	---
	02/21/96	09:05	5.45	500	7.70	19.0	---
	03/12/96	15:15	4.50	420	7.80	20.0	
	03/13/96	13:25	6.40	460	8.20	18.4	7.93
	03/15/96	11:30	3.60	520	7.80	19.3	8.50
	03/16/96	11:35	4.30	510	7.80	19.4	8.44
	03/17/96	11:30	4.80	510	7.70	19.7	8.66
	03/18/96	12:00	5.70	520	7.60	19.8	8.30
	03/19/96	13:15	5.80	500	7.30	20.1	8.55
	03/20/96	12:15	4.20	500	7.10	20.4	8.40
	03/21/96	13:35	4.50	500	7.30	20.4	7.82
	03/22/96	11:35	5.00	680	7.20	19.8	7.70
	03/24/96	13:03	5.00	500	8.05	19.7	7.54

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Juniper Spring (Continued)	03/27/96	12:25	6.10	480	7.10	20.0	---
	04/06/96	14:56	5.20	550	7.50	20.3	8.53
	04/18/96	10:47	5.50	570	7.90	19.1	8.01
	06/06/96	15:00	4.0	530	7.40	21.3	9.43
	10/02/96	14:30	4.0	550	7.80	20.8	4.40
	12/17/96	12:15	3.9	550	7.80	14.5	---
White Spring	12/20/95	10:20	1.76	390	7.00	16.0	---
	12/26/95	13:00	1.67	440	7.50	15.0	---
	12/27/95	09:00	1.67	420	7.30	15.0	---
	02/21/96	10:30	0.72	400	7.30	11.5	---
	03/12/96	18:20	0.58	380	8.40	16.0	---
	03/13/96	10:30	0.58	325	8.00	15.8	4.1
	03/15/96	12:15	0.43	420	7.60	16.1	2.90
	03/16/96	12:10	1.25	430	7.50	16.4	1.36
	03/17/96	12:05	1.25	440	7.40	16.6	0.82
	03/18/96	12:45	1.50	440	7.40	16.6	0.40
	03/19/96	14:10	1.50	400	8.20	16.3	3.81
	03/20/96	13:50	1.36	400	7.00	16.3	3.08
	03/21/96	09:42	1.50	420	7.20	16.2	4.26
	03/22/96	08:20	1.50	420	7.10	16.0	4.10
	03/23/96	09:18	1.50	470	7.40	15.5	3.59
	03/24/96	08:45	1.30	420	8.20	14.8	3.31
	04/18/96	17:18	0.71	455	7.85	16.4	3.54
	06/07/96	08:50	0.53	455	8.00	---	---
	10/02/96	10:50	0.75	440	7.45	19.4	1.0
	12/17/96	14:15	0.68	420	7.40	11.5	---
Yarnell Spring	12/26/95	15:15	57.75	530	8.40	12.0	---
	12/27/95	12:10	56.68	520	8.50	12.0	---
	02/21/96	08:40	51.15	480	8.00	13.0	---

TABLE F-1 (Continued)
Summary of Field Measurements at Springs and Stream Stations

Source Identification	Date	Time	Flow Rate (gpm)	Field parameters			
				EC (µmhos/cm)	pH	Temperature (°C)	Dissolved oxygen (mg/l)
Yarnell Spring (Continued)	03/12/96	15:54	50.87	400	8.30	14.5	---
	03/13/96	13:55	52.39	410	8.30	11.5	9.34
	03/15/96	10:35	61.63	500	8.30	11.0	10.15
	03/16/96	10:30	58.14	490	8.20	11.6	9.92
	03/17/96	10:35	57.65	490	8.10	12.1	9.76
	03/18/96	11:00	56.81	490	8.10	12.3	9.68
	03/19/96	12:00	52.48	460	7.80	13.1	9.40
	03/20/96	11:20	52.62	460	7.90	12.6	9.50
	03/21/96	12:10	54.56	460	7.80	13.2	9.48
	03/22/96	10:45	52.67	440	7.50	12.1	9.50
	03/24/96	12:20	57.52	450	7.30	12.3	8.86
	03/27/96	13:05	54.72	450	7.20	14.0	---
	04/06/96	12:25	50.81	500	8.20	13.7	8.50
	04/18/96	12:40	53.29	530	8.15	13.6	8.37
	06/06/96	16:10	19.51	570	8.15	21.1	7.60
	10/02/96	13:50	9.84	675	8.20	18.0	4.11
	12/17/96	11:30	8.53	500	8.20	11.5	---

gpm = gallons per minute
Umhos/cm = micromhos per centimeter. A mho is the reciprocal ohm. Micro = one millionth.
°C = degrees Centigrade
mg/l = milligrams (one thousandth of a gram) per liter

APPENDIX G

PLANT SPECIES

TABLE G-1
Plant Species List

Species	Common Name	Family
Trees		
Juniperus osteosperma	Utah juniper	Cupressaceae
Populus fremontii	Fremont cottonwood	Salicaceae
Salix gooddingii	Goodding willow	Salicaceae
Shrubs/Subshrubs		
Acacia constricta	White thorn	Leguminosa
Acacia greggii	Catclaw acacia	Fabaceae
Aloysia wrightii	Aloysia	Verbenaceae
Arctostaphylos pungens	Manzanita	Ericaceae
Atriplex confertifolia	Saltbush	Chenopodiaceae
Baccharis emoryi	Emory baccharis	Euphorbiaceae
Baccharis glutinosa	Seepwillow	Compositae
Baccharis pteronioides	Yerba-de-pasmo baccharis	Asteraceae
Baccharis sarothroides	Desert broom	Euphorbiaceae
Baccharis sergiloides	Waterweed	Asteraceae
Berberis haematocarpa	Holly grape	Berberiadaceae
Brickellia californica	California brickellia	Asteraceae
Brickellia grandiflora	Tasselflower	Asteraceae
Calliandra eriophylla	False mesquite	Leguminosa
Canotia halocantha	Crucifixion thorn	Celastraceae
Ceanothus greggii	Desert ceanothus	Celastraceae
Celtis pallida	Hackberry	Ulmaceae
Cercidium microphyllum	Foothill paloverde	Leguminosa
Cercocarpus betuloides	Birchleaf mountain mahogany	Rhamnaceae
Cercocarpus montanus	Alderleaf mountain mahogany	Rosaceae
Chilopsis linearis	Desert willow	Bignoniaceae
Encelia frutescens	Brittlebush	Compositae
Ephedra viridis	Ephedra	Ephedraceas
Eriogonum fasciculatum	Bush buckwheat	Polygonaceae
Fendlera rupicola	Fendler bush	Rosaceae
Garrya flavescens	Silktassel bush	Garryaceae
Gutierrezia sarothrae	Snakeweed	Asteraceae
Haplopappus acredenius	Paleleaf goldenweed	Compositae
Haplopappus cuneata	Wedgeleaf goldenweed	Asteraceae
Haplopappus larcifolius	Turpentine bush	Asteraceae
Hymenoclea monogyra	Burrobush	Compositae
Krameria parviflora	Range ratany	Leguminosa
Larrea tridentata	Creosotebush	Zygophyllaceae
Menodora scoparia	Twinberry	Oleaceae
Mimosa biuncifera	Wait-a-minute bush	Fabaceae
Phoradendron californium	Desert mistletoe	Loranthaceae
Prosopis julifolia	Mesquite	Fabaceae
Psilostrophe cooperi	Paperflower	Compositae
Ptelea angustifolia	Hoptree	Rutaceae
Quercus dunnii	Palmer oak	Fabaceae
Quercus turbinella	Live oak	Fabaceae

TABLE G-1 (Continued)
Plant Species List

Species	Common Name	Family
Rhamnus ilicifolia	Buckthorn	Rhamnaceae
Rhus ovata	Sugar sumac	Anacardiaceae
Rhus trilobata	Smooth sumac	Anacardiaceae
Salazaria mexicana	Bladder sage	Labiatae
Sapindus saponaria	Soapberry	Aceraceae
Senecio douglasii ssp. monoense	Douglas groundsel	Asteraceae
Tamarix pentandra	Saltcedar	Tamaricaceae
Succulents		
Carnegiea giganteus	Saguaro	Cactaceae
Echinocereus fasciculatus	Hedgehog cactus	Cactaceae
Ferrocactus acanthoides var. lecontei	Barrel cactus	Cactaceae
Mammillaria microcarpa	Pincushion cactus	Cactaceae
Opuntia acanthocarpa	Buckthorn cholla	Cactaceae
Opuntia basilaris	Beavertail prickly pear	Cactaceae
Opuntia bigelovii	Teddy bear cholla	Cactaceae
Opuntia chlorotica	Pancake pear	Cactaceae
Opuntia leptocaulis	Christmas cactus	Cactaceae
Opuntia phaeacantha var. discata	Engelmann prickly pear	Cactaceae
Yuccas/Nolinas		
Agave desertii	Desert agave	Amaryllidaceae
Nolina bigelovii	Nolina	Liliaceae
Nolina microcarpa	Beargrass	Liliaceae
Yucca baccata	Banana yucca	Liliaceae
Yucca elata	Soaptree	Liliaceae
Perennial Graminoids		
Aristida barbata	Harvard threeawn	Poaceae
Aristida glauca	Reverchon threeawn	Poaceae
Aristida parishii	Parish threeawn	Poaceae
Aristida purpurea	Purple threeawn	Gramineae
Aristida ternipes	Spider grass	Poaceae
Bouteloua curtipendula	Sideoats grama	Poaceae
Bouteloua eriopoda	Black grama	Poaceae
Bouteloua gracilis	Blue grama	Poaceae
Cynodon dactylon	Bermuda grass	Poaceae
Enneapogon desvauxii	Spike pampasgrass	Poaceae
Eragrostis intermedia	Plains lovegrass	Poaceae
Eragrostis lehmanniana	Lehmann lovegrass	Poaceae
Hilaria rigida	Big galleta	Gramineae
Juncus balticus	Wire rush	Juncaceae
Koeleria cristata	June grass	Poaceae
Leptochloa dubia	Green sprangletop	Poaceae
Lycurus phleoides	Wolftail	Poaceae
Muhlenbergia asperifolia	Alkali muhly	Poaceae
Muhlenbergia porteri	Bush muhly	Gramineae
Panicum sp.	Panic grass	Poaceae
Poa fendleriana	Muttongrass	Poaceae

TABLE G-1 (Continued)
Plant Species List

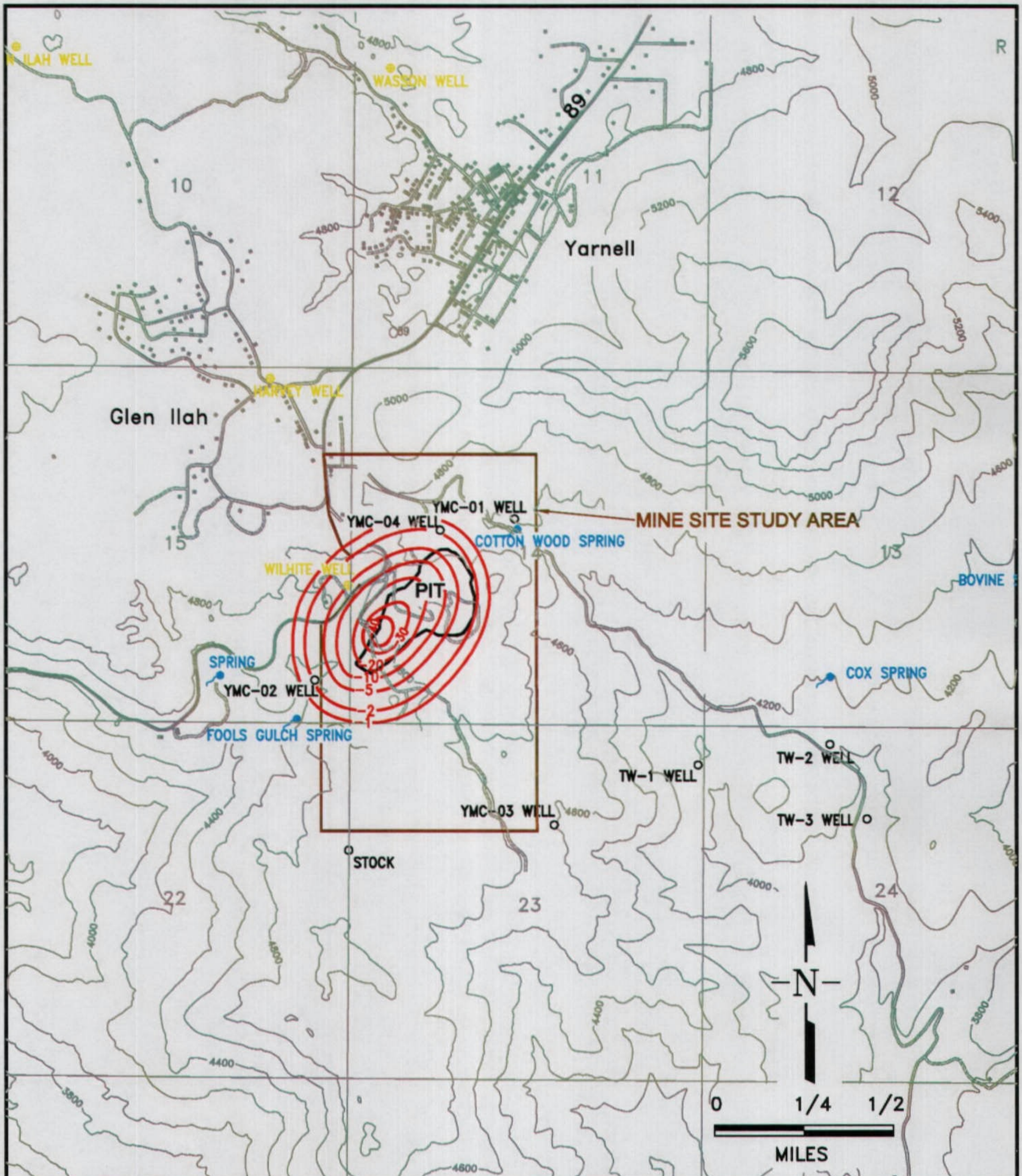
Species	Common Name	Family
Polypogon monspeliensis	Rabbitfoot grass	Poaceae
Scirpus microcarpus	Bulrush	Cyperaceae
Setaria macrostachya	Bristlegrass	Poaceae
Sitanion hystrix	Squirreltail	Poaceae
Sporobolus cryptandrus	Sand dropseed	Gramineae
Stipa speciosa	Desert needlegrass	Gramineae
Trichachne californica	Cottontop	Poaceae
Tridens pulchellus	Fluffgrass	Poaceae
Annual Grasses		
Aristida adscensionis	Six weeks threeawn	Poaceae
Bromus rubens	Red brome	Poaceae
Eragrostis cilianensis	Stinkgrass	Poaceae
Perennial Forbs		
Abutilon parvulum	Indian mallow	Malvaceae
Arabis perennans	Rockcress	Brassicaceae
Argemone platyceras	Prickly poppy	Papaveraceae
Artemisia dracunculoides	False tarragon	Asteraceae
Artemisia ludoviciana	Wormwood	Asteraceae
Aster canescens	Aster	Asteraceae
Boerhaavia coccinea	Spiderling	Nyctaginaceae
Cassia bauhinioides	Desert senna	Leguminosae
Castilleja integra	Paintbrush	Scrophulariaceae
Cirsium sp.	Thistle	Asteraceae
Dalea sp.	----	Fabaceae
Datura meteloides	Jimsonweed	Labiatae
Erigeron oreophilus	Fleabane	Asteraceae
Eriogonum wrightii	Wright buckwheat	Polygaonacae
Euphorbia brachycera	Spurge	Euphorbiaceae
Euphorbia melanadenia	Euphorbia	Euphorbiaceae
Euphorbia pediculifera	Rattlesnake weed	Euphorbiaceae
Franseria confertiflora	Bursage	Asteraceae
Galium microphyllum	Bedstraw	Rubiaceae
Gilia sp.	----	Polemoniaceae
Gnaphalium wrightii	Cudweed	Asteraceae
Hedeoma oblongifolium	Mock-pennyroyal	Lamiaceae
Heterotheca subaxillaris	Camphorweed	Asteraceae
Marrubium vulgare	Horehound	Labiatae
Medicago sativa	Alfalfa	Fabaceae
Mentzelia pumila	Stickweed	Loasaceae
Mirabilis glandulosa	Four o'clock	Nyctaginaceae
Penstemon pseudospectabilis	Penstemon	Scrophulariaceae
Perezia wrightii	Perezia	Asteraceae
Phoradendron californium	Desert mistletoe	Loranthaceae
Physalis hederifolia	Ground cherry	Solanaceae
Senecio multicapitatus	Senecio	Asteraceae
Solidago wrightii	Goldenrod	Asteraceae

TABLE G-1 (Continued)
Plant Species List

Species	Common Name	Family
Sphaeralcea ambigua	Desert mallow	Malvaceae
Sphaeralcea grossulariaefolia	Globemallow	Malvaceae
Stephanomeria pauciflora	Wire lettuce	Asteraceae
Tragia stylaris	Nose-burn	Euphorbiaceae
Typha latifolia	Cattail	Typhaceae
Verbena gooddingii	Vervain	Valerianaceae
Annual/Biennial Forbs		
Allionia incarnata	Trailing four o'clock	Nataginaceae
Ambrosia psilostachya	Western ragweed	Asteraceae
Argemone pleiacantha	Prickly poppy	Papaveraceae
Baileya multiradiata	Desert marigold	Compositae
Boerhaavia coulteri	Spiderling	Nyctaginaceae
Cryptantha circuimscissa	Cryptantha	Boraginaceae
Eriastrum diffusum	Eriastrum	Polemoniaceae
Eriogonum annuum	Wild buckwheat	Polygonaceae
Eriogonum inflatum	Desert trumpet	Polygonaceae
Erodium cicutarium	Heronbill	Fabaceae
Haplopappus gracilis	Goldenweed	Asteraceae
Helianthus annuus	Annual sunflower	Asteraceae
Ipomea coccinea	Star-glory	Convolvulaceae
Melilotus alba	White sweetclover	Fabaceae
Melilotus officinale	Yellow sweetclover	Fabaceae
Mentzelia pumila	Stickweed	Loasaceae
Nicotiana trigonophylla	Tobacco	Solanaceae
Physalis lobata	Ground cherry	Solanaceae
Plantago purshii	Woolly plantain	Plantaginaceae
Portulaca mundala	Purslane	Portulaceae
Thelypodium wrightii	Thelypodium	Cruciferae
Verbascum thapsus	Mullein	Scrophulariaceae
Verbesina encelioides	Crownbeard	Asteraceae
Xanthium strumarium	Cocklebur	Asteraceae
Vines		
Clematis drummondii	Virgin's bower	Ranunculaceae
Evolvulus arizonica	Wild morning glory	Convolvulaceae
Maurandya antirrhiniflora	Climbing snapdragon	Scrophulariaceae
Sarcostemma cynanchoides	Climbing milkweed	Asclepiadaceae
Vitis arizonica	Canyon grape	Vitaceae
Cryptogans		
Cheilanthes tomentosa	Woolly lip fern	Polypodiaceae
Pellaea truncata	Spiny cliffbrake	Polypodiaceae

APPENDIX H

WATER DRAWDOWN PLOTS



CONTOURS OF EQUAL WATER LEVEL DRAWDOWN IN FEET.

YMC-02 WELL — WELL LOCATION

SPRING — SPRING LOCATION

YARNELL PIT

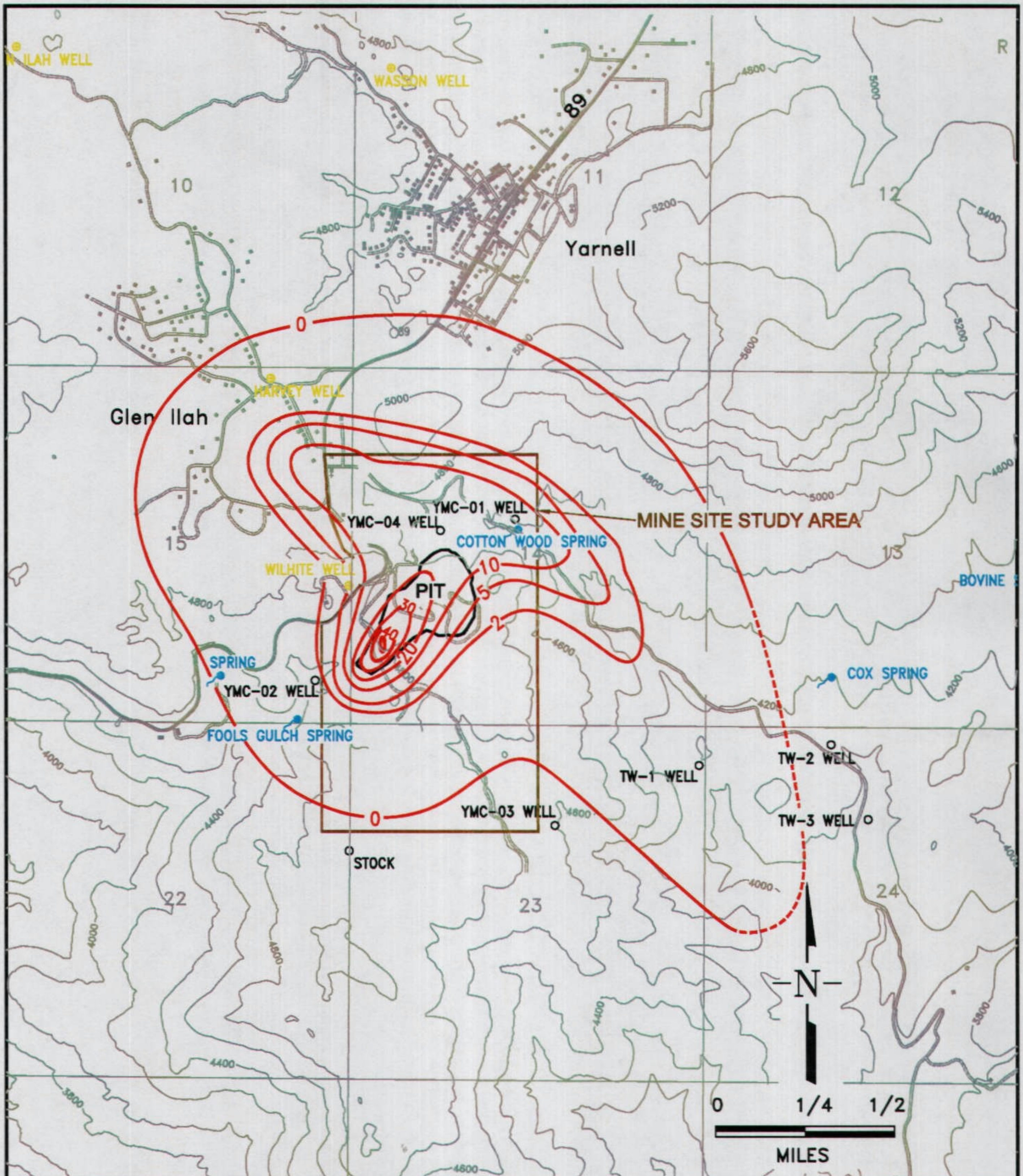
NOTE: No pumping from YMC-04.
Pit dewatering during years 6 and 7.
Includes recharge.

PROPOSED YARNELL PROJECT

YAVAPAI COUNTY, ARIZONA

FIGURE H-1

MODELED GROUNDWATER DRAWDOWN CONTOURS AT END OF YEAR SEVEN WITH RECHARGE NO YMC-04 PUMPAGE



CONTOURS OF EQUAL WATER LEVEL DRAWDOWN IN FEET, DASHED WHERE INFERRED.

YMC-02 WELL — WELL LOCATION

SPRING — SPRING LOCATION

YARNELL PIT

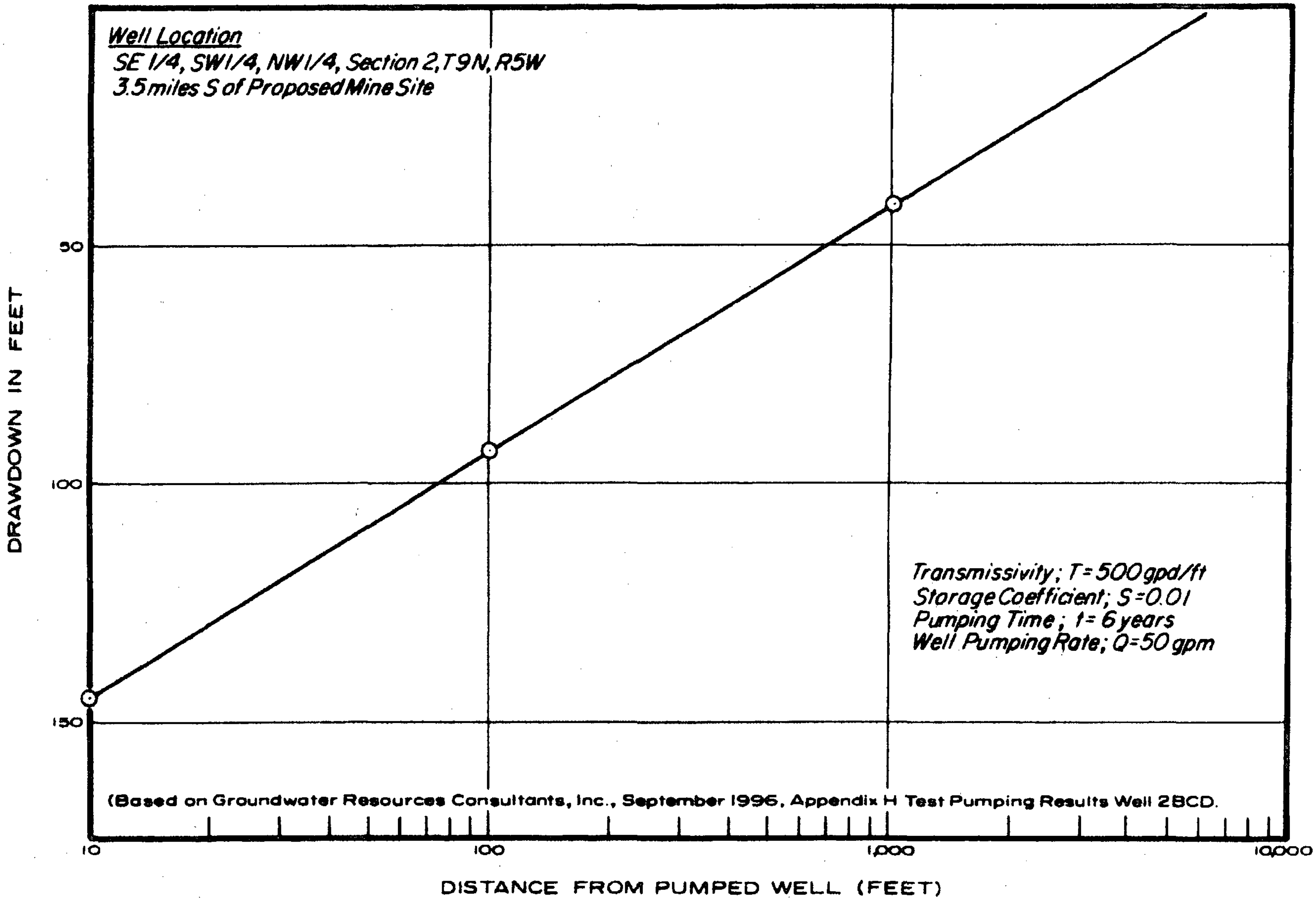
NOTE: Maximum recharge equals 5% of annual precipitation. YMC-04 pumping at 15 GPM for 7 years. Pit dewatering during years 6 and 7.

PROPOSED YARNELL PROJECT

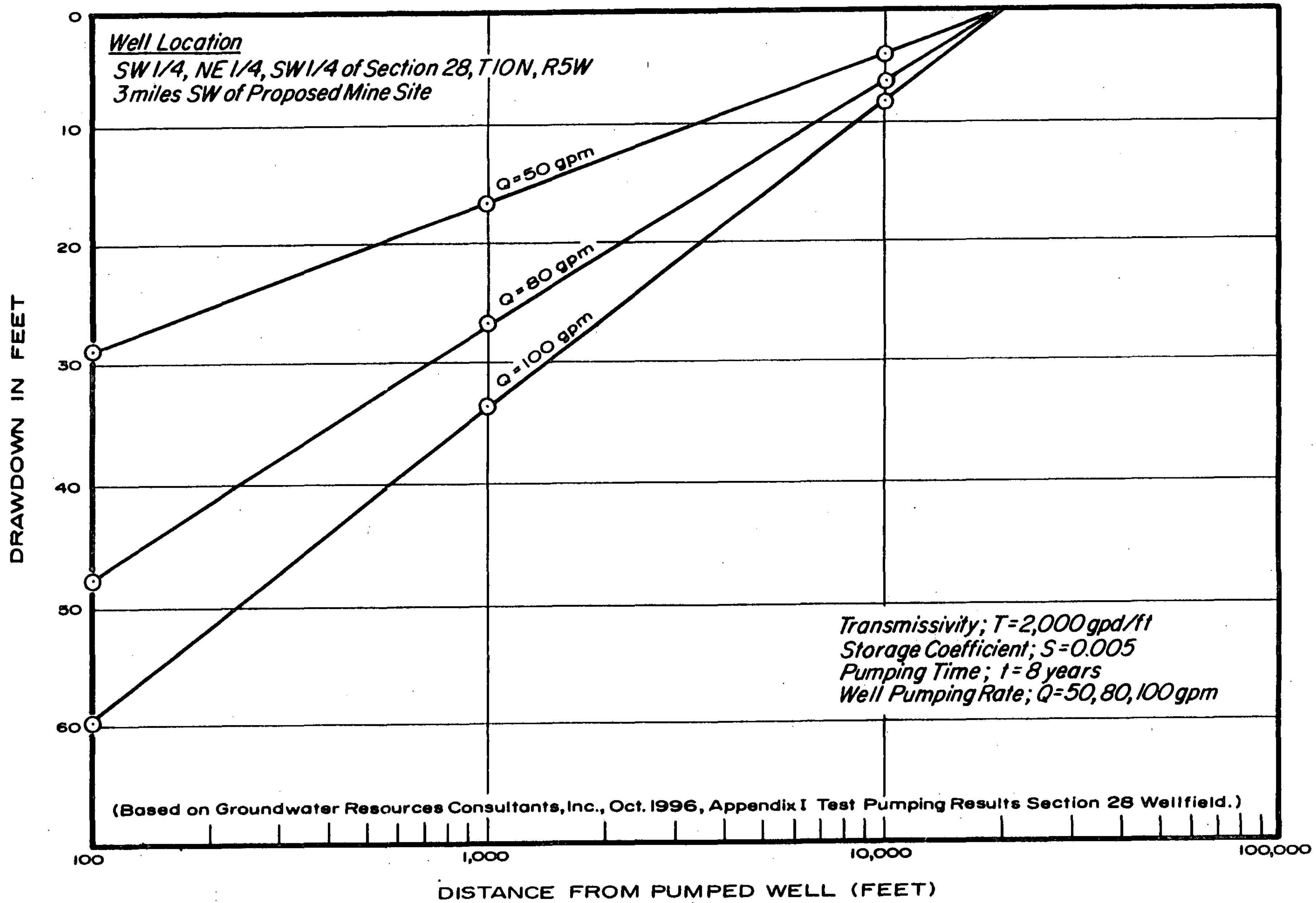
YAVAPAI COUNTY, ARIZONA

FIGURE H-2

MODELED GROUNDWATER DRAWDOWN CONTOURS AT END OF YEAR SEVEN WITH RECHARGE AND PUMPING YMC-04



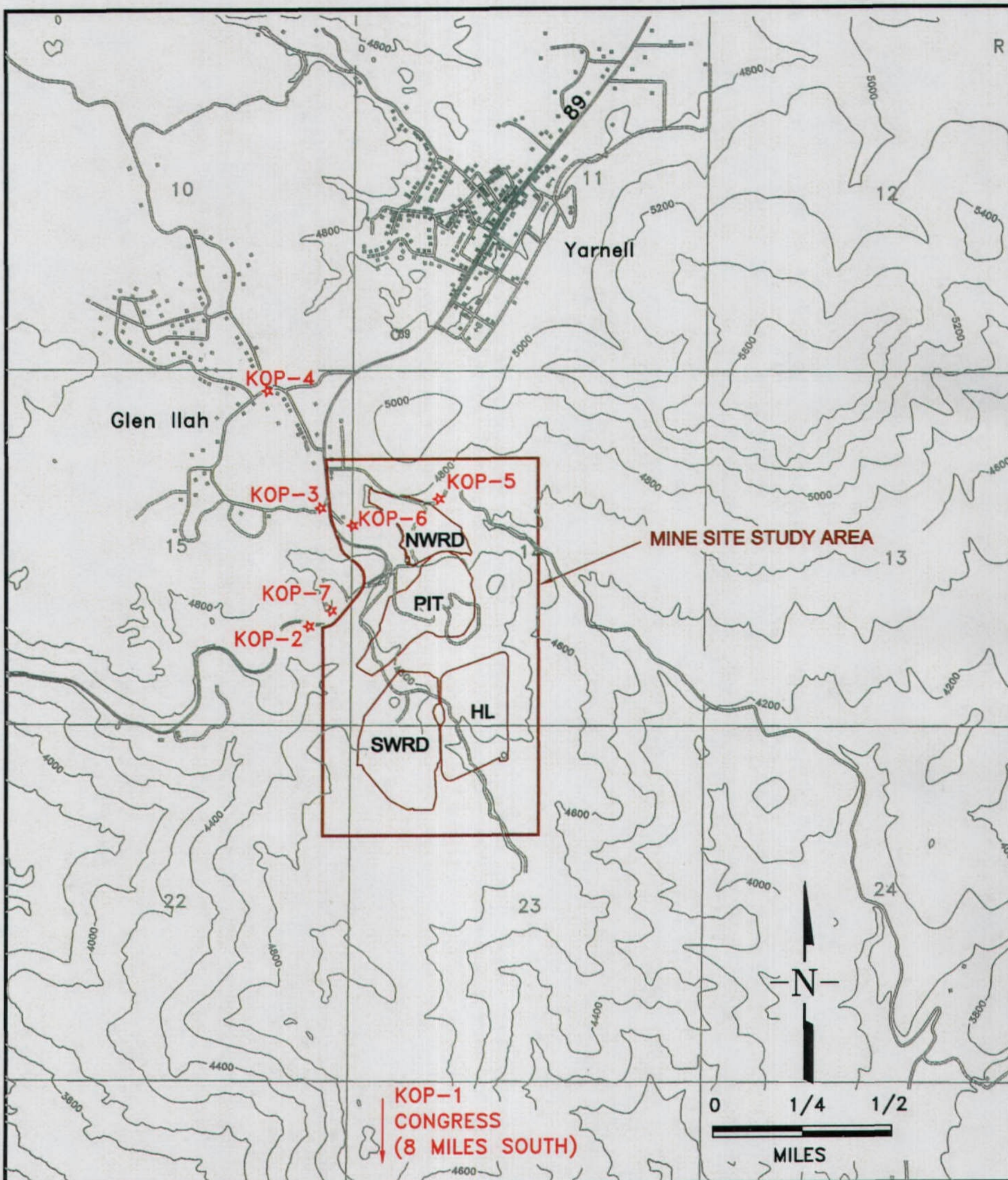
PROJECTED THEORETICAL DRAWDOWN RESULTING FROM PUMPING WELL 2BCD.



PROJECTED THEORETICAL DRAWDOWN RESULTING FROM THE PUMPING OF SECTION 28 WELLFIELD.

APPENDIX I

VISUAL SIMULATIONS



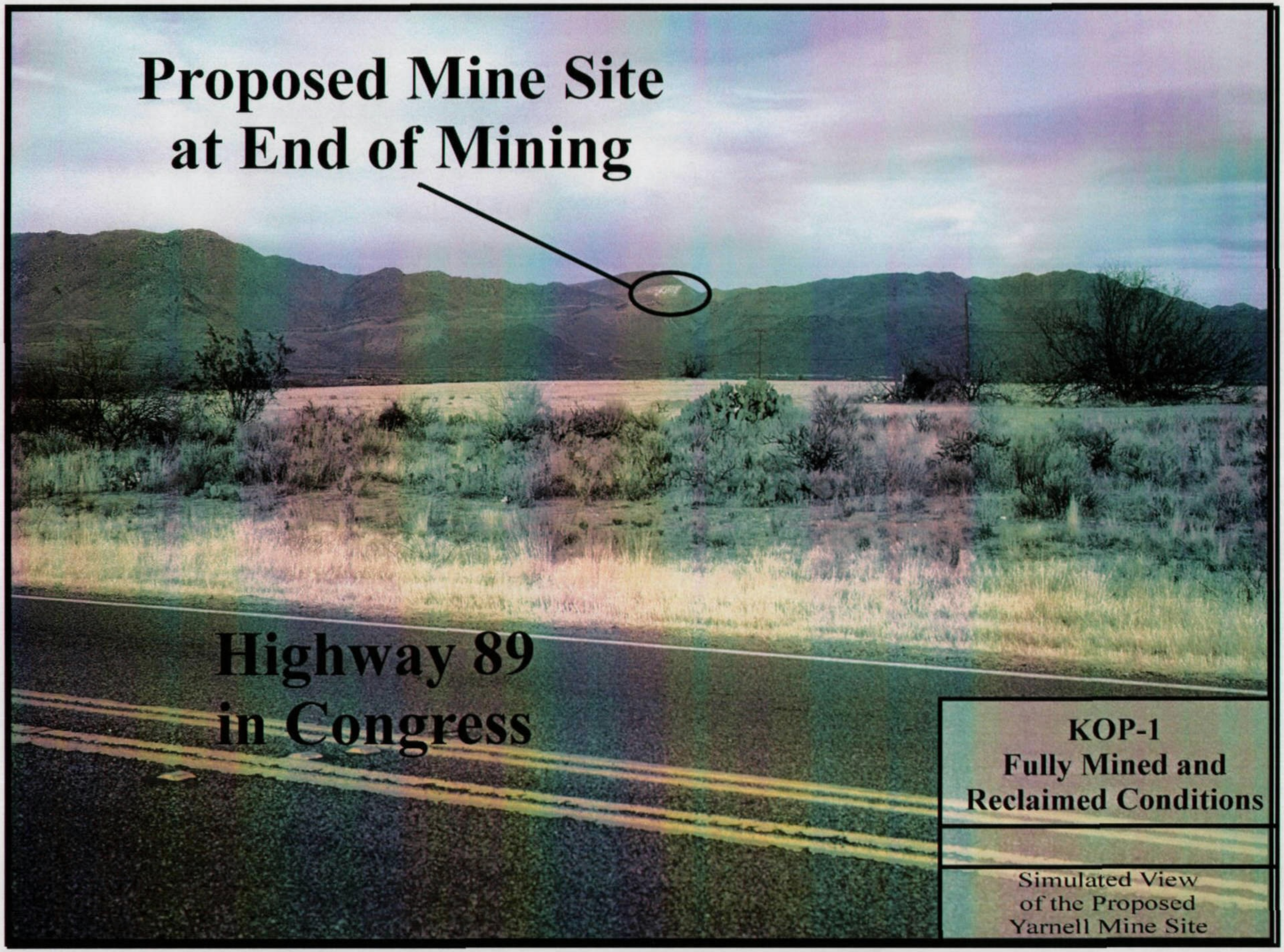
KOP-1	*	KEY OBSERVATION POINTS
NWRD		NORTH WASTE ROCK DUMP
SWRD		SOUTH WASTE ROCK DUMP
HL		HEAP LEACH FACILITY
PIT		YARNELL PIT

PROPOSED YARNELL PROJECT
YAVAPAI COUNTY, ARIZONA

FIGURE I-1

LOCATIONS OF KEY OBSERVATION POINTS


Proposed Mine Site
Highway 89
in Congress
KOP-1
Pre-Mining
Conditions
Existing View
of the Proposed
Yarnell Mine Site

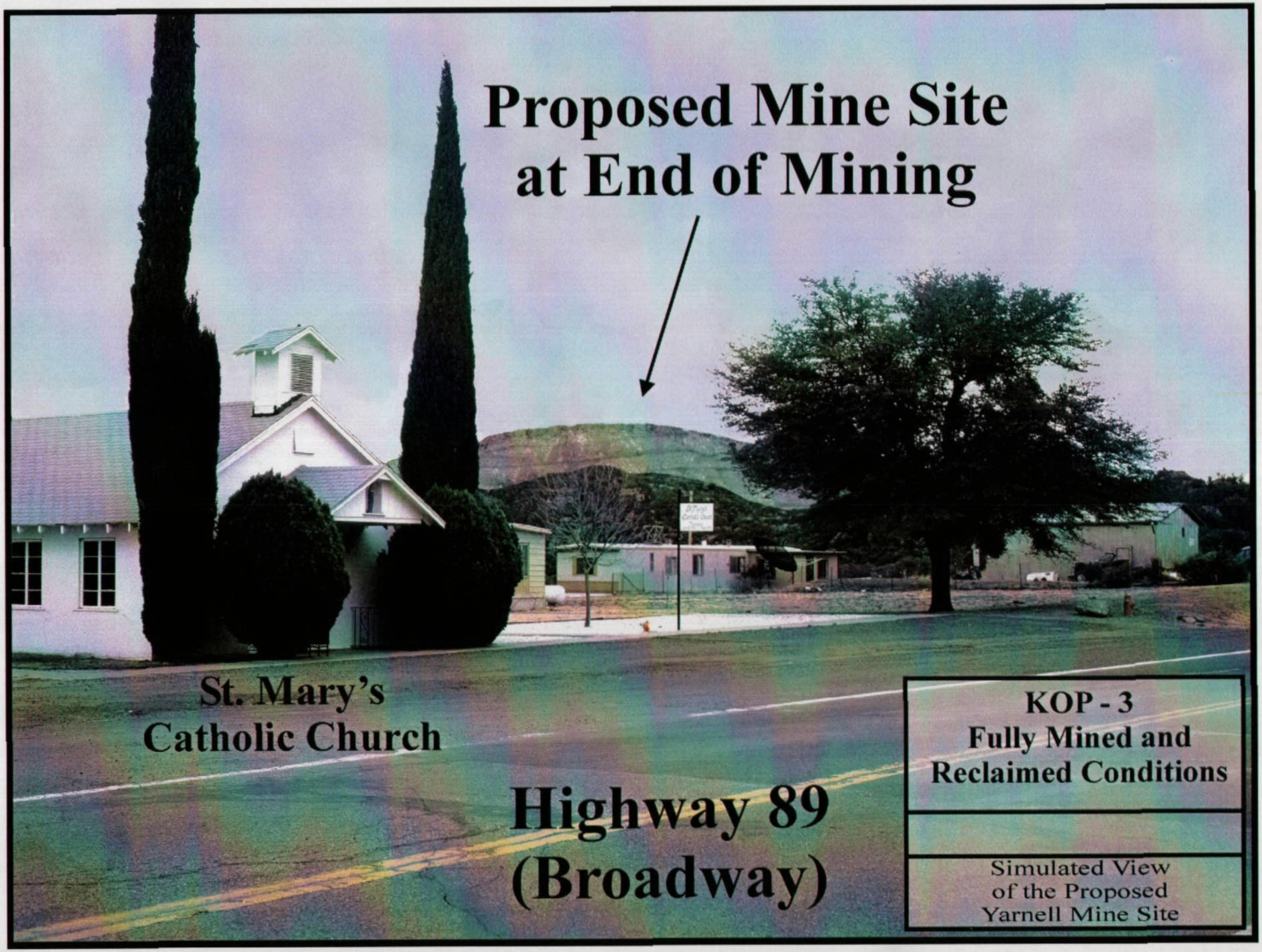

Proposed Mine Site
at End of Mining
Highway 89
in Congress
KOP-1
Fully Mined and
Reclaimed Conditions
Simulated View
of the Proposed
Yarnell Mine Site

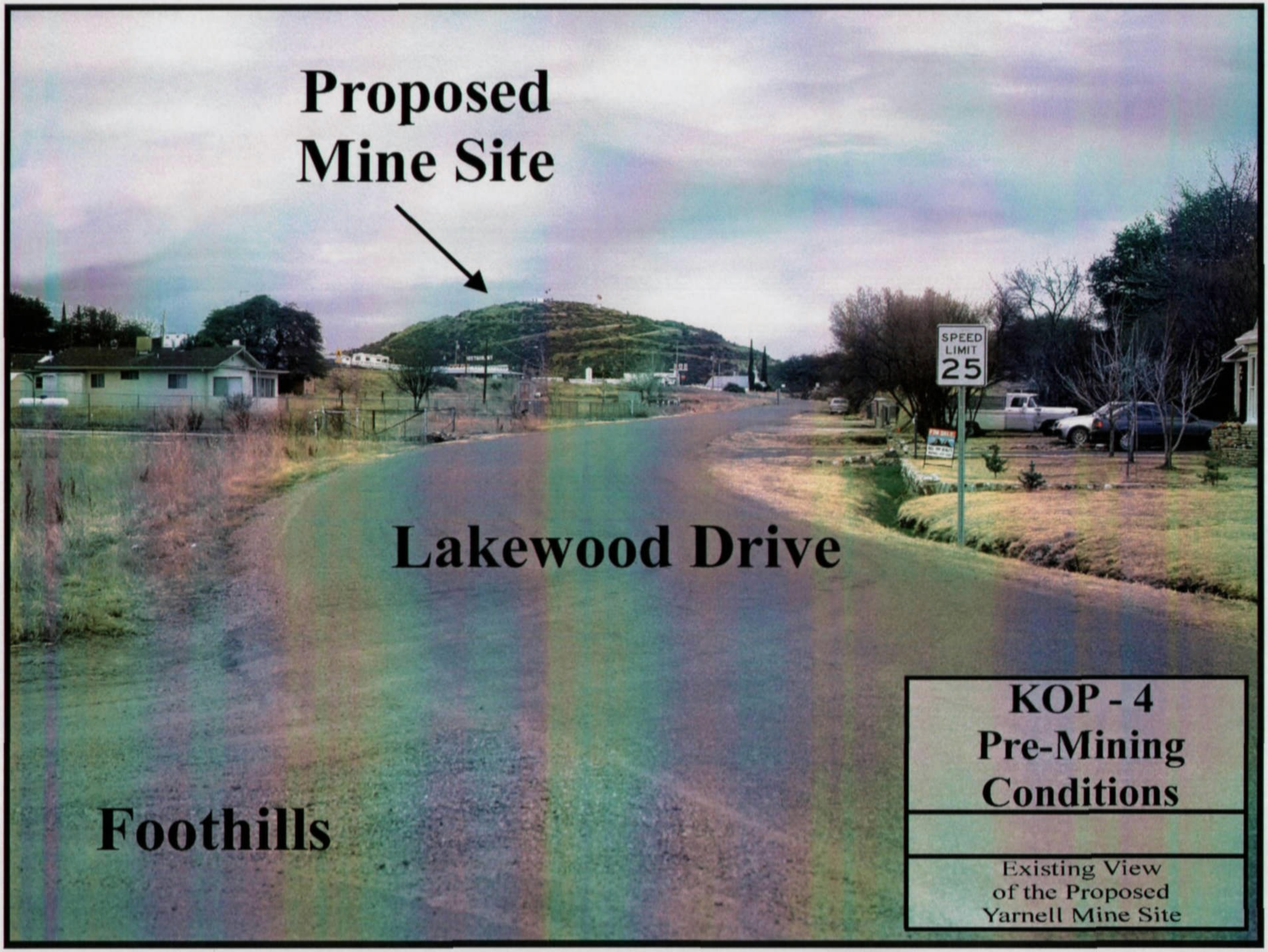

Proposed
Mine Site Area
Highway 89
KOP - 2
Pre-Mining
Conditions
Existing View
of the Proposed
Yarnell Mine Site

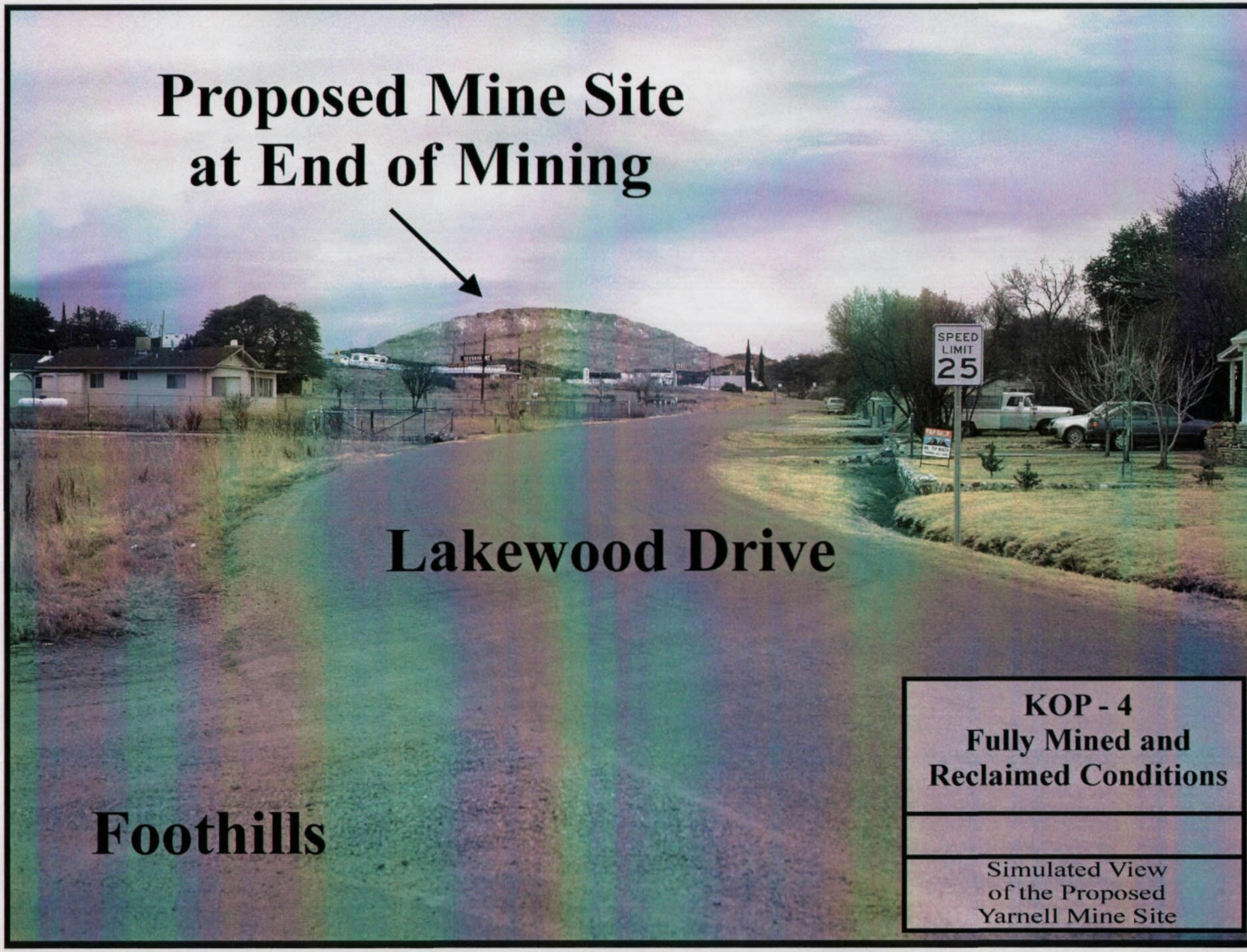

Proposed Mine Site
at End of Mining
Top Soil
Stockpile
Mine Pit
Waste Rock
Haul Roads
Highway 89
KOP - 2
Fully Mined
Conditions
Simulated View
of the Proposed
Yarnell Mine Site


Proposed
Mine Site Area
Reclaimed
Waste Rock
Mine Pit
Highway 89
KOP - 2
Full Reclamation
Conditions
Simulated View
of the Proposed
Yarnell Mine Site


Proposed
Mine Site
St. Mary's
Catholic Church
Highway 89
(Broadway)
KOP - 3
Pre-Mining
Conditions
Existing View
of the Proposed
Yarnell Mine Site


Proposed Mine Site
at End of Mining
St. Mary's
Catholic Church
Highway 89
(Broadway)
KOP - 3
Fully Mined and
Reclaimed Conditions
Simulated View
of the Proposed
Yarnell Mine Site


Proposed
Mine Site
SPEED
LIMIT
25
Lakewood Drive
Foothills
KOP - 4
Pre-Mining
Conditions
Existing View
of the Proposed
Yarnell Mine Site



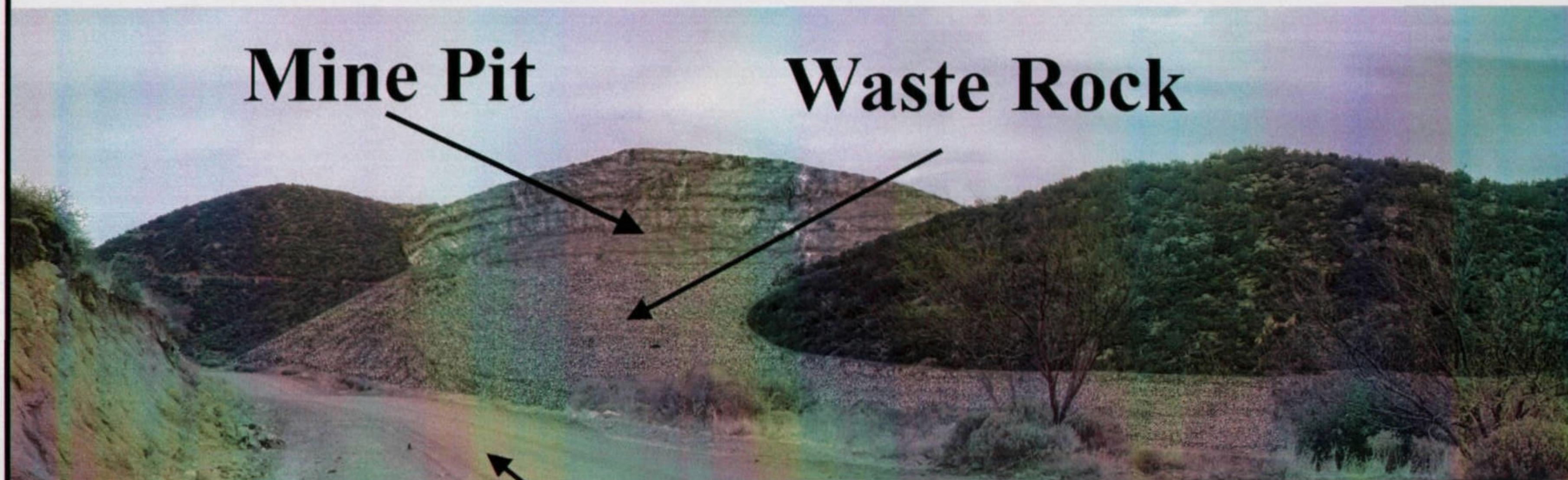
Proposed Mine Site
at End of Mining
SPEED LIMIT 25
Lakewood Drive
Foothills
KOP - 4
Fully Mined and
Reclaimed Conditions
Simulated View
of the Proposed
Yarnell Mine Site

Proposed Mine Site Area

Mina Road

KOP - 5 Pre - Mining Conditions
Existing View of the Proposed Yarnell Mine Site

Proposed Mine Site at End of Mining



Mina Road

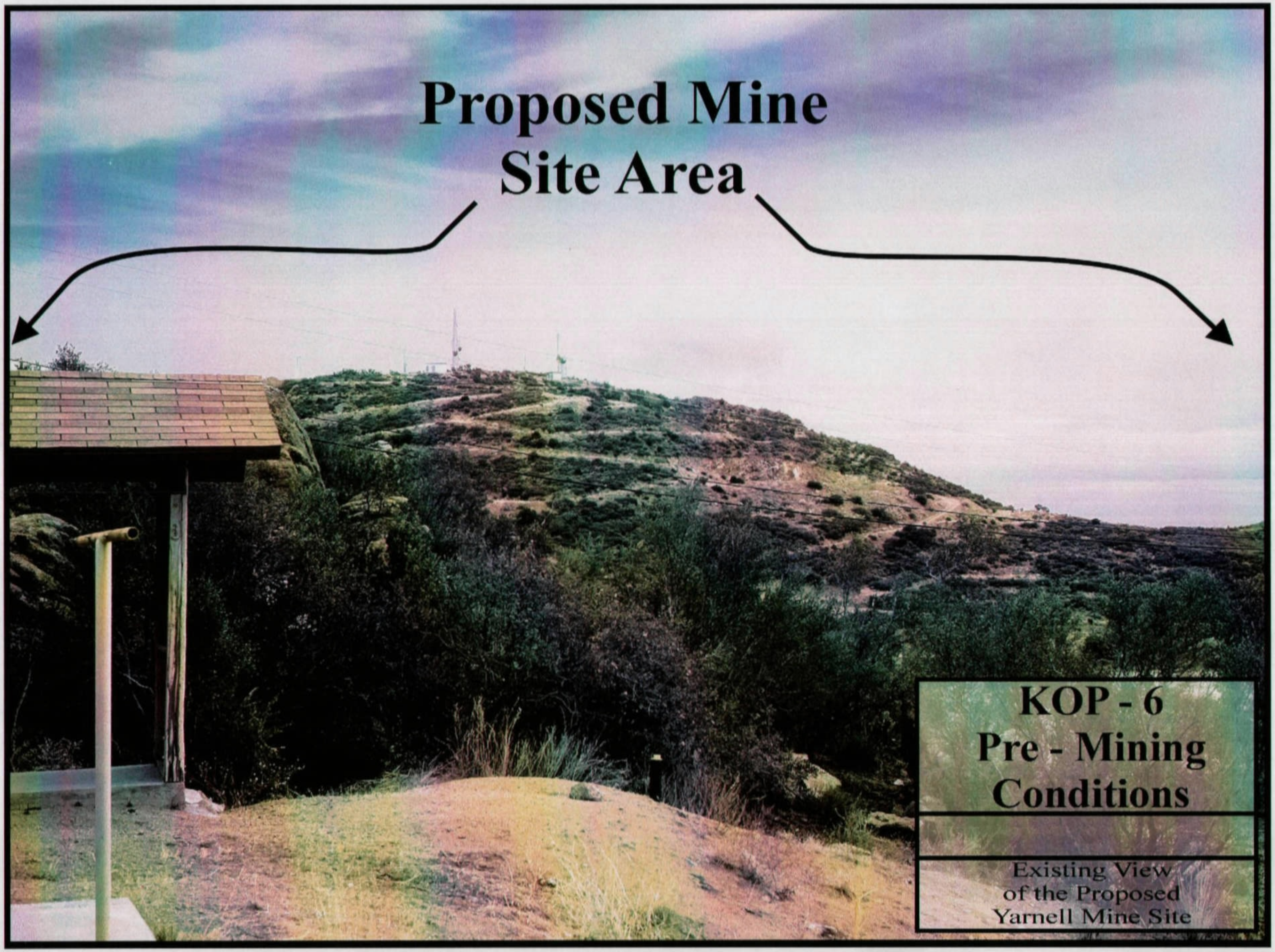
KOP - 5
Fully Mined Conditions

Simulated View
of the Proposed
Yarnell Mine Site

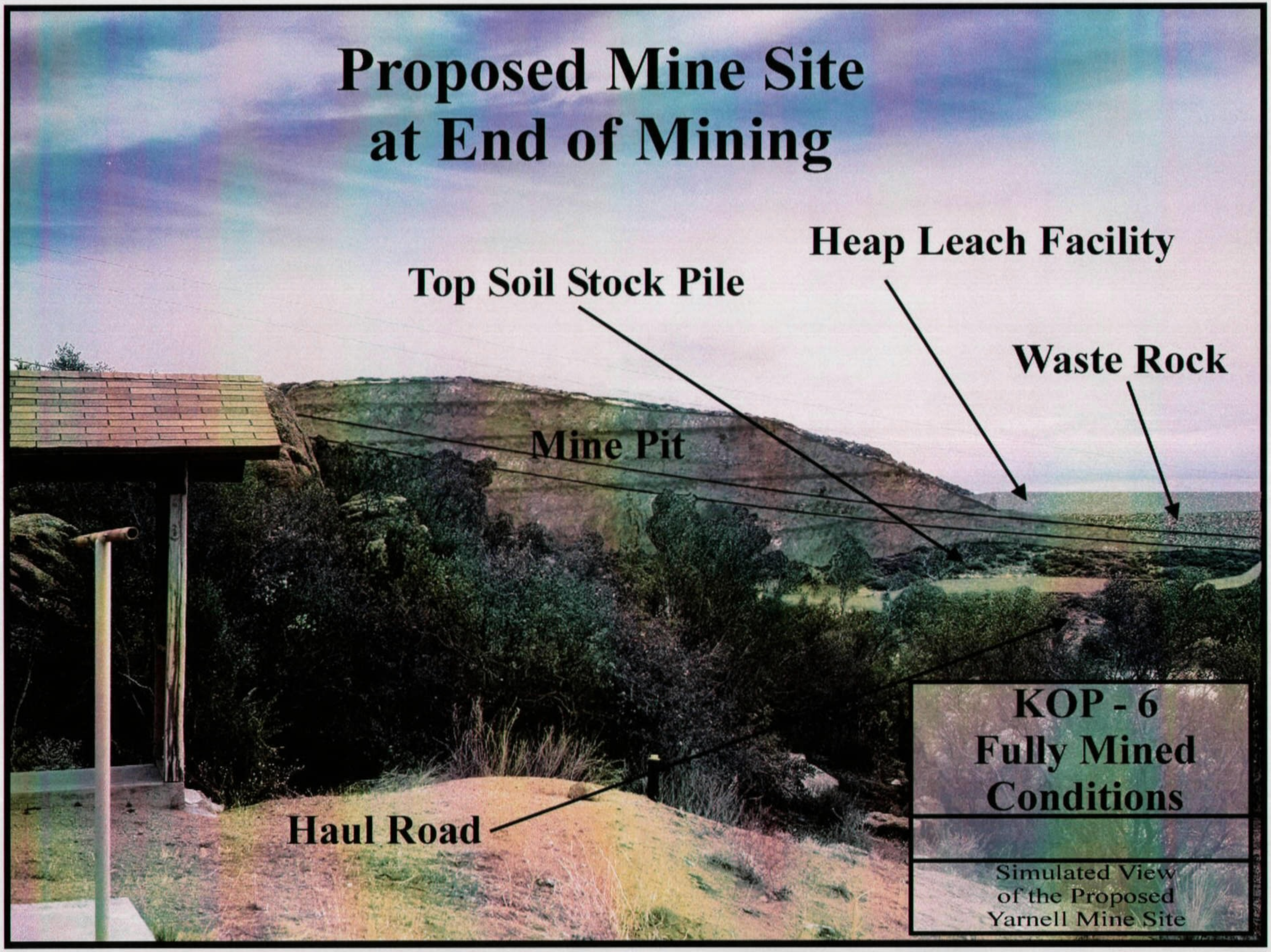
Proposed Mine Site at End of Mining

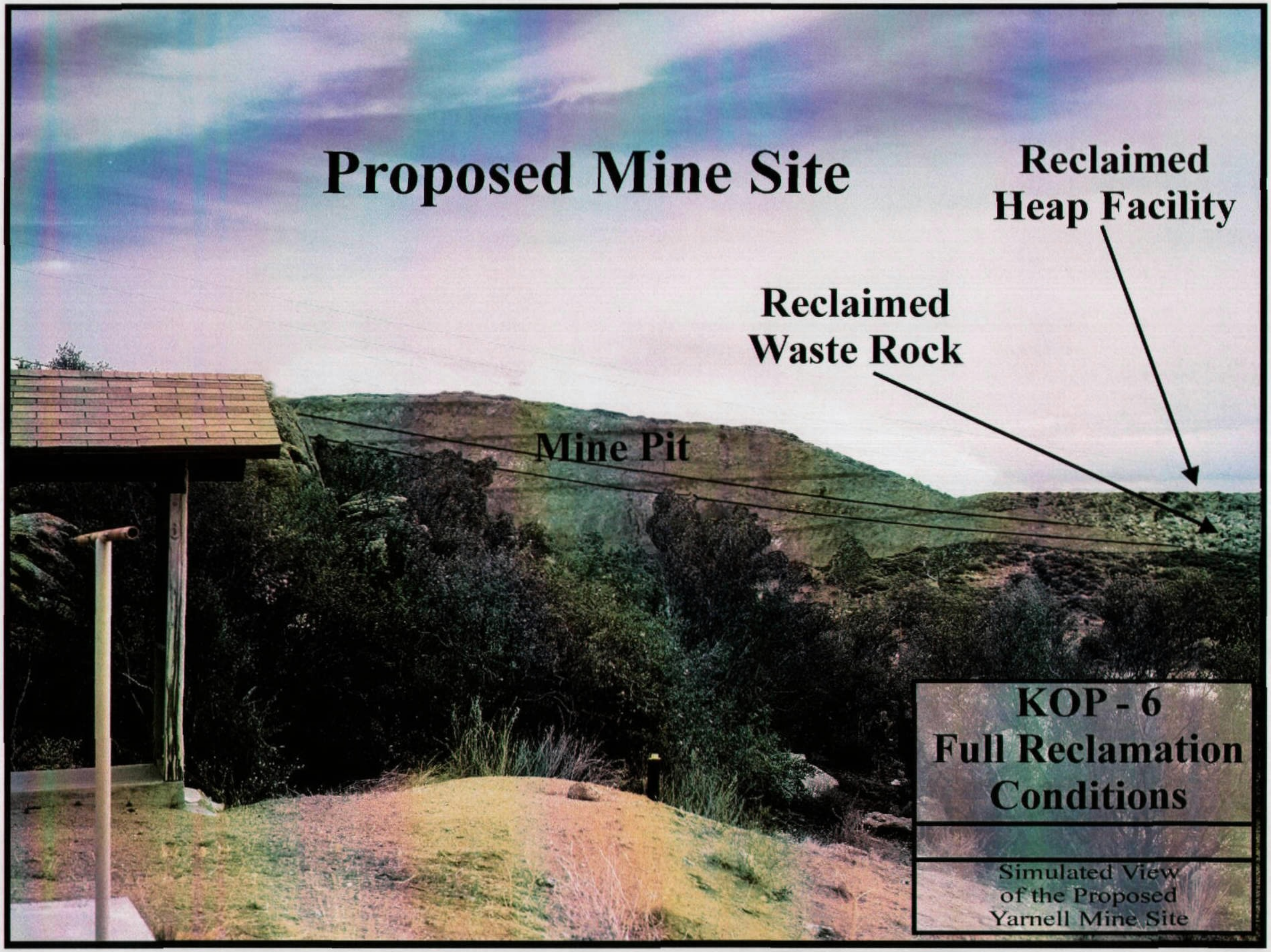
KOP - 5
Fully Reclaimed Conditions

Simulated View of the Proposed Yarnell Mine Site



Proposed Mine
Site Area
KOP - 6
Pre - Mining
Conditions
Existing View
of the Proposed
Yarnell Mine Site


Proposed Mine Site
at End of Mining
Heap Leach Facility
Top Soil Stock Pile
Waste Rock
Mine Pit
Haul Road
KOP - 6
Fully Mined
Conditions
Simulated View
of the Proposed
Yarnell Mine Site


Proposed Mine Site
Reclaimed
Heap Facility
Reclaimed
Waste Rock
Mine Pit
KOP - 6
Full Reclamation
Conditions
Simulated View
of the Proposed
Yarnell Mine Site

Proposed Mine Site

KOP - 7
Pre - Mining
Conditions

Existing View
of the Proposed
Yarnell Mine Site

Proposed Mine Site at End of Mining

KOP - 7
Fully Mined Conditions

Simulated View
of the Proposed
Yarnell Mine Site

Proposed Mine Site at End of Mining

KOP - 7 Full Reclamation Conditions
Simulated View of the Proposed Yarnell Mine Site