EXHIBIT B

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. 85-033

NPDES NO. CA0080110

WASTE DISCHARGE REQUIREMENTS
FOR
WALKER MINE
ROBERT R. BARRY
CALICOPIA CORPORATION
AND THE STANDARD BULLION COMPANY, INC.
PLUMAS COUNTY

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that:

1. The Walker Mine, owned by the Calicopia Corporation and Robert R. Barry (hereafter Discharger), is a non-operating copper mine in east central Plumas County about twenty miles (32 km) east of Quincy; T24N, R4E, MDB&M.

2. A Report of Waste Discharge (RWD) was filed on 2 November 1984. The RWD indicates that the mine operator is The Standard Bullion Company, Inc., (hereafter Discharger).

3. Mining operations ceased in 1941, but acid mine drainage continues to discharge to Dollie Creek near its confluence with Little Grizzly Creek, which is tributary to Indian Creek, thence the East Branch North Fork Feather River, waters of the United States.

4. Available data indicates the water quality of the discharge to be as follows:

Constituents	Median	Range	Units
Flow	0.2	0.0 - 0.5	cfs
pH	4.8	4.4 - 6.6	-
Copper	11.0	0.23 - 69	mg/l
Zinc	0.78	0.09 - 3.2	mg/l
Aluminum	4.8	0.9 - 12	mg/l
Iron	0.8	0.01 - 1.4	mg/l

5. The Board, on 25 July 1975, adopted a Water Quality Control Plan for the Sacramento River Basin (5A) which contains water quality objectives for all waters of the Basin. These requirements are consistent with that Plan.

6. The beneficial uses of the Feather River and its tributaries are municipal, industrial, and agricultural supply; recreation; esthetic enjoyment; navigation; ground water recharge, fresh water replenishment; hydroelectric power generation; and preservation and enhancement of fish, wildlife and other aquatic resources. The aquatic resources of much of Little Grizzly Creek have been eliminated by the discharge from Walker Mine.

ATTACHMENT A

7. On 21 December 1983, the Regional Board filed a complaint in the Plumas County Superior Court for preliminary and permanent injunction and civil penalties against Robert R. Barry and Calicopia Corporation and Does I through XXX, inclusive. This matter has not been brought to trial.

8. Effluent limitations, and toxic and pretreatment effluent standards established pursuant to Sections 208(b), 301, 302, 304, and 307 of the Clean Water Act and amendments thereto are applicable to the discharge.

9. The discharge is presently governed by waste discharge requirements Order No. 80-058 adopted by the Board on 30 May 1980 which expires 1 May 1985.

10. The action to adopt an NPDES permit is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21000, et seq.), in accordance with Section 13389 of the California Water Code.

11. The Board has notified the Discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge and has provided them with an opportunity for a public hearing and an opportunity to submit their written views and recommendations.

12. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

13. This Order shall serve as a NPDES permit pursuant to Section 402 of the Clean Water Act, or amendments thereto, and shall take effect ten days from the date of hearing, provided EPA has no objections.

IT IS HEREBY ORDERED that the Calicopia Corporation, and The Standard Bullion Company, Inc., and Robert R. Barry, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act and regulations and guidelines adopted thereunder, shall comply with the following:

A. Effluent Limitations:

1. The discharge shall not have a pH less than 6.5 nor greater than 8.5.

2. The discharge shall not contain more than 0.2 ml/l settleable solids.

B. Sludge and Solid Waste Disposal:

1. Sludge and/or solid wastes generated by treatment facilities or during mining exploration shall only be disposed at sites which have been approved by the Executive Officer.

C. Receiving Water Limitations:

1. The discharge shall not cause concentrations of constituents in the receiving waters to exceed the following limits:

Constituents	Units	30-Day Average	Daily Maximum
Copper	mg/l	0.02	0.05
Zinc	mg/l	0.10	0.20
Aluminum	mg/l	0.20	0.40
Iron	mg/l	0.20	0.40

2. The discharge shall not cause visible oil, grease, scum, foam, floating or suspended material in the receiving waters or watercourses.

3. The discharge shall not cause concentrations of any materials in the receiving waters which are deleterious to human, animal, aquatic, or plant life.

4. The discharge shall not cause esthetically undesirable discoloration of the receiving waters.

5. The discharge shall not cause fungus, slimes, or other objectionable growths in the receiving waters.

6. The discharge shall not cause bottom deposits in the receiving waters.

7. The discharge shall not increase the turbidity of the receiving waters by more than 20% over background levels.

8 The discharge shall not alter the normal ambient pH of the receiving water more than 0.5 units.

9. The discharge shall not cause a violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board as required by the Clean Water Act and regulations adopted thereunder. If more stringent applicable water quality standards are approved pursuant to Section 303 of the Clean Water Act, or amendments thereto, the Board will revise and modify this Order in accordance with such more stringent standards.

D. Provisions:

1. Neither the discharge nor its treatment shall create a nuisance or pollution as defined in Section 13050 of the California Water Code.

2. The requirements prescribed by this Order amend the requirements prescribed by Order No. 75-119, which expired on 1 March 1980.

3. The Discharger shall comply with the Standard Provisions and Reporting Requirements dated 1 October 1984 which are part of this Order.

4. The Discharger shall comply with the attached Monitoring and Reporting Program No. 85-033 as ordered by the Executive Officer.

5. This Order expires on 1 February 1990 and the Discharger must file a Report of Waste Discharge in accordance with Title 23, California Administrative Code, not later than 180 days in advance of such date as application for issuance of new waste discharge requirements.

6. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the Discharger, the Discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be forwarded to this office.

I, WILLIAM H. CROOKS, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 25 January 1985.

WILLIAM H. CROOKS, Executive Officer

12/24/84:EZC:gs

Attachments

WALKER MINE PROJECT
FINAL
FEASIBILITY AND DESIGN REPORT
CONTRACT NO. 4-051-150-0

Prepared for
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, California 95816

Prepared by
Steffen Robertson and Kirsten (Colorado) Inc.
3232 South Vance Street, Suite 210
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November, 1985

TABLE OF CONTENTS

	Page No.
EXECUTIVE SUMMARY	
1.0 INTRODUCTION	1
1.1 Location and History	1
1.2 Statement of the Problem	2
1.3 Scope of Work	3
1.4 Constraints	4
2.0 STUDIES AND RESULTS	6
2.1 Site Visits	6
2.2 Hydrology	9
2.2.1 Introduction	9
2.2.2 Available Information	10
2.2.3 Setting	11
2.2.3.1 The Mine	11
2.2.3.2 Hydrology	13
2.2.3.3 Water Quality	14
2.2.3.4 Flows Within the Mine	15
2.2.4 Evaluation of Current Conditions	17
2.2.4.1 Conceptual Flow Model	17
2.2.4.2 Groundwater Inflow to Mine	19
2.2.4.3 Surface Water Inflow to the Mine	19
2.2.4.4 Discharge to Deep Rock System	20
2.2.5 Summary of Present Mine Flow System	22
2.2.6 Evaluation of Remedial Actions	23
2.2.6.1 Do Nothing Alternative	23
2.2.6.2 Effects of Installing a Seal in the 700 Level Access Adit	23
2.2.6.3 Additional Plugging to Isolate Piute Section	24
2.2.7 Conclusions	25
2.3 Geology and Geotechnical Considerations	27
2.3.1 Condition of Main Access	27
2.3.2 Rock Mass Classification	28
2.3.2.1 General	28
2.3.2.2 Rock Mass Rating	29

TABLE OF CONTENTS (cont'd)

		Page No.
2.3.3	Site Characterization	30
2.3.3.1	Geology	30
2.3.3.2	Material Properties - Strength	31
2.3.4	Bulkhead Design	35
2.3.4.1	Location	35
2.3.4.2	Design	36
2.4	Results	39
3.0	PLUG SPECIFICATION AND CONSTRUCTION CONSIDERATIONS	41
3.1	Plug Specifications	41
3.1.1	Location and Dimensions	41
3.1.2	Site Preparation	41
3.1.3	Formwork	41
3.1.4	Concrete	42
3.1.5	Piping and Valves	42
3.1.6	Grouting	43
3.1.7	Monitoring	43
3.1.8	Operation	44
3.2	Discussion of Alternatives	44
3.3	Construction Consideration and Cost Estimates	48
3.3.1	Construction Considerations	48
3.3.2	Cost Estimates	50
4.0	MONITORING	54
4.1	Water Level in Mine Workings	54
4.2	Surface Springs and Seepage	54
4.3	Precipitation and Temperature	55
5.0	CONCLUSIONS AND RECOMMENDATIONS	56
5.1	Observations	56
5.1.1	Achievement of Primary Objective	56
5.1.2	Potential Adverse Effects	56
5.1.3	Mitigation of Adverse Effects	56
5.1.4	Maximum Security Option	57
5.1.5	Critical Appraisal of Maximum Security Option	58
5.2	Conclusions	60
5.3	Recommendations	63

TABLE OF CONTENTS (cont'd)

	Page No.
6.0 GLOSSARY	65
APPENDIX I - CONCRETE MIX DESIGN RECOMMENDATIONS	
ADDENDUM 1 - CONCRETE AND EARTHWORK FOR WALKER MINE 700 LEVEL PLUG AND DIVERSION DITCHES	
ADDENDUM 2 - FLOW EVALUATION WITHIN THE WALKER MINE ADDENDUM REPORT TO WALKER MINE PROJECT FINAL FEASIBILITY AND DESIGN REPORT CONTRACT NO. 4-051-150-0	

LIST OF TABLES

TABLE 1 ESTIMATE OF VOIDS AS MINED
TABLE 2 TYPICAL SELECTED WATER QUALITY PARAMETERS (Kaback, June, 1978)
TABLE 3a ESTIMATED MINE FLOWS (September 20, 1984)
TABLE 3b ESTIMATED MINE FLOWS (June 19, 1985)
TABLE 4 AVERAGE ANNUAL FLOW TO SINKHOLES (GPM)

LIST OF FIGURES

FIGURE 1 PROJECT LOCATION
FIGURE 2 SITE PLAN AND TOPOGRAPHY
FIGURE 3 APPROXIMATE PLUG LOCATIONS PLAN VIEW
FIGURE 4 VERTICLE PROJECTIONS SHOWING MINE WORKINGS
FIGURE 5 MINE OUTFLOWS
FIGURE 6 COPPER CONCENTRATION FROM PORTAL
FIGURE 7 CATCHMENT AREAS
FIGURE 8 MAIN PORTAL SECTION
FIGURE 9 TYPICAL ROCK MASS CLASSIFICATION RATING FOR GRANODIORITE
FIGURE 10 TYPICAL ROCK MASS CLASSIFICATION RATING FOR HORNFELS SCHIST
FIGURE 11 COMPRESSIVE STRENGTH vs. APPLIED STRESS FOR SQUARE TUNNELS
FIGURE 12 PRINCIPAL STRESS RELATIONSHIPS
FIGURE 13 ESTIMATED SHEAR STRENGTH OF ROCK MASS
FIGURE 14 VERTICAL SECTION THROUGH MAIN ACCESS DRIFT SHOWING ASPERITIES
FIGURE 15 DISTRIBUTION OF PEAK FRICTIONAL STRENGTH
FIGURE 16 MAIN ADIT PLUG LOCATIONS PLAN AND SECTIONS
FIGURE 17 TYPICAL DRAIN PIPE DETAILS

EXECUTIVE SUMMARY

I STATEMENT OF PROBLEM

The Walker Mine discharges acid- and heavy metal-laden water from an adit and mine waste dump into Dolly Creek which is a tributary to Little Grizzly Creek. The discharge from the mine is reported to have totally eliminated aquatic life in Dolly Creek, and in Little Grizzly Creek for a distance of approximately ten miles downstream from the mine.

The primary goal of the California Regional Water Quality Control Board (the Board) is to restore Little Grizzly Creek and Dolly Creek to a condition capable of supporting a diversity of aquatic life.

The first objective of the studies forming the subject of this report is to evaluate the effectiveness and feasibility of sealing the Walker Mine adit in such a manner as to prevent a direct discharge of acid- and heavy metal-laden water from the underground workings. The second objective is to design and estimate construction costs for such a seal, should it prove to be warranted.

II SCOPE OF WORK

A. Feasibility

Steffen Robertson and Kirsten's (SRK) studies have been directed towards evaluating the feasibility of sealing the actual and potential portals through which acid mine drainage (AMD) might discharge by:

1) Performing a hydrologic assessment of the underground mine and its environs;

2) Examining available maps of the underground workings, surface features, and fault systems;

3) Examining available data to assess general groundwater movement and the potential for the escape of mine waters through surface springs or seepage; and

4) Identifying possible alternative outlets for mine water, when it is prevented from following its present course by sealing of the 700 Level Adit.

B Design Criteria

1) Concrete bulkheads have been designed to seal the main Access Adit on the 700 Level and to minimize the potential for the escape of mine water through other outlets.

Site selection for seals was made to:

- Minimize the potential for seepage around the seal;
- Maximize the structural integrity of the seal; and
- Permit future replacement of the seal, if necessary.

2) Seal design has taken into account:

- The maximum possible head of water to be held behind the seal;

- Installation of pipes through the seal to permit future dewatering of the mine in case that should become necessary;

- Materials and construction techniques appropriate to the environment in which the seal is to be located, and the objective of a design life in excess of 100 years; and

- Installation of a pressure gauge to monitor the head of water behind the seal.

C. Reporting

All feasibility studies and plug design will be submitted to the Board for review and approval.

D. Construction

Following the Board's approval of plug feasibility and design, and authorization for construction, the approved structures will be installed.

III STUDIES AND CONCLUSIONS

Data available from the Board's records and previous studies were evaluated, and related to current conditions through site visits during the weeks of September 17, 1984 and June 17, 1985. The physical conditions of accessible underground workings on the Main 700 Level from the portal to the Piute Section (a distance of approximately 8,000 ft.) were observed, and all accessible surface outlets from the mine workings were visited. Potential sources of surface inflows to the mine were also observed.

The results of site observations indicated that a single concrete bulkhead plug in the 700 Level Adit, at a point close to the South Orebody workings, would effectively stop the discharge of AMD from the Walker Mine Adit. Minor improvements and additions to the existing system of diversion ditches, around surface subsidence over the underground workings, would further minimize inflow of water to the workings.

Consideration was given to the possibility that water would rise in the mine workings behind the proposed plug and might eventually discharge through the next-lowest outlet, the Piute Shaft Landing Tunnel. The studies described in this report demonstrate the strong probability that water would not rise to the level of the Piute Shaft Landing Tunnel: equilibrium between inflow to the workings and outflow

as recharge to the groundwater system would probably be reached below that level.

The cost of constructing an internal plug to compartmentalize the mine workings and protect against the remote possibility that water might rise to a level at which it could discharge, was found to be unjustifiable. Insurance against any possible discharge through the Piute Shaft could be provided by monitoring the level of water in the mine workings. If, at any time in the future, as a result of excessive precipitation or snowmelt, the water should approach the overflow level, a controlled flow of AMD could be released through a valve in the 700 Level Adit plug, treated to acceptable standards, and discharged into Dolly Creek. The costs of proposed remedial measures, and of rejected alternative courses of action were estimated. A treatment system was found to be more cost efficient than the alternative of an internal plug.

IV RECOMMENDATIONS

The following course of action is recommended:

1. Rehabilitate and extend the existing diversion ditches around surface subsidence sinkholes, to minimize inflow of surface water to the underground mine workings.

2. Conduct a water flow and quality balance survey along the 700 Level Haulage and Adit, through the abandoned plant site area, and along Dolly Creek to its confluence with Little Grizzly Creek.

3. Install a single plug in the 700 Level Adit approximately 2,700' from the portal.

4. Monitor water levels in the mine workings by means of gauges reading pressure behind the plug.

5. Prepare a contingency plan for future construction and operation of a small treatment plant at the 700 Level Adit Portal, to treat AMD that might have to be discharged periodically (in the order of ten or more years after installation of the plug) to relieve any excess buildup of water that might threaten to overflow out of the Piute Shaft.

V COSTS

The cost of the recommended course of action, in 1985 dollars to the nearest $500, would be:

Rehabilitation of Diversion Ditches	$ 14,000
Water Balance Survey	6,500
Main Adit Plug Construction	150,000
Discharge Treatment Plant Specifications	6,500
Total Initial Cost of Abatement	$177,000

Future work associated with the recommended course of action would be:

Routine Monitoring	$ 1,000/year
Maintenance of Diversion Ditches	2,500/year
Total On-going Cost of Abatement	$ 3,500/year

Possible future costs could include:

Build Discharge Treatment Plant	$250,000
Operate Discharge Treatment Plant	5,000/year

The additional cost of rejected precautions, over the recommended course of action, is estimated as:

Internal 712/Piute Plug (minimum)	$227,000
Piute Landing Tunnel Plug	23,000
Sawmill Adit Plug	20,000
Total Cost of Rejected Precautions	$270,000

1.0 INTRODUCTION

1.1 Location and History

The Walker Mine is an inactive copper mine located some 20 miles east of Quincy, in Plumas County, California, approximately 20 miles by road from Portola. Access is by well-graded gravel road through the Plumas National Forest from California Highway 70 at Portola. Situated in hilly country at an altitude of between Elev. 6,000 and 7,000 ft, the mine site is subject to heavy snowfall in winter and is generally inaccessible to motor vehicles between November and April.

Copper ore was first discovered at the Walker Mine site in 1904. Production commenced in 1916, continuing until 1932 and again from 1935 to 1941, when it was closed down by the operator, Walker Mining Company, a subsidiary of Anaconda Copper Company. Mining started on the 200 Level (approximately 6,670 ft elevation) near the outcrop of the Central Orebody, but the Main Haulage Tunnel on the 700 Level (approximately 6,200 ft elevation) was driven in the early 1920's. The Main Access Adit on the 700 Level was driven as an adit from the millsite at Dolly Creek, cross-cutting north by northeast some 3,000 ft to intersect the South Orebody. From there, the haulage was driven north by northwest, following the vein through the Central, North, 712 and Piute Orebodies. Approximately 10,000 ft from the portal, the Piute Shaft was raised in the vein from the 700 Level to surface in 1927/28. The portal of the 700 Level Main Access Adit remains the lowest point at which the underground workings reach the surface.

No stoping was done below the 700 Level until the 1930's. The deepest level from which ore was mined was the 1000 Level (approximately 5,720 ft elevation) and the deepest exploration winze was sunk to below the 1200 Level (approximately 5,400 ft elevation) on the Central Orebody.

A total of 5,319,000 tons of ore was mined between 1916 and 1941, from which 83,890 tons of copper were recovered (an average recoverable grade of 1.58% Cu with 0.03 oz/ton gold and 0.68 oz/ton silver recovered as by-products).

Soon after cessation of mining in November, 1941, all the mining equipment was removed and the surface plant was dismantled. When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage (AMD) water flowing from the main Access Adit Portal on the 700 Level began to affect the Dolly Creek and the Little Grizzly Creek. Increasing concern over the detrimental effects of the AMD prompted the California Regional Water Quality Control Board (the Board) to commission several investigations, including the studies forming the subject of this report.

1.2 Statement of the Problem

The Walker Mine discharges acid- and heavy metal-laden water from an adit and mine waste dump into Dolly Creek which is a tributary to Little Grizzly Creek. The discharge from the mine is reported to have totally eliminated aquatic life in Dolly Creek downstream from its confluence with mine drainage water, and in Little Grizzly Creek downstream from its confluence with Dolly Creek for a distance of approximately ten miles downstream from the Walker Mine.

The primary goal of the Board is to restore Little Grizzly Creek and Dolly Creek to a condition capable of supporting a diversity of aquatic life.

The first objective of the studies forming the subject of this report is to evaluate the effectiveness and feasibility of sealing the Walker Mine adit in such a manner as to prevent a direct discharge of acid- and heavy metal-laden water from the underground workings. The second objective is to design and estimate construction costs for such a seal, should it prove to be warranted.

1.3 Scope of Work

In terms of Contract No. 4-051-150-0, signed on August 20, 1984, and the subsequent order to proceed given on September 5, 1984, Steffen Robertson and Kirsten (Colorado) Inc. (SRK), has pursued the following scope of work:

A. Studies have been directed towards evaluating the feasibility of sealing all actual and potential portals through which AMD might discharge by:

1) Performing a hydrologic assessment of the underground mine and its environs;

2) Examining available maps of the underground workings, surface features, and fault systems;

3) Examining available data to assess general groundwater movement and the potential for the escape of mine waters through surface springs or seepage; and

4) Identifying possible alternative outlets for mine water, when it is prevented from following its present course by sealing of the 700 Level Adit.

B. Design Criteria

1) Concrete bulkheads have been designed to seal the main Access Adit on the 700 Level and to minimize the potential for the escape of mine water through other outlets.

The selection of sites for seals has been made to:

- Minimize the potential for seepage around the seal;
- Maximize the structural integrity of the seal; and
- Permit future replacement of the seal, if necessary.

2) Seal design has taken into account:

- The maximum possible head of water to be held behind the seal;

- Installation of pipes through the seal to permit future dewatering of the mine in case that should become necessary;

- Materials and construction techniques appropriate to the environment in which the seal is to be located, and the objective of a design life in excess of 100 years; and

- Installation of pressure gauges to monitor the head of water behind the seal.

C. Reporting

This report has been prepared to detail the observations and conclusions arising from the feasibility studies, and to specify the design of the proposed bulkhead plug.

D. Construction

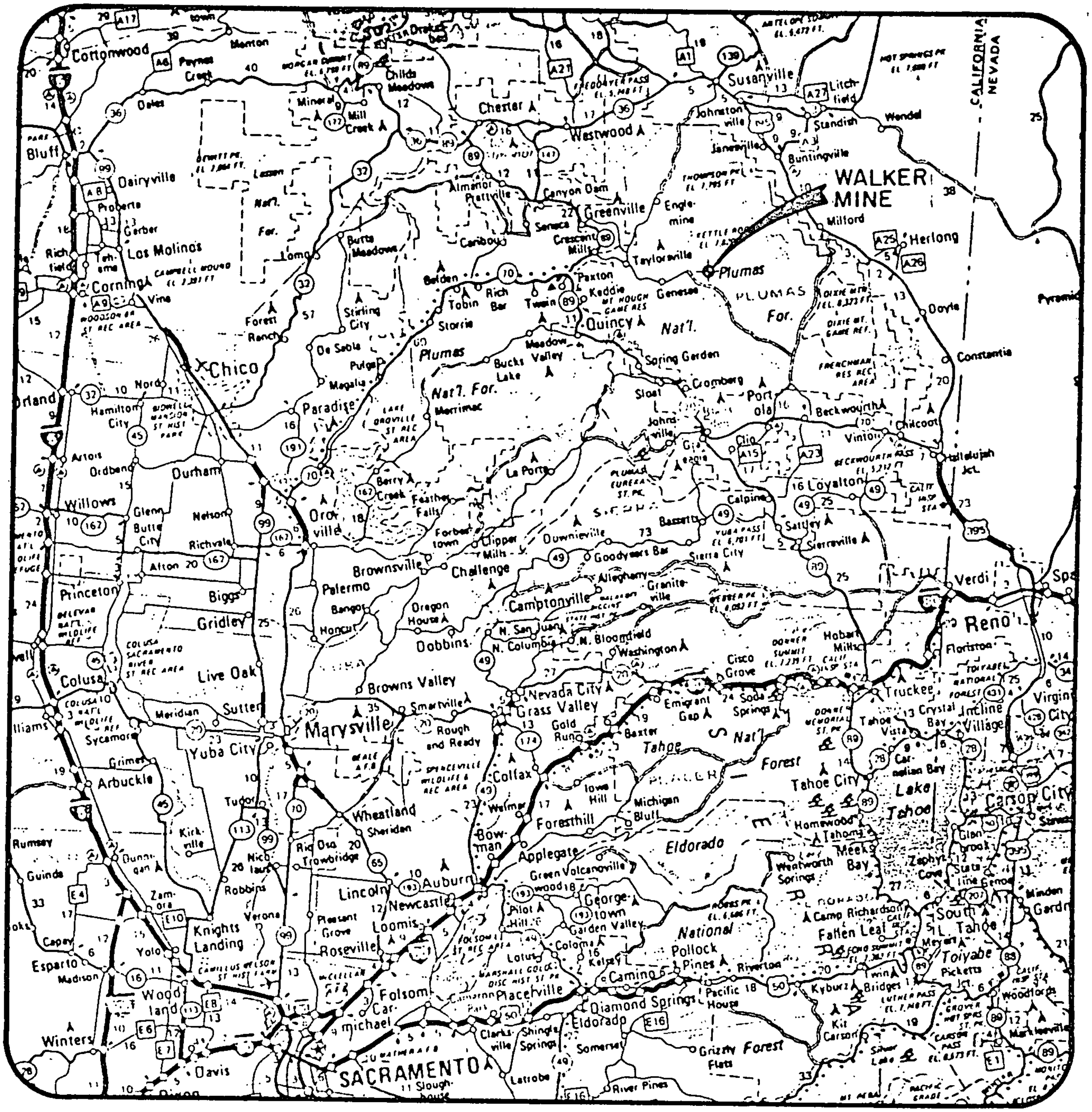
Following the Board's approval of plug feasibility and design, and authorization for construction, the approved structures will be installed.

1.4 Constraints

It must be emphasized that many of the opinions and conclusions recorded in this report are subjective and based on professional judgement. Assumptions have had to be made on the basis of limited or nonexistent data, to serve as a base on which professional experience and judgement can develop logical courses of action or events.

Certain information, such as underground plans showing the final extent of the mine workings and the locations of potential points (such as air raises or adits) for egress of water rising in the old workings, were not initially available. Research through the California Division of Mines and Geology discovered a vertical projection of the mine workings used to indicate ventilation flows at the time of an underground fire in 1940. Though incomplete and not necessarily indicating the full extent of the workings when mining stopped in 1941, this drawing has been used in the evaluation presented in this report.

Information regarding water flows and quality, both in surface streams and from the 700 Level Access Adit Portal, has been drawn from available sources. Time and restricted access have not permitted complete physical verification, but indirect checks have been applied. Water flows from the 700 Level were estimated by indirect measurements during the field visit by SRK in September, 1984 and June, 1985.



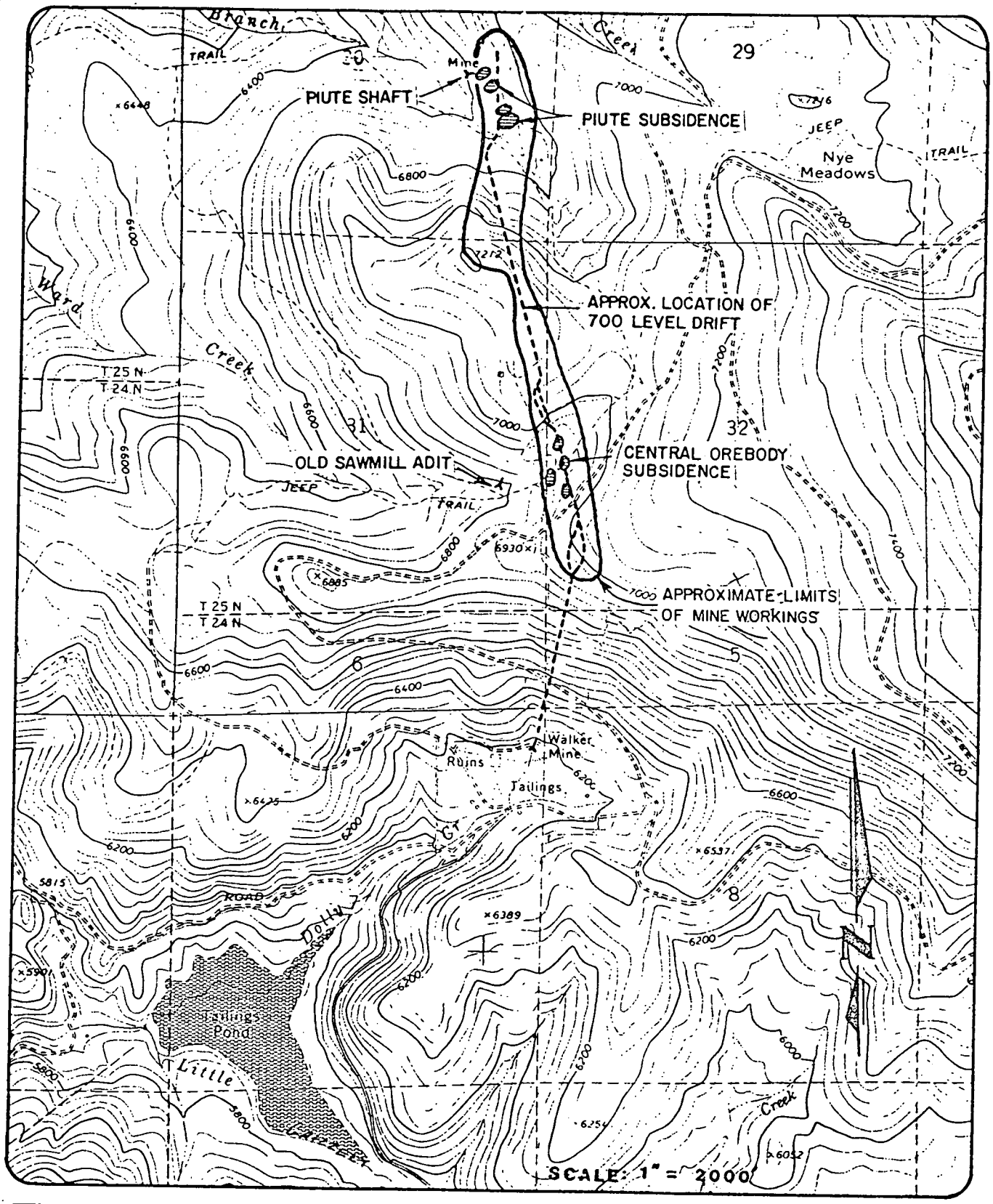
0 20 40

APPROX. SCALE IN MILES

N

LOCATION OF MAP ABOVE

PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 1
DATE 3/85		PROJECT LOCATION
REVISION NO. 0		



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 2
DATE 3/85		SITE PLAN AND TOPOGRAPHY
REVISION NO. 0		

2.0 STUDIES AND RESULTS

2.1 Site Visits

Unexpected delays were experienced by the Board in obtaining rights of access to the mine following signature of their contract with SRK. On September 5, 1984, a court order for entry onto the property was obtained, allowing SRK to examine the site and the accessible parts of the underground workings of the Walker Mine during a ten-day period between September 17 and 26. A site visit was arranged for the week of September 17 to enable all key members of the team to make a quick visual inspection of the mine workings and their environs.

Prior to the site visit, members of SRK's project team met with officials of the Board in Sacramento and studied the Board's project files relating to the Walker Mine. A composite underground plan of the main working levels at the Walker Mine, (at a scale of 1" = 200') was obtained, but no vertical projections or cross sections of the underground workings were available.

The 700 Level Main Access Adit was examined from its portal to the northern end of the Central Orebody workings. Data collected included:

- Observation and assessment of rock mass classification, noting evidence of permeability and orientation of fissures;

- Observation of the quantity and quality of water flow in the 700 Level tunnels at various locations from the Central Orebody workings to the adit portal;

- Measurement of tunnel profiles at selected alternative locations for a bulkhead seal in the 700 Level Main Access Adit, close to its intersection of the South Orebody; and

- Assessment of the transport and utility facilities available for construcion of a bulkhead seal.

All subsidence areas on surface were visited, as were the collars of the Main and Piute Shafts, and the portal area of the Sawmill Adit.

The effects of mine drainage from the Walker Mine 700 Level Adit were observed in the Dolly and Little Grizzly Creeks, and the tailings impoundment was examined visually. No evidence was found of seepage of mine drainage through outlets other than the 700 Level Adit, but it was recognized that this did not mean that seepage might not occur at other times of the year, at the same time in other years, or in other places.

Subsequent to the site visit, plans or other records concerning the underground workings and geology of the Walker Mine were sought from the Anaconda Minerals Company but, despite their generous cooperation, none could be found. However, valuable information in the form of a 1" = 200' scale vertical projection of the mine workings as of April, 1940 (shortly before the final cessation of operations) was obtained through the California Division of Mines and Geology.

Delays in obtaining access to the site did not allow more than a single cursory examination before the onset of winter prevented further access. This factor, combined with a paucity of documentary evidence of underground geological and mining features, and limited records of water flows and quantities up and downstream of the mine workings, forced the project team to base its preliminary conclusions on circumstantial evidence to a greater extent than it considered ideal.

Conclusions, drawn from available data and observations made during the first site visit led to a maximum security recommendation in SRK's Draft Feasibility and Design Report

The nature and volume of sludge, fallen timbers and rockfall in the haulage were observed and related to the work that would be required to remove them.

The presence or absence of rail track was checked by probing with a steel rod. The track's condition was noted at the few points where it was exposed and could visually be inspected.

Branches of the 700 Level haulage that could have led to another connection between the 712 and Piute Sections were checked and found to dead-end. The possibility of a connection at a higher level could not be checked as access into the 712 Orebody workings through the collapsed northern most stope drawpoint chute was considered unsafe on examination. In subsequent conversation with the owner's representative, Mr. Donato, he confirmed that he had descended through the Piute Shaft and workings to the 700 Level haulage, but had not ventured into the flooded part leading southward to the 712 Section. He had returned to surface up the Piute Shaft, checking the workings at each level for a connection to the 712 Section. No connection was found.

In addition to their underground inspection, SRK's engineers examined the diversion works around the sinkholes above the mine workings.

2.2 Hydrology

2.2.1 Introduction

This section of the report sets out the findings of a study of the hydrological effects of plugging the main access adit of the Walker Mine.

The mine has been generating and discharging acid drainage since its closure in 1941. The copper carried by

presented in February 1985. This recommendation required the installation of a second, internal plug, between the 712 and Piute Sections, in addition to a main plug in the 700 Level Adit. This requirement was based on concerns that water, held back by a single plug in the main adit, might rise to a level at which it could overflow through the Piute shaft and pollute the hitherto uncontaminated catchment of Ward Creek. The high degree of uncertainty attached to this possibility mandated a very conservative approach.

The Regional Board suggested a second visit to further investigate several specific questions they presented in a letter to SRK dated May 31, 1985. It was considered that the information gathered would permit SRK to attach a higher degree of confidence to their recommendations.

A court order was obtained on June 13, 1985 permitting SRK to enter the mine between June 17 and June 31, 1985. After two days of delay awaiting the owner's representative who held the keys to the property and the adit door, forced entry was made on June 18, 1985.

The team made a one-day underground inspection on June 19, 1985, the last day available in the team's schedule. It took over 3 hours to reach the Piute Orebody Section along the 700 Level haulage, and about 2½ hours to return by the same route .

Tunnel dimensions were measured, and rock quality observed, at the site selected for a possible internal plug between the 712 and Piute Sections. The selected site was flooded to a depth of about 3'-6".

Approximate measurements of water flow rates were made where flow was sufficiently channelized to be measurable, to estimate a flow profile along the 700 Level haulage. The locations of major inflows to and losses from the haulage were listed.

the water has reportedly rendered the receiving streams (Dolly Creek and Little Grizzly Creek) essentially barren of aquatic biota for about 10 miles downstream. In order to mitigate this impact, the Regional Board has proposed to install a plug in the mine portal. This section of the report comments on the effectiveness of this action to:

- Provide an immediate relief from the contaminated flow from the mine; and
- Build up the water level in the mine, thus reducing the volume of material capable of generating AMD,

and indicates the general order of magnitude of the effects to be expected following the installation of the mine plug. The anticipated results of this action are assessed in terms of:

- Effectiveness in achieving long-term improvement in water quality in the vicinity of the mine; and

- Extent and likelihood of possible undesirable side effects, and steps that can be taken to mitigate them.

2.2.2 Available Information

This study was performed entirely on the basis of existing information, together with field trips to the site in September, 1984 and June, 1985. The documents available were:

- Composite plan of the main levels of the mine, at a scale of 1" = 200', dated August 1, 1941;

- Vertical projection of mine workings at a scale of 1" = 200', as of early 1940;

- Report on "Plans to Proceed Toward Abatement of the Water Pollution Problems Incident to Water Emanating from the Walker Mine, Plumas County," California Division of Mines & Geology, August, 1972;

- Report on "Evaluation of Water Pollution Sources and Development of Conceptual Pollution Abatement Plans, Walker Mine, Plumas County, California", D'Appolonia Consultants, December, 1979;

- Water quality data from Conoco, for 1976 and 1977 (Pine, 1979), 1980 and 1981 (Hart, 1980 & 1981); and

- Water quality data from the California Regional Water Quality Control Board, Central Valley Region for 1977 and 1978 (Matteoli, 1977, and 1978; and Croyle 1985).

While this database is limited, particularly with respect to flows, it is considered to be adequate for the present evaluation. Little independent checking of the data was possible in the time available; however, consistency checks have been made when possible and some information has been omitted as a result.

2.2.3 Setting

2.2.3.1 The Mine

The Walker Mine is located in Plumas County,

California as shown in Figure 1. The workings strike approximately north-south, over a distance of nearly 1½ miles. The tabular orebody, 10 to 100 ft thick, was mined at an average stoping width of 35 ft, dipping to the east at about 60^{0} to 70^{0}. The mine excavations extended from surface above elevation 7,000 ft to below elevation 5,400 ft. A section through the mine is shown in Figure 4.

Rock containing sub-economic grades of copper was not mined, and remained in place. A study done during World War II estimated about 4 million tons of copper-bearing rock remained in the mine area. Subsequent exploration by several mining companies has failed to identify sufficient reserves to justify reactivation of mining.

The volume of voids resulting from mine excavations was estimated as a function of location based on Figure 4. In absence of transverse sections of the workings, an average stoping width of 35 ft was assumed throughout. The volume of rock excavated from the mine is estimated to be about 5,319,000 tons of ore plus an estimate of 680,000 tons of waste rock. Visual inspection of the mine suggested that the mine is still very stable and it is likely that little collapse of the hanging wall has taken place since the mining operation. It is assumed that the effective volume of the voids caused by mining is equivalent to the volume of rock excavated, i.e. some six million tons of rock or 543 million gallons of water. The estimated void volumes are shown in Table 1.

TABLE 1

ESTIMATE OF VOIDS AS MINED

SECTION	VOID VOLUMES (MILLION GALLONS)			
	Above 6600'	6200'-6600'	Below 6200'	Total
Piute	-	88	19	107
"712"	6	57	-	63
North	57	76	57	190
Central	44	63	50	157
South	-	13	13	26
Totals	107	297	139	543

2.2.3.2 Hydrology

The mine is located in the catchment area of Little Grizzly and Ward Creeks, both of which flow north to Indian Creek (Figure 2). Flow from the mine currently discharges out through a 3,000-ft long adit (700 Level Access Adit) at about the 6,200 elevation to the south of the mine. This flow varies considerably over the year, as shown in the data for 1978 (Figure 5). Much of the portal flow is believed to originate as surface flow, which is captured by sinkholes which connect the mine to the South and Middle Forks of Ward Creek. Remedial actions and diversions in recent years have probably reduced the peak flow below that shown in Figure 5.

Water from the adit flows into Dolly Creek, which flows to Little Grizzly Creek, which in turn flows to Indian Creek. Average flows in these creeks have been calculated to be of the order of 1.7 cubic feet per second per square mile of catchment (1.2 gpm/acre - Table 1 D'Appolonia, 1979).

2.2.3.3 Water Quality

The quality of water in local streams which are unaffected by the mine is excellent. The flow from the portal is, however, of low pH and high in copper and other dissolved metals, as shown in Table 2.

There is a seasonal variation in the copper concentrations measured in the water flowing from the portal of the mine. The available data are plotted in Figure 6. It is of interest to note that the copper concentration is highest during periods of greatest flow. This is a result of the spring flushing of acid generated in the mine all winter, which has a lower pH and a higher copper content than the flow later in the year. It is noteworthy that the total dissolved solids (TDS) of the mine water is low, indicating a low residence time in the ground and suggesting that the greater part of the flow is derived from surface inflow.

TABLE 2

TYPICAL SELECTED WATER QUALITY PARAMETERS

(Kaback, June, 1978)

Parameter	Unit	Portal	Streams
Ca	mg/l	24.5	5.8
Na	mg/l	2.7	2.8
K	mg/l	1.6	0.7
Mg	mg/l	6.4	2.2
SO_4	mg/l	146	5
HCO_3	mg/l	0	23
CO_3	mg/l	-	-
pH	Units	4.1	7.6
NO_3	mg/l	4.5	0.7
NH_3	mg/l	0.01	0.01
Cl	mg/l	1	-
Cu	mg/l	29	0.03
Zn	mg/l	0.93	0.01
Fe	mg/l	1.0	0.15

2.2.3.4 Flows Within the Mine

During the initial site visit, the flows in the southern part of the mine were measured using the floating object method. The results of these measurements are presented in Table 3a.

TABLE 3a
ESTIMATED MINE FLOWS (SEPTEMBER 20, 1984)

Location	Flow (GPM)	Comment
Between North and Central Orebodies	174	Location just south of north end of Central orebody
At junction of portal adit and the Central Orebody	229	-
At portal in timbered section	116	-

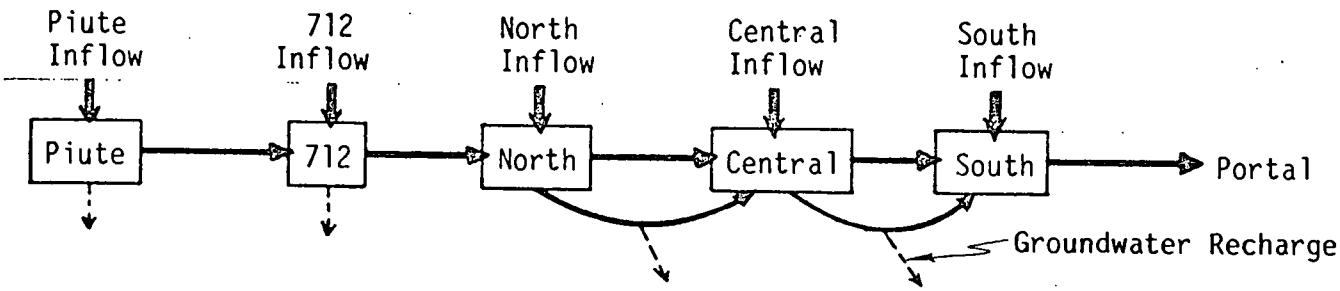
Based on these measurements, it was concluded that:

1. At the time there was apparent flow continuity in the southern portion of the mine, and
2. There appeared to be some flow loss along the portal adit.

Accordingly, it was considered wise to locate any adit plug remote from the portal. In addition, a more detailed flow survey was proposed to better defined in-mine flow.

During the second site visit, a portable direct-reading flow meter was used to determine flow velocity at points where the cross-sectional area of the channel could be estimated reasonably. Where no appropriate channel sections existed, flows were estimated by eye.

The results are presented in terms of flow from blocks of the mine, as indicated in the following sketch:



The results of the rough measurements are presented in Table 3b.

TABLE 3b
ESTIMATED MINE FLOWS (June 19, 1985)

Location	Flow (GPM)	Comment
Between Piute and 712 orebodies	130	Rough measurement.
Within 712 orebody	100	Visual estimate.
Flow on 700 Level at south end of North orebody	270	Rough measurement; does not include above 230 gpm, as this was observed to flow into lower mine workings.
Flow on 700 Level at south end of Central orebody	60	Rough measurement; does not include upstream flows, which entered lower workings.
Flow on 700 Level at south end of South orebody	215	Rough measurement.
Discharge from portal	275	Rough measurement.

Based on this set of readings (which do not cover the entire mine area due to measurement difficulties and shortness of time), it is concluded that, in all likelihood, the flows entering the mine exceed the flow entering the mine adit from the workings, suggesting a deep point of egress of inflow water within the mine.

2.2.4 Evaluation of Current Conditions

2.2.4.1 Conceptual Flow Model

In order to have a means of evaluating the probable behavior of the mine after remedial action, it is necessary to develop a conceptual model of the flow behavior of the mine system. The inflowing water is made up of the following components:

1. Surface water inflow. This enters from sinkholes near the Piute and Central orebody areas. As it is close to its source, quality is expected to be excellent.

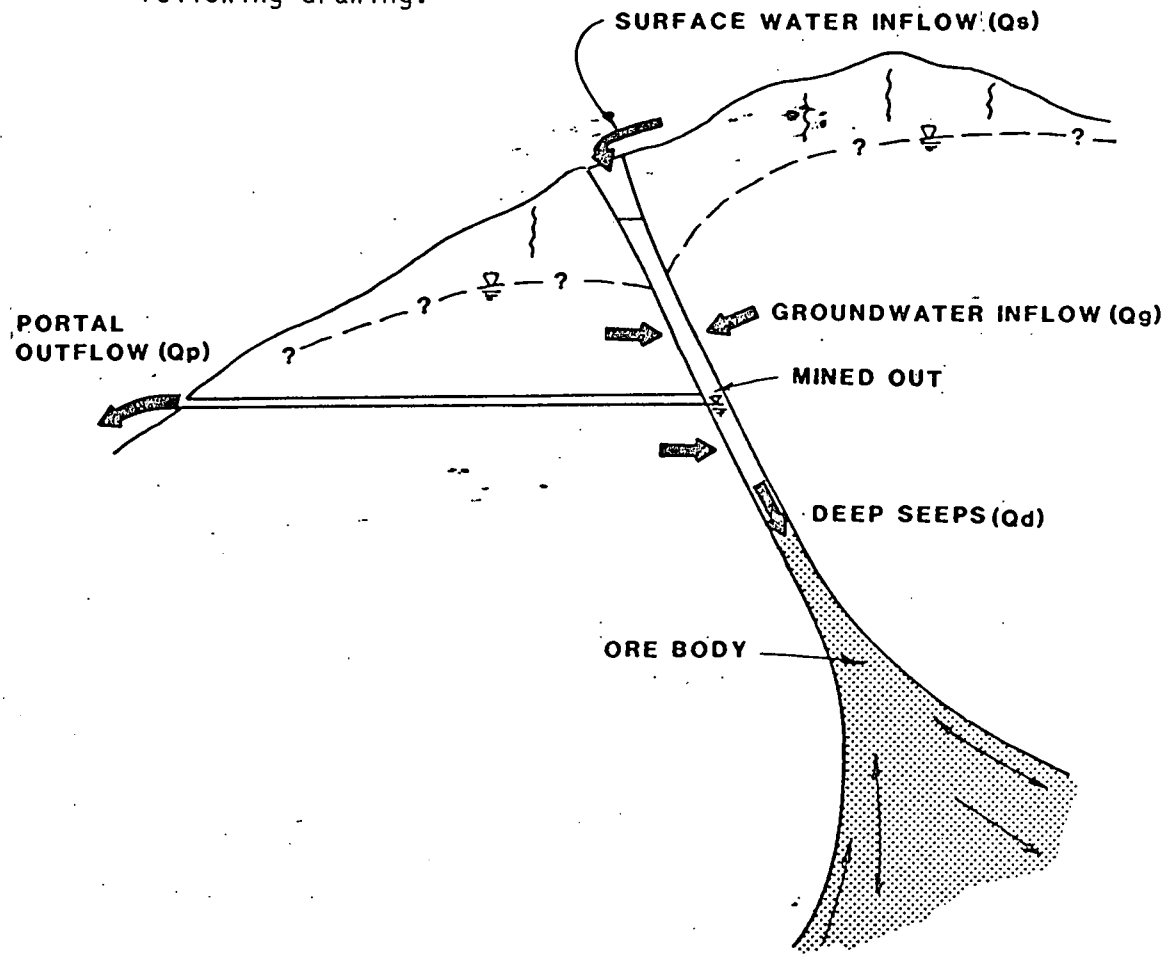
2. Groundwater inflow. The drainage of the mine has caused a groundwater sink in the vicinity of the mine. Local groundwater of (likely) moderate TDS and low metal content is flowing into the mine.

The outflowing water is made up of essentially two components:

1. Flow from the portal. This is essentially an overflow from the mine void, at the elevation of the intersection of the portal adit and the mine.

2. Discharge to deep groundwater system. As noted above, it is entirely possible that there is a deep conduit for flow from the mine. This conduit could allow discharge of water from the mine to the deep bedrock flow system via open pathways through the rock.

The total flow system is shown schematically in the following drawing:



Clearly the relationship between the flows shown for the steady state condition is

$$Q_s + Q_g = Q_p + Q_d$$

2.2.4.2 Groundwater Inflow to Mine

The portion of the measured flow due to groundwater influx to the mine is difficult to evaluate. The minimum low flow from the mine is an indication of the minimum groundwater inflow rate, on the assumption that there is no other outflow from the mine, and that the inflow from surface sources is negligible during low flow periods. The minimum inflow reported is zero (California Division of Mines and Geology, 1972) and 50 gpm (Kaback, 1979). That the flow due to groundwater is small, is further suggested by the low TDS of the Adit flow discussed in Section 2.2.3.3.

It is possible to check the reasonableness of this range of low flows. The groundwater inflow estimate can be used to back-calculate the average hydraulic conductivity of the host rock. Simple evaluation, based on Darcy's law, produces an average hydraulic conductivity of 10^{-5} cm/sec or less. Based on the observations of the rock mass made during the site inspection, this hydraulic conductivity is reasonable for the rock penetrated by the mine.

2.2.4.3 Surface Water Inflow to the Mine

The recorded flow from the mine adit has been as high as 3,000 gpm in the spring. This flow is presumed to be essentially surface water flow. This presumption may be checked by comparison with stream flows in the areas of the sinkholes above the mine.

The peak flow in 1978 presumably resulted from some stream capture at sinkholes in the Middle and South Forks of Ward Creek. As shown on Figure 7, the catchment area to the sinkholes at the Piute Shaft area is 234 acres,

while that to the central orebody sinkholes is about 212 acres. Applying flow/drainage relationships based upon local soil, vegetation, precipitation and runoff data, the total estimated average flow in these streams at these locations is given in Table 4.

This figure (525 gpm) compares well with the computed average flow of about 420 gpm in 1978, prior to much of the recent stream diversion activities.

TABLE 4
AVERAGE ANNUAL FLOW TO SINKHOLES (GPM)

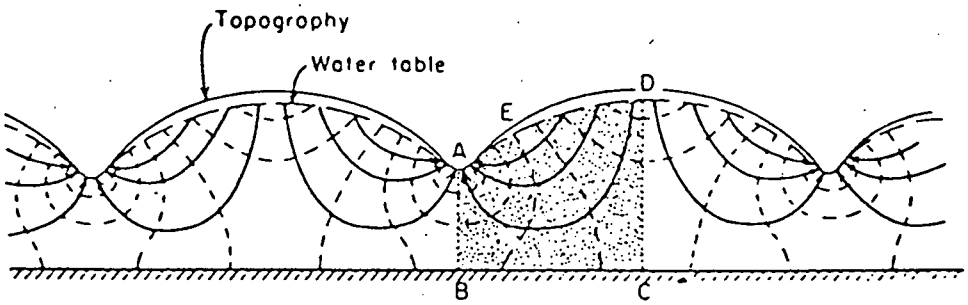
LOCATION	PIUTE	CENTRAL	TOTAL
Area (Ac)	234	212	546
Rate (GPM/Ac)	1.2	1.2	1.2
Flow (GPM)	275	250	525

2.2.4.4 Discharge to Deep Rock System

As noted above, it appears that more water currently flows into the mine than flows out via the 700 Level Adit. This suggests that water is being lost to the deep groundwater system using the mine as a conduit.

This process is possible under the following scenario. The area around the mine has high topographic relief. The current water level in the mine is Elev. 6,200 ft. The level of Grizzly Creek (about 2½ miles to the southwest) is around Elev. 5,000-5,500 ft, some 700-1,200 ft lower. The level of Indian Creek, some five miles to the northwest, is about Elev. 3,000 ft, some 2,400 ft lower. The hydraulic gradient to these two

possible regional groundwater receptors is about 0.1. Based on the evaluations of Toth et al (1963), it has become clear that deep groundwater circulation patterns differ from shallow patterns, because heads at depth are less dramatically influenced by topography. This effect is illustrated below by a figure from Freeze and Cherry.



GROUNDWATER FLOW NET IN A TWO-DIMENSIONAL VERTICAL SECTION THROUGH A HOMOGENIOUS, ISOTROPIC SYSTEM BOUNDED ON THE BOTTOM BY AN IMPERMEABLE BOUNDARY (after HUBBERT, 1940)

Accordingly, it is possible to have head conditions in the Walker Mine area which cause groundwater inflow to the mine near the surface, and flow out of the lower portions of the mine to the deep groundwater system.

It is possible to obtain an appreciation of the possible flow ranges which might occur by back-analyzing flow from the mine using some assumptions:

1. The head at an elevation of 4,000 ft (3,000 ft below surface at the mine) is 5,000 ft elevation (about half way between the mine water head and that at Indian Creek.
2. Flow is down the orebody fault zone only.
3. The fault zone in which flow occurs is 40-ft wide and 6,000-ft long.
4. Flow is downward.

Using these assumptions, the flows which result out of the mine are:

Hydraulic Conductivity (cm/s)	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}
Flow (gpm)	0.2	2	20	200	2000

A typical hydraulic conductivity for fractured rock is in the range of 10^{-4} cm/sec to 10^{-5} cm/sec. This suggests a reasonable flow estimate for present discharge from the mine to deep groundwater is about 20-200 gpm, which is in the same order as groundwater inflow to the mine.

2.2.5 Summary of Present Mine Flow System

A summary of the estimated mine inflow and outflow system is as follows:

Component	Winter (min)	Spring (max)
Surface Water	0	3000
Groundwater	50-200	50-200
Total Input	50-200	3050-3200
Deep Flow	20-200	20-200
Portal Flow	0-50	3000
Total Output	20-250	3020-3200

As can be seen, this is roughly in balance.

2.2.6 Evaluation of Remedial Actions

2.2.6.1 Do Nothing Alternative

In this alternative, the mine is allowed to flush of its own accord. Based upon continuing leaching of broken ore left in stopes and mineralized wall rocks fractured by mining, as little as 100,000 tons would continue to produce acidic, copper-bearing water at a concentration of 3 mg/l (Figure 6) for over a century. It appears clear that acid drainage can be expected to continue for a long time if unabated.

2.2.6.2 Effects of Installing a Seal in the 700 Level Access Adit

The proposed action is to install a seal in the main access adit which will cause the water level to build up in the mine. The mine water buildup will continue until inflow is equal to outflow in the mine system. The most probable effect of the water level rise in the mine will be to reduce groundwater inflow and increase the deep groundwater outflow. It is expected that the equilibrium water level will be considerably below the Piute Shaft outlet so no direct egress of the mine water to the surface is expected. The level to which the water will rise is a very strong function of the success of diverting surface water away from the Piute and Central Orebody sinkholes; therefore, it is difficult to estimate the final level. In addition, this level will fluctuate in the mine on a seasonal basis.

It is possible, but extremely unlikely, that there is no significant deep groundwater discharge from the mine. If this extreme condition were to occur, the water level would probably rise to the next exit from the mine (apparently the Piute Shaft at elevation 6,600 feet), or until the inflow is equalled by the outflow from the mine into the containing host rock.

The minimum time that it would take for the water level to rise up to the level of the Piute Shaft Landing Adit can be estimated by assuming no flow from the mine into the rock, and this calculation is presented below:

Volume to be filled = 297,000,000 gal (Table 1)
Time at 420 gpm = 1.3 years
Time at 50 gpm = 11.3 years

It would appear that refill to the level of the Piute Shaft collar could take between 5 and 10 years, given reasonable success diverting flows around the sinkholes, and given the extreme assumption of no groundwater outflow within the mine workings.

Flow could possibly occur from the Piute Shaft area under this scenario. This flow is expected to be no higher than 10 gpm because the head driving the inflow of groundwater would reduce as the water level rose in the mine workings, provided the diversion of the South Fork of Ward Creek around the Central Section sinkhole area was adequately maintained.

This flow would probably be of a similar quality to the water currently discharging from the main adit, as acid generation will continue in the un-submerged parts of the North, Central and 712 Orebodies, and it is mainly this water which would pass down through the 700 Level haulage connection and flow out of the Piute Shaft.

2.2.6.3 Additional Plugging to Isolate Piute Section

An alternate remedial strategy to avoid flow from the Piute Shaft after sealing the main portal is to isolate the Piute Section. This could be achieved by plugging the only connecting drift between the Piute and

712 Sections on the 700 Level at Elev. 6,200 ft. This could be done in two ways:

1. Before sealing the main adit, using conventional methods. This would require rehabilitating the 700 Level haulage to the plug location and installing the plug. It would provide a positive seal in this location.

2. After sealing the main adit, using a seal implaced via boreholes. This would be done from surface, and might be less effective than the conventional seal due to extreme difficulty of hitting the small target drift and ensuring an effectively watertight seal.

If a plug were successfully emplaced in this location, and if inflows were not balanced by net flows recharging the groundwater systems, the entire mine would likely refill with water, thus eliminating further acid generation through exclusion of oxygen.

2.2.7 Conclusions

The conclusions of this hydrologic evaluation are:

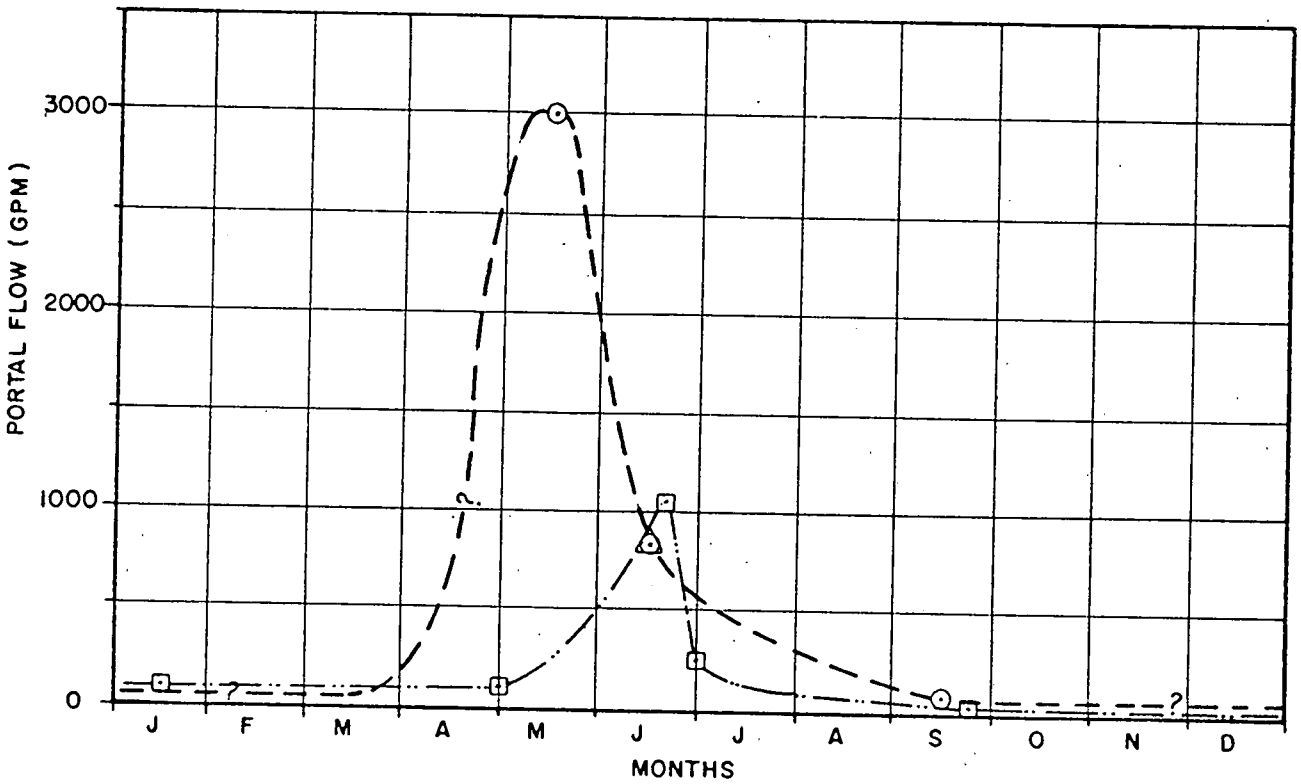
1. Sealing the main 700 Level Adit of Walker Mine will effectively remove the main source of copper contamination from Little Grizzly Creek, assuming there are no other, as yet unidentified outlets. The possibility of seepage of acid mine water from the flooded workings to surface in the catchment of Dolly Creek is considered to be extremely remote.

2. There is only a remote chance that a small flow of acidic water containing dissolved copper could ultimately occur from the Piute Shaft area, as a result of the single-plug strategy.

3. The remote chance of possible flow from the Piute Shaft could be minimized, and probably eliminated, by emplacement of another seal to separate the main mine from the Piute Section in addition to diverting surface water from the mine. This precaution would be extremely expensive, and is considered to be unjustified in view of alternative precautions and the low risk of flow.

4. Observations indicating a significant recharge of the groundwater system through outflow from the mine workings add substantially to confidence that equilibrium will be reached before the level of water in the mine workings rises to the level of the Piute Shaft Landing Tunnel (6,585 ft elevation).

5. The magnitude of the outflow inferred from the lower workings suggests a deep groundwater flow path from the mine. The orientation of regional faults (which appear from underground observation to be aquacludes) runs perpendicular to the direct path from the workings to the valley of the Little Grizzly Creek, and would tend to inhibit flow in this direction. Visual observation revealed no seepage into the valleys of the Dolly or Little Grizzly Creeks which could be identified as groundwater recharged from the Walker Mine workings.



⊙ 1978 (KABACK, 1978)

△ 1978 (MATTEOLI, 1978)

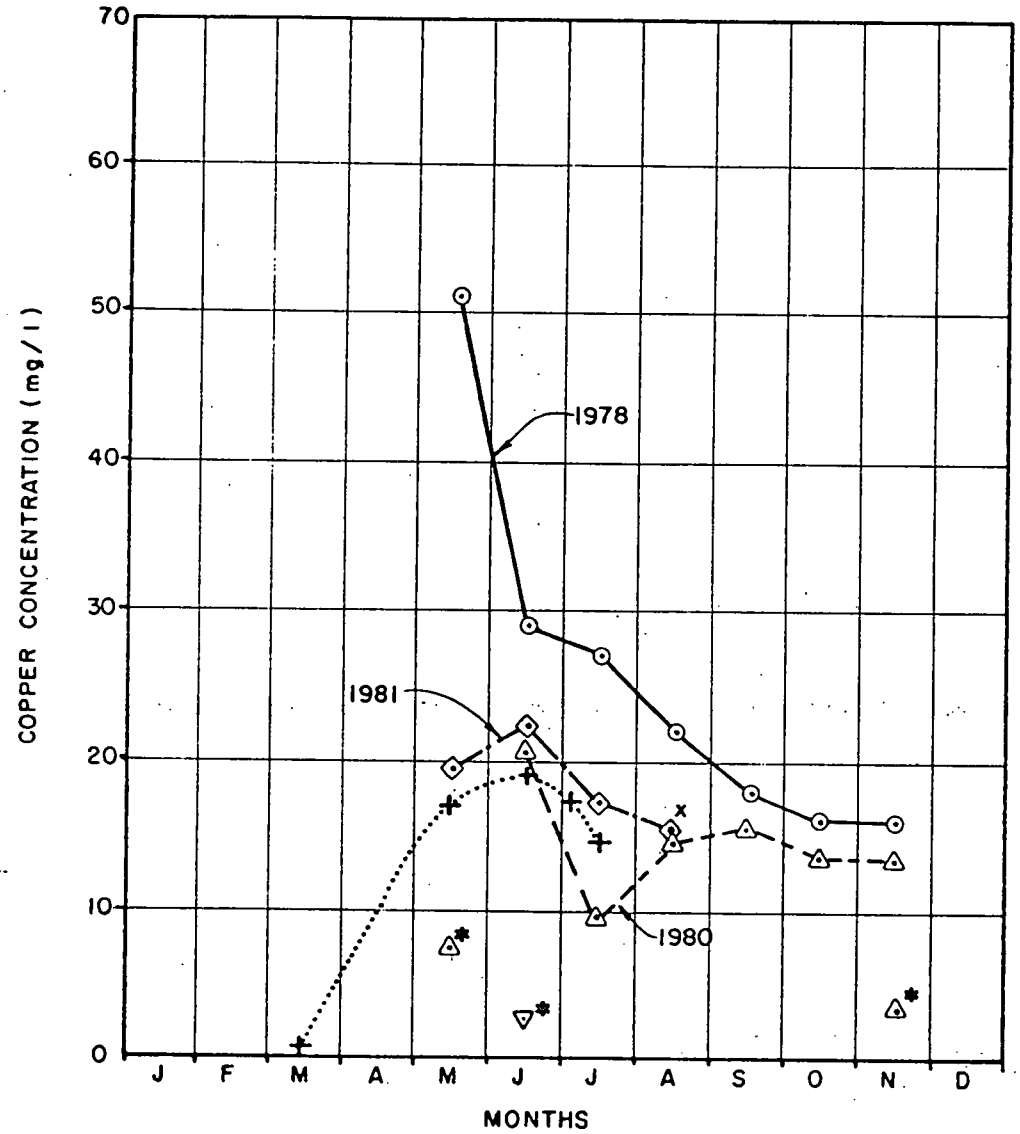
⊡ 1985 (CROYLE, 1985)

PROJECT NO. 6901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 5
DATE 3/85		MINE OUTFLOWS
REVISION NO. 0		

⊡ 1977 (MATTEOLI, 1977)
⊙ 1978 (KABACK, 1978)
▽ 1978 (MATTEOLI, 1978)
◇ 1980 (HART, 1980)
△ 1981 (HART, 1981)
x 1984 (CRAWFORD)
+ 1985 (CROYLE)

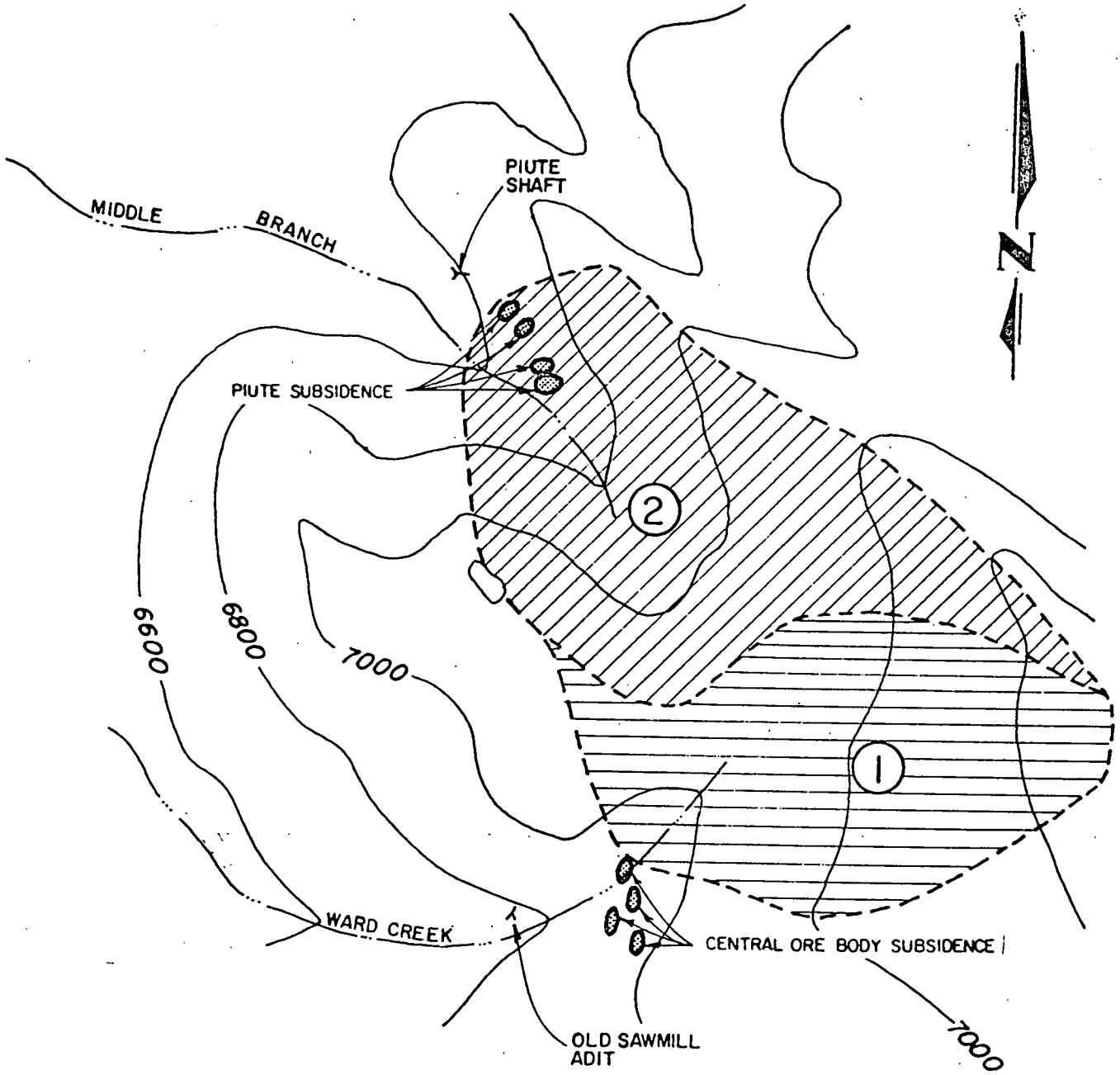
NOTE

DATA FROM AMAX LABS NOT INCLUDED AS Cu ≃ 0 mg/l



* pH ≃ 6-7, UNACIDIFIED SAMPLE ?

PROJECT NO. 6901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 6
DATE 3/85		COPPER CONCENTRATION FROM PORTAL
REVISION NO. 0		



AREA (1) = 212 ACRES

AREA (2) = 234 ACRES

0 1500
SCALE IN FEET

PROJECT NO. 6901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 7
DATE 3/85		CATCHMENT AREAS
REVISION NO. 0		

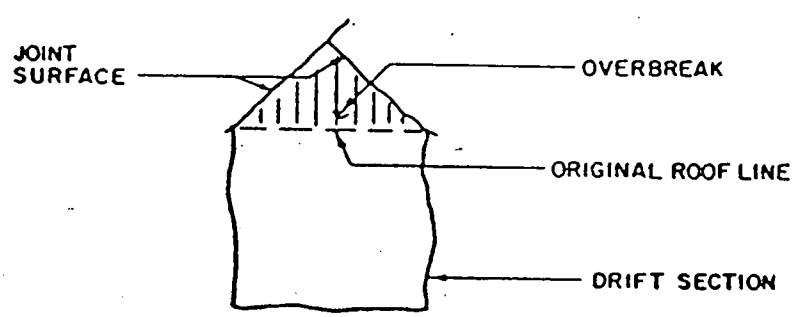
2.3 Geology and Geotechnical Considerations

2.3.1 Condition of Main Access

The main access drive was examined in order to determine its condition and its suitability as a site at which to install a bulkhead. Figure 8 shows schematically the main drive.

The first 1,300 ft of the drive from the mine portal is heavily supported. Timber square sets on approximately 3 ft centers are used, together with timber lagging. The surrounding ground is highly weathered granodiorite which has, in places, a soil-like consistency.

Beyond 1,300 ft from the portal, ground conditions are excellent. There is no installed support, little indication of blast damage, and no indication of any stress-induced failure. Due to the blocky nature of the ground, overbreak had been experienced during the original driving. The overbreak was generally in the roof as shown below:



The overbreak was a result of falls of ground along intersecting joint planes. The nature of the overbreak indicates a general lack of confinement on the rock mass

which, in turn, implies that a high in situ stress field does not exist.

A number of faults and shear zones were observed. These zones generally transect the drift at approximately right angles. The zones consisted of a composite of sheared and altered granodiorite and clay gouge. Due to the presence of the clay gouge, it is considered that such zones will act as regional groundwater barriers.

With the exception of the poor ground adjacent to the mine portal, the main access drift was essentially dry.

2.3.2 Rock Mass Classification

2.3.2.1 General

In order to summarize key geological and geotechnical data and to provide a tool for decision making during design, a system of rock mass classification and rating has been used. This type of classification makes use of measurable parameters in an attempt to minimize judgemental bias. This gives an effective quantitative method of rock mass description. The suggested method of rock mass description developed by the International Society for Rock Mechanics (1977), lists the following parameters:

- Number of joint sets;
- Orientation;
- Spacing (block size);
- Condition of joint walls;
- Joint roughness;
- Joint persistance;
- Joint opening; and
- Water seepage.

All of these parameters can either be directly measured or scaled against carefully calibrated descriptive scales.

To summarize these parameters into a single value, a rock mass classification system is used. The system considered appropriate to the bulkhead design at the Walker Mine was developed by Barton et al. (1974) and subsequently modified by Kirsten (1983). Rock mass quality (Q) is related to the parameters described above by the following expression:

$$Q = \frac{RQD}{Jn} \cdot \frac{Jr}{Ja} \cdot \frac{Jw}{SRF}$$

where RQD is the Rock Quality Designation, a measure of joint spacing, Jn the number of joint sets present, Jr the joint roughness, Ja joint alteration, Jw a measure of water pressure, and SRF a measure of the in situ stress condition.

2.3.2.2 Rock Mass Rating

Two important parameters relating to bulkhead design are rock mass strength, which in part will control the position and length of the bulkhead, and rock mass permeability, which will control the risk of leakage past the bulkhead. These parameters are both functions of rock mass quality.

An initial rock mass quality rating has been estimated from a number of observations and measurements carried out in the main access drive. Figure 9 shows the results of the observations made in granodiorite (the dominant rock type) while Figure 10 shows the results obtained in the hornfels schists that occur adjacent to

the orebody. The figures give the ratings obtained using the Q-system proposed by Barton et al (1974). For corroboration purposes, the CSIR system developed by Bieniawski (1973) was also undertaken.

The ratings from both systems indicated that the rock mass in the main access drive (granodiorite) can be regarded as good quality (Q-system) or very good quality (CSIR-system). The hornfels schists adjacent to the orebody are of slightly lesser quality, being rated as fair quality (Q-system) and good quality (CSIR-system).

The ratings estimated are in agreement with the observed conditions of the main access drive and the footwall drives visited which have stood unsupported for periods in excess of 40 years without deterioration.

2.3.3 Site Characterization

2.3.3.1 Geology

The Walker Mine is situated in a series of metasediments that have been metamorphosed by the intrusion of the Sierra Nevada Batholith. At the southern end of the mine, the hornfels and intruding diorite are unconformably overlain by flat-lying volcanic and clastic rocks.

The ore deposits consist of a series of vein-like pods with mineralization occurring in or adjacent to granitoid veins in hornfels and diorite. Major ore minerals include chalcopyrite, pyrrhotite, pyrite, cubanite, magnetite and sphalerite.

Structures in the mine area include cleavage, joints, and faults. The D'Appolonia report (1979) states

that the orientation of cleavage in the hornfels above the mine is northwest-trending and dips 53° to the southwest (approximately the same strike as the orebody). Jointing was observed in the main access drive and generally two sets, in addition to the cleavage, are present. Faulting is also evident in the main access drive and, according to the D'Appolonia report (1979), has been mapped on surface. The dominant fault set trends north to northwest and dips 50° to 80° east to northeast. A subordinate and apparently conjugate set trends northeast to east and dips 50° to 80° southeast to south. A more complete description of regional and local geology is given by D'Appolonia (1979).

2.3.3.2 Material Properties - Strength

The bulkhead and the surrounding rock can be regarded as a discontinuum consisting of a series of blocks of intact rock and concrete, separated by various planes of weakness. The behavior of this system will be controlled by both the strength and deformation moduli of the intact material and the strength and stiffness along the planes of weakness.

Values for these various components of strength have been evaluated from a number of simple field observations and measurements and from published data.

Intact Rock Strength

Intact rock strength was estimated from a series of simple field measurements. These indicated that the uniaxial compressive strength of the granodiorites is in the range of 22,000 to 29,000 psi. The hornfels schist is weaker with an estimated uniaxial compressive strength in the range of 12,000 to 17,000 psi.

A cross-check on these estimated strengths was carried out with the aid of the relationship between uniaxial compressive strength, vertical stress and tunnel condition given by Hoek and Brown (1980). The relationship is shown in Figure 11. The access tunnel and the footwall drifts were found to be in a stable condition (i.e. $p_2/\sigma_c = 0.1$ in Figure 11). It has been assumed that the vertical stress is equivalent to the overburden load of approximately 1,450 psi. Entering this value on Figure 11 and projecting up to the $p_2/\sigma_c = 0.1$ line, the minimum uniaxial compressive strength can be read off. This value is 16,000 psi and compares well with estimates done from field measurement.

Rock Mass Strength

Hoek (1983) has developed a failure criterion that can be used to predict rock mass strength. A series of approximate equations were derived that allow Mohr's strength envelopes to be constructed for different rock types and quality.

The rock mass classification outlined in the previous section was used to determine the appropriate strength equations as shown in Figure 12. From these equations, failure envelopes were constructed and are shown in Figure 12 for both the granodiorite and hornfels schist.

Strength at Rock-Bulkhead Interface

The strength along the rock/bulkhead contact is dependent upon the following parameters:

- Rock/concrete frictional and adhesion properties;

- The roughness and size of asperities along the rock surface;
- The condition of the rock; and
- The stress acting across the contact.

Strength estimates have, therefore, been based upon a series of field observations and tests, and published data.

The roughness and size of asperities found along a potential shear surface have a major influence on the shear strength of that surface. Patton (1966) has demonstrated that the roughness angle (i) can be combined with the base friction angle ($\emptyset_b$) of the surface to obtain an estimate of the peak frictional strength available along the surface.

Observations in the main access drift indicate that at least two orders of asperities exist. These are illustrated in Figure 14. The first order asperities reflect the roughness along individual joint planes and have been termed the roughness factor. The second order of asperities are at a greater scale and arise due to the intersection of joints with different orientations. This has been called the step factor.

For failure to occur along the rock/bulkhead interface, the following sequence of events must take place:

- The base frictional properties between the concrete and the rock must be exceeded;

- Shear through or dilation over the first order asperities (roughness factor); and

- Shear through or dilation over the second order asperities (step factor).

The peak strength of the contact (τ_p) is, therefore, a function of

$$\tau_p = f\ (\tau_b, \tau_r, \tau_s)$$

where τ_b is the strength component attributable to the base frictional properties, τ_r the strength component attributable to the roughness factor and τ_s the strength component attributable to the step factor.

An estimate of base frictional strength of the two principal rock types can be made from published data. Figure 15 shows a composite of results obtained by Einstein et al, 1979. The granodiorite rocks fall within the Group IV rock (Figure 15) while the hornfels schist falls within the Group III rock (Figure 15).

From Figure 15, it is estimated that the base frictional strength of the granodiorite is 30° and that of the hornfels schist 25°.

A number of observations were made underground on joint roughness. These observations indicate that some 2° can be added to the base frictional strength to account for surface roughness.

As can be seen from Figure 14, the walls of the access drive comprise a series of large rock steps. The average relief change over one of these steps is approximately 8 inches. Any shear surface along a bulkhead/rock contact must either pass through the rock mass or dilate over the step. To account for this effect, the peak frictional strength can be increased. Based upon

results given by Robertson (1971), it is considered that 15° can be added to the base friction angle to account for the stepped rock surface.

Based upon the above discussion, the peak frictional strength available along the rock/bulkhead is estimated to be:

$$\tau_p = \tau_n \tan (30^{o} + 2^{o} + 15^{o}),$$

where τ_n is the normal stress acting across the contact.

2.3.4 Bulkhead Design

2.3.4.1 Location

Two bulkhead positions have been considered. The first is in the main access drive and is intended to block the main discharge point of mine water. However, this will in turn cause the mine water to backup within the old workings until it might eventually issue out of the Piute Shaft. In order to minimize the consequences of this, a second bulkhead could be located between the 712 Orebody and the Piute Orebody. As indicated in Section 2.2.7.3, the installation of an internal plug is not recommended. Consideration of its technical feasibility and the cost of its construction is necessary for an effective evaluation of its merits on a cost/benefit basis.

The approximate locations of the two bulkheads is shown in Figures 3 and 4. The main bulkhead is positioned approximately 2,700 ft from the mine portal. Figure 16 shows the profile of the roof, floor and walls. The position was specifically chosen for its geometry; the narrowing of the drive at that point will greatly enhance the stability of the bulkhead.

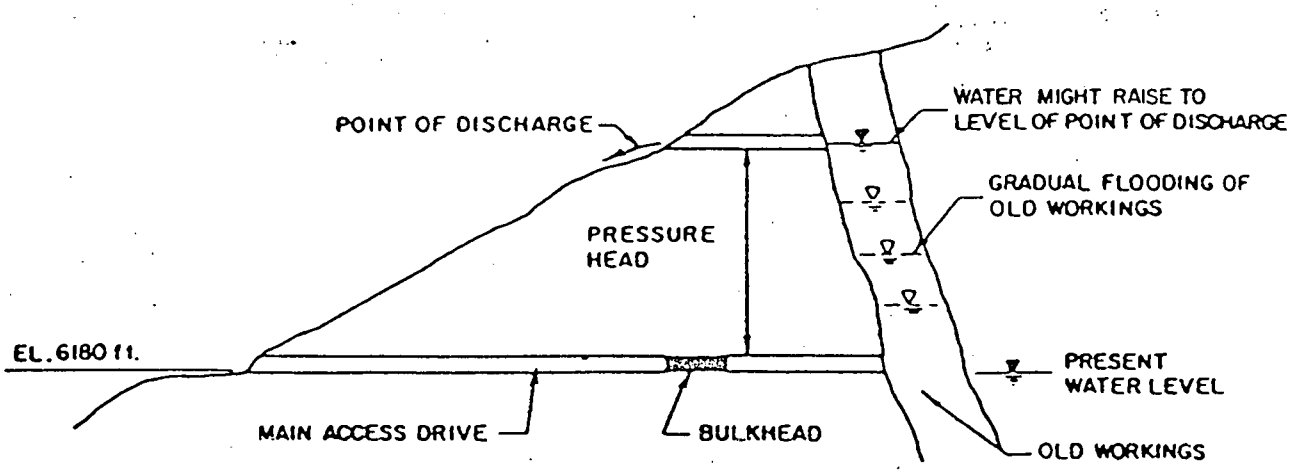
2.3.4.2 Design

The stability of a bulkhead will depend upon several factors. These include:

- The water pressure applied to the bulkhead;
- The strength of the bulkhead;
- The strength of the surrounding rock; and
- The strength along the bulkhead/rock interface.

Pressure on Bulkhead

The water pressure on a bulkhead is dependent on the head of water maintained behind it. As the flow of water is stopped by the bulkhead, the water will gradually back up through the mine until equilibrium is reached or a higher exit point is encountered. The difference in elevation between the higher exit point and the bulkhead elevation represents the pressure head the bulkhead has to resist. This is shown on the following drawing.



Two bulkhead locations have been studied, namely the main bulkhead and the Piute bulkhead. Examination of old mine records and plans indicate that with only the main bulkhead in place, the next point of egress for mine water will be the Piute Shaft. The difference in elevation between the Piute Shaft Landing Tunnel and the main bulkhead is approximately 390 ft. However, with both the main and Piute bulkheads in place, the point of egress for water contained between the two bulkheads will be the Old Sawmill Adit where it exits from the caved area above the Central Orebody. The pressure head in this instance is 570 ft. It should be noted that the water contained beyond the Piute bulkhead could still exit from the Piute Shaft.

For design purposes, it has, therefore, been assumed that the higher head acts against both bulkheads. In addition, a factor of safety of 2.5 has been applied to this head giving a design pressure head of 1,400 ft.

Bulkhead Dimensions

The water retained behind a bulkhead exerts a load on the bulkhead. This load is transferred to the surrounding rock in the form of shear stresses. It has been assumed, for design purposes, that the stress distribution is uniform over the length of the bulkhead.

Based upon the above assumptions, the bulkheads can be dimensioned by using the following relationship (Garret and Pitt, 1961):

$$l = \frac{p \cdot a \cdot b}{2(a + b)\, f_s}$$

where:

p = pressure applied to the bulkhead

a = width of bulkhead

b = height of bulkhead

l = length of plug

f_s = safe average shear stress

The two bulkheads would be placed in approximately 12 ft x 12 ft drifts. By using the pressure head established in the previous section, the relationship can now be written as:

$$l = \frac{1400 \times (0.434)\ (12 \times 12)\ (12 \times 12)}{2\ (12 + 12)\ (12)\ fs}$$

$$= \frac{21874}{f_s} \text{ units in } \frac{lb/in}{lb/in^2}$$

F_s, the safe average shear stress can be estimated from Section 2.3.3.2, Material Properties. In this section, it was shown that, due to the roughness and stepped nature of the tunnel walls, any shearing along the bulkhead/tunnel interface will result in either dilation over the surface or shear through the rock mass.

The shear strength of the rock mass can be estimated from the curves shown in Figure 13. For design purposes, it has been assumed that there is little or no normal load acting across the bulkhead/rock interface. The design shear stress used is, therefore, the intercept on the shear stress axis. By using the value at $\sigma_n = 0$ (i.e. assuming no normal load across the interface; a conservative assumption), the estimated length of the bulkheads is:

granodiorite = 10 ft

hornfels schist = 14 ft

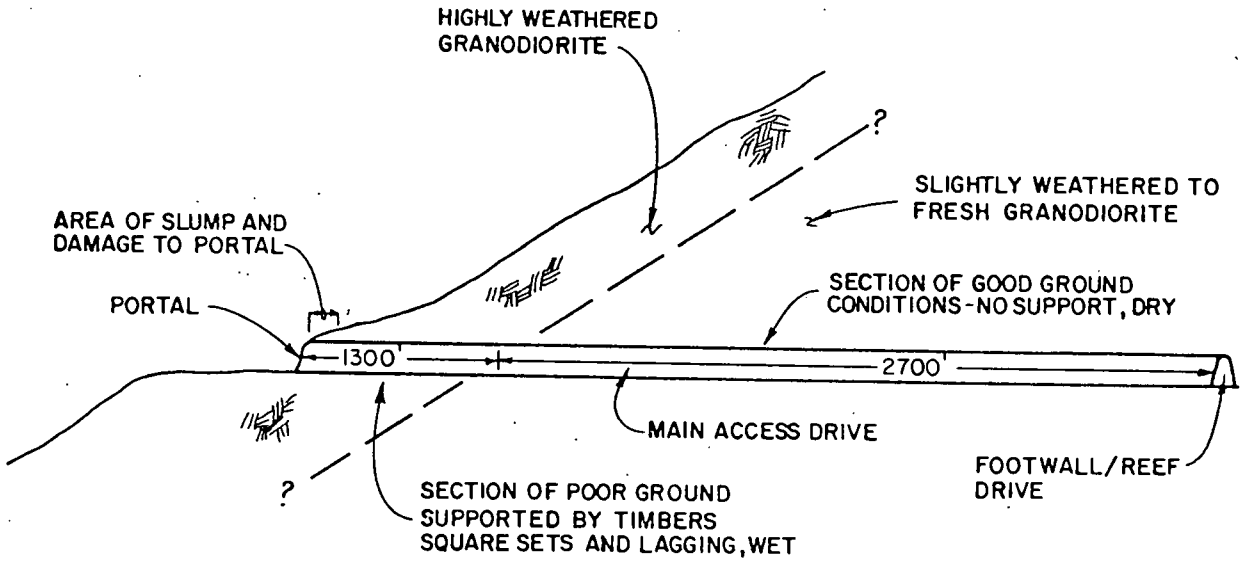
If dilation occurs, shearing has to occur within the plug. Therefore, a similar exercise was carried out by using an appropriate f_s value for concrete. The strength of concrete was taken as 2000 psi at 28 days. Some 10 ft of bulkhead length was found to be sufficient to preclude shear failure through the concrete. Therefore, to ensure the stability of the bulkhead, minimum bulkhead lengths of 10 ft in fresh granodiorite rocks and 14 ft in hornfels schists are required.

Practical experience gained in high pressure bulkheads used in South African gold mines has indicated that it is generally more difficult to stop leakage around a bulkhead than to make it strong enough to resist thrust. Recommendations put forward by Cummins and Given (1973) indicate that the pressure gradients along the plug should be moderate and experience has proven that gradients of up to 40 psi per ft are effective (though in a number of cases, gradients of up to 400 psi per ft have been achieved). By using the design pressure head of 1,400 ft (608 psi), the bulkhead length necessary to obtain the required pressure gradient is 15 ft. This value is in excess of the length necessary for bulkhead stability. It is, therefore, recommended that both the main bulkhead and the Piute bulkhead be 15-ft long.

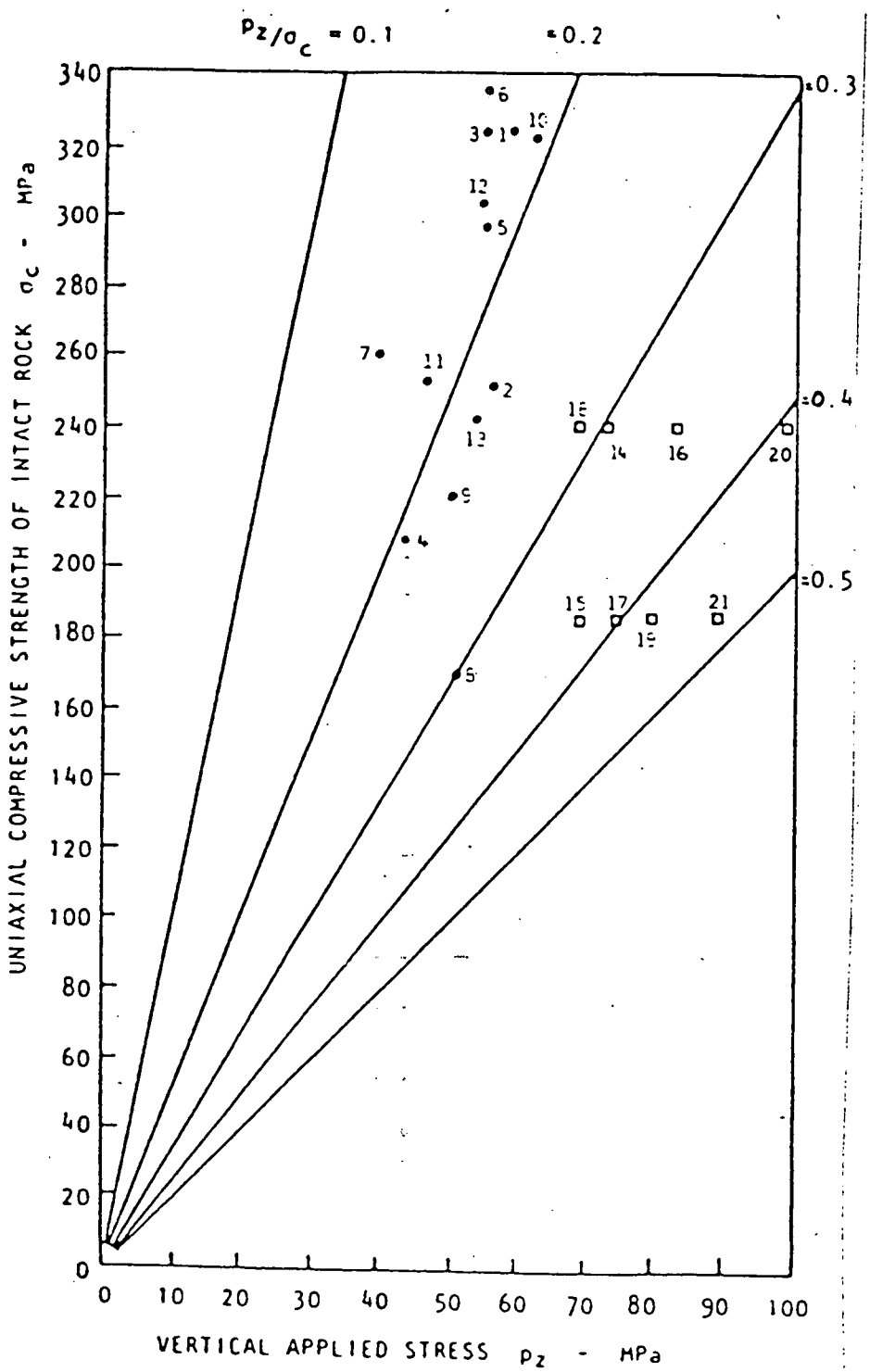
2.4 Results

Observations on surface and underground at the Walker Mine provided substantial confirmation of hydrological and geotechnical data derived from previous reports, relevant literature and the SRK team's past experience. Confidence in the available and derived data was sufficient to permit design and specification of the concrete bulkheads considered as seals in the 700 Level tunnel between the Piute and 712 Sections, and in the Access Adit close to its intersection of the South Orebody.

Observation of the condition and dimensions of the 700 Level Adit provided sufficient information to permit fairly accurate (-10% to +25%) estimates of construction costs for the proposed main (Adit) bulkhead seal. The 700 level Haulage had not been cleaned beyond the South Orebody at the time of the site visits, but the work required to clear it sufficiently to permit access for construction of an internal plug between the 712 and Piute Sections was estimated on the basis of visual inspection on June 19, 1985.



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 8
DATE 3/85		MAIN PORTAL SECTION
REVISION NO. 0		



p_z/σ_c = 0.1 - stable unsupported tunnel.

p_z/σ_c = 0.2 - minor sidewall spalling.

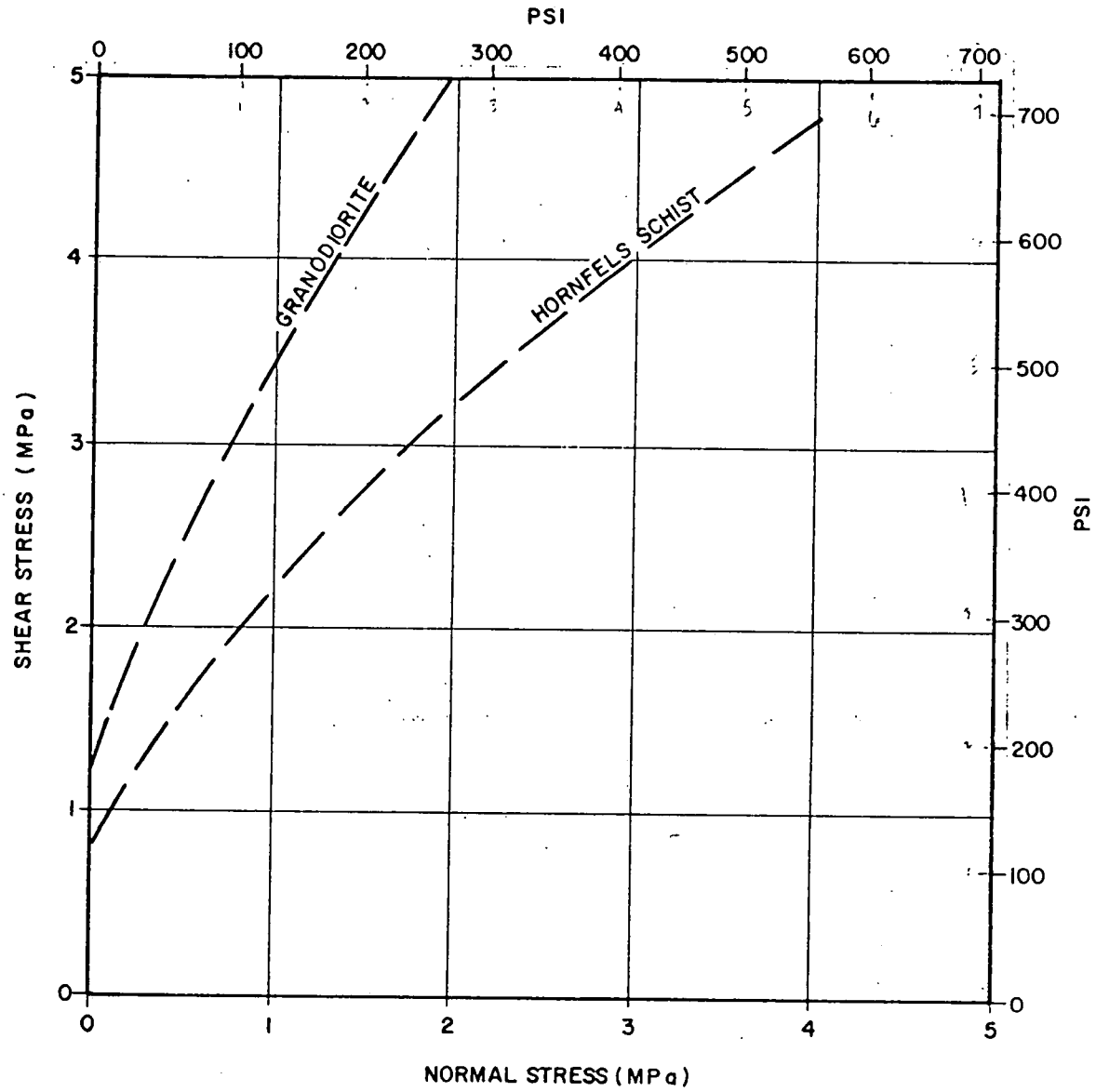
p_z/σ_c = 0.3 - severe sidewall spalling.

p_z/σ_c = 0.4 - heavy support required.

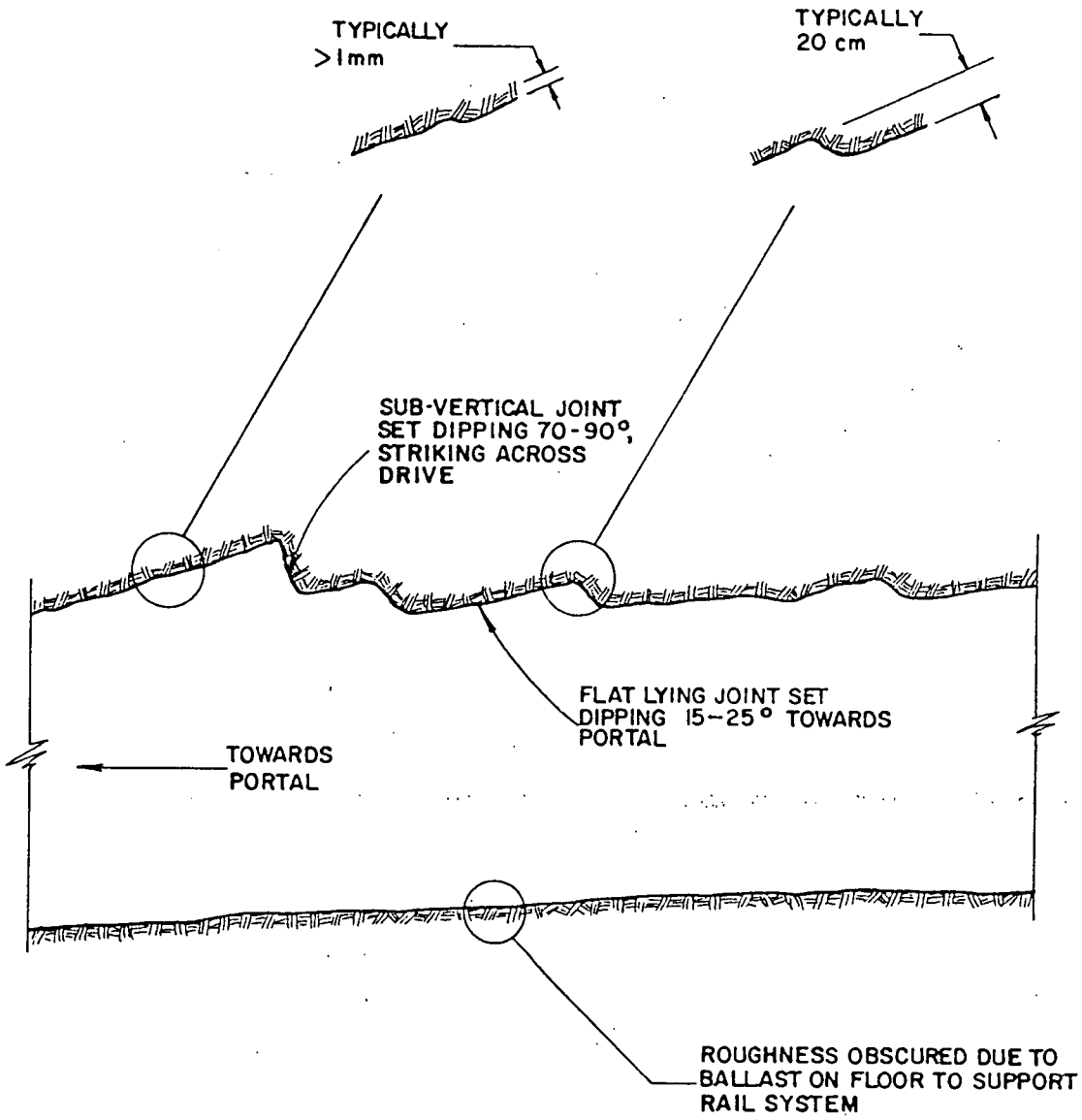
p_z/σ_c > 0.5 - possible rockburst conditions.

NOTE: 1 MPa = 145 PSI

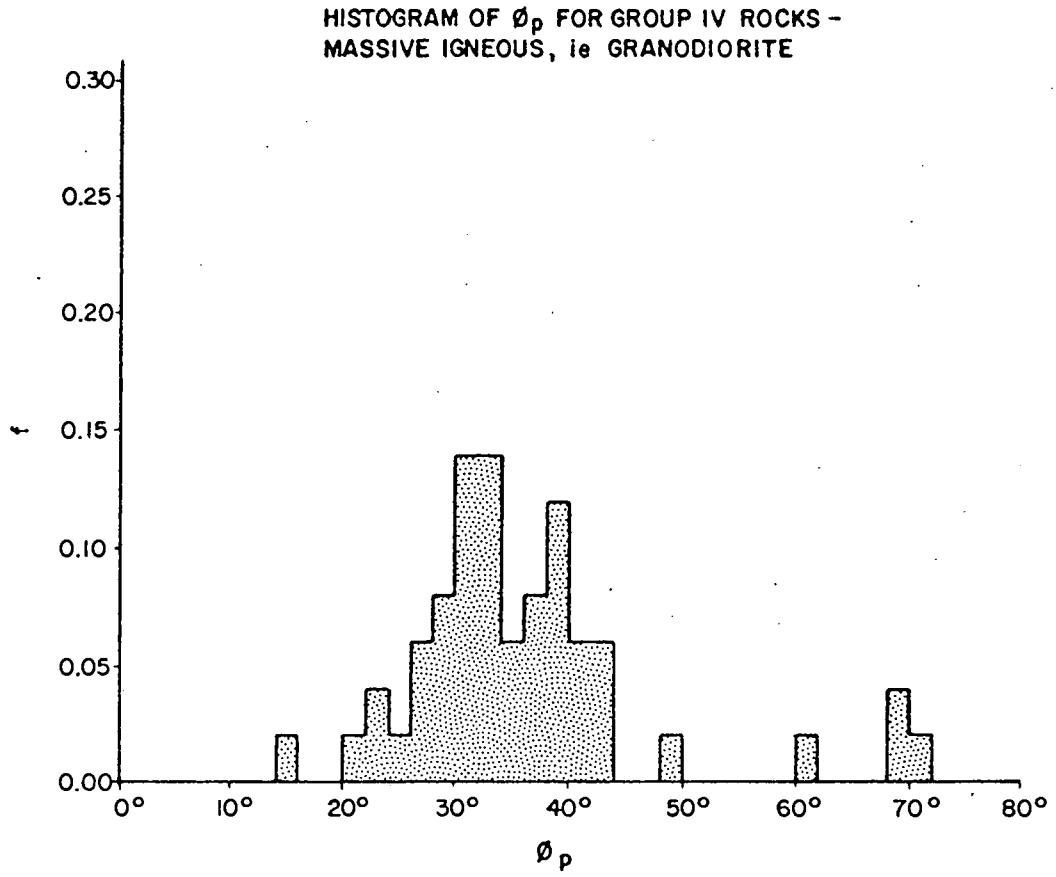
PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 11
DATE 3/85		COMPRESSIVE STRENGTH vs. APPLIED STRESS FOR SQUARE TUNNELS
REVISION NO. 0		

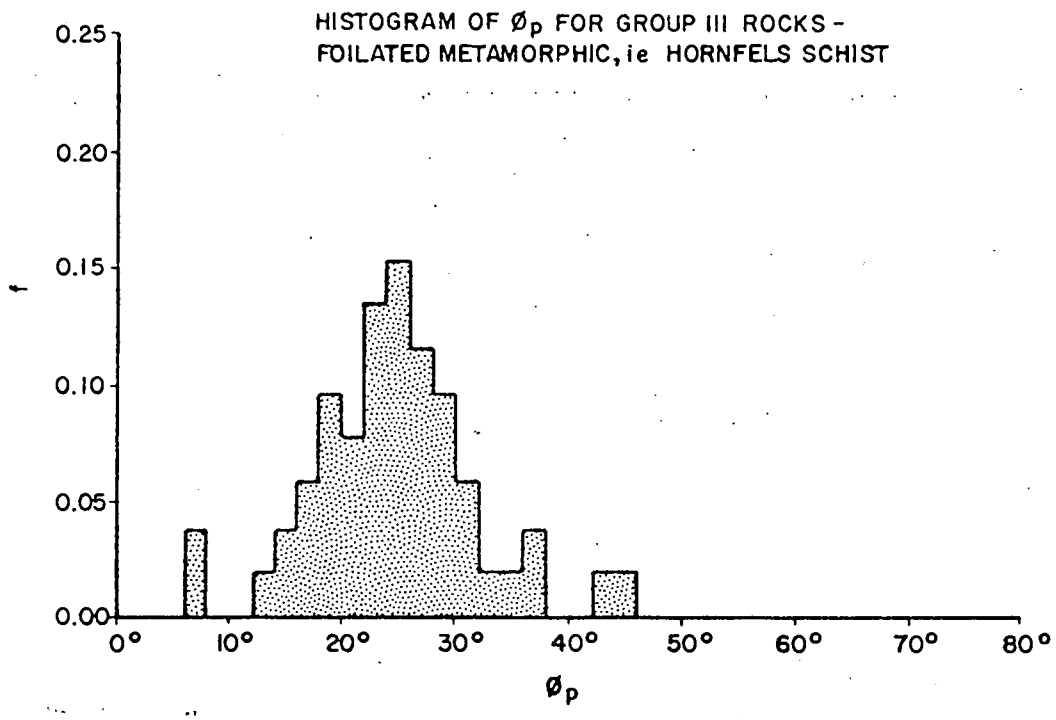


PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 13
DATE 3/85		ESTIMATED SHEAR STRENGTH OF ROCK MASS
REVISION NO. 0		

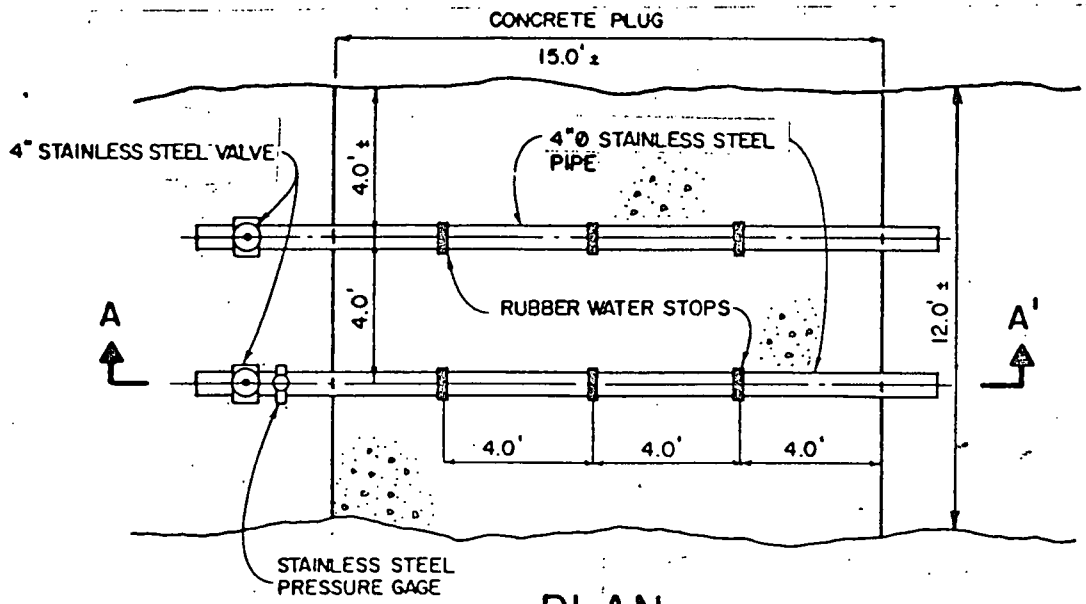


PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 14
DATE 3/85	Consulting Engineers	VERTICAL SECTION THROUGH MAIN ACCESS DRIFT SHOWING ASPERITIES
REVISION NO. 0		

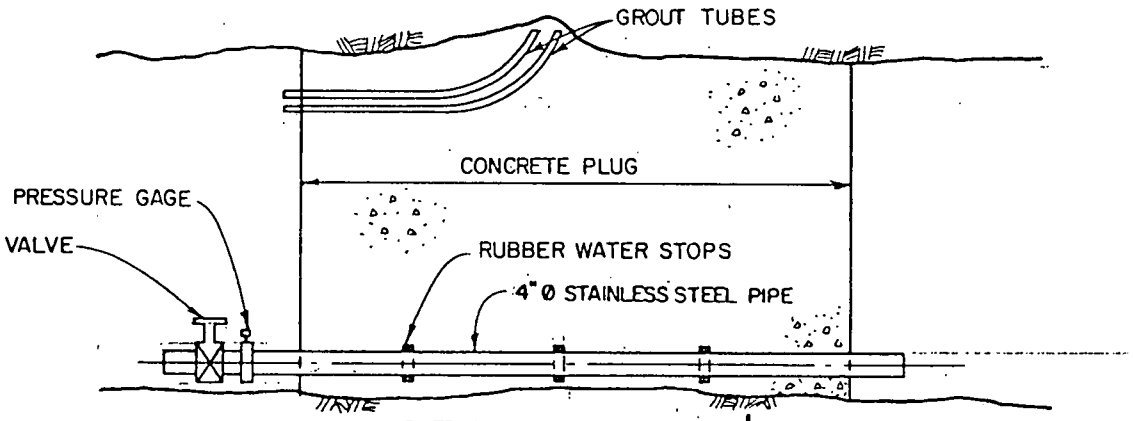




PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 15
DATE 3/85		DISTRIBUTION OF PEAK FRICTIONAL STRENGTH
REVISION NO. 0		



PLAN



SECTION A-A'

PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 17
DATE 3/85		TYPICAL DRAIN PIPE DETAILS
REVISION NO. 0		

3.0 PLUG SPECIFICATION AND CONSTRUCTION CONSIDERATIONS

3.1 Plug Specifications

The sections below summarize materials to be used in the construction of the plug. Discussions on the proposed mix design are presented in Appendix I. Technical specifications for bid purposes are presented in the attached addendum to this report.

3.1.1 Location and Dimensions

Main Adit Plug at approximately 12,950 N, 11,420 E
Plug Length = 15 ft
Piute Plug at approximately 18,600 N, 10,000 E
Plug Length = 15 ft

3.1.2 Site Preparation

The plug site shall be cleaned and prepared to ensure an adequate bond between the rock and concrete surfaces. Methods of site preparation shall be proposed by the contractor and approved by the engineer prior to construction. The cleaned and prepared surface shall be approved by the engineer prior to placement of concrete.

Access to the sites may require additional site preparations for transporting construction materials. This shall be done on an as-needed basis. Such site work need not be to the extent of maintaining permanent access, but shall be such that safe working conditions are established.

3.1.3 Formwork

The formwork for the bulkheads shall be constructed of good quality material and in such a manner as to provide a good seal for containment of the concrete and

any grout that may be injected. The design of the formwork shall be sufficient to withstand the fluid pressure of the concrete and any increased pressures due to grouting or concrete placement. The formwork will be subject to the engineer's approval prior to placement of the concrete.

3.1.4 Concrete

The concrete used to form the plugs shall be a 3,000 psi, 28-day strength mix. The mix shall use fine aggregate of the gradation and durability as specified in ASTM C 33-82 and C 117-80. The cement shall be sulfate-resistant Portland cement. Slump shall be 4 to 7 inches (see Appendix 1). Water used in the mix shall be of good quality so as not to degrade the concrete. Mine and mine drainage waters are not acceptable for use in the concrete mix. The mix design and admixtures are presented in Section 4.4 of the Addendum.

Concrete delivery and placement shall be according to ASTM and ACI standards. Under no circumstances shall delivery scheduling or placement methods be such that a cold joint shall be formed in the plug. If necessary, curing retards may be included in the mix design.

3.1.5 Piping and Valves

Two drainage pipes through the main adit plug shall each be 4-inch diameter schedule 40 stainless steel pipe. The valve(s) shall be of a corrosion resistant metal as specified in Section 4.5 of the Addendum or equivalent. Placement of the pipe shall be of good standard practice. Minimum clearance around the pipe shall be 12 inches.

A stainless steel screen shall be placed around the upstream end of the pipes. The screen shall have 3/4-inch opening. Placement and anchoring shall be determined as part of construction.

Piping for grout tubes shall consist of flexible nylon, PVC, or HDPE tubing.

3.1.6 Grouting

Grouting shall be done in areas of overhangs or protrusions to provide a tight seal between the rock and concrete. Grout tubes shall be placed such that air entrapment does not occur in the voids. A return line shall be installed at each location to provide a means of determining total void filling with grout. Placement of the grout lines is subject to the approval of the engineer.

Grouting may not be done within the first seven days after concrete emplacement. Grout pressures shall not exceed 1,500 psi. The grout shall be a neat mix of sulfate-resistant Portland cement. Chemical grouts may be used upon approval by the engineer.

3.1.7 Monitoring

Monitoring pressure head behind the in place plug in the main adit shall be done by means of a direct-reading pressure gauge inserted in one of the drainage pipes. In the event that an internal plug is constructed, pressure head in the Piute Section will be measured by an open standpipe piezometer installed from the surface or by a piezometer or vibrating wire piezometer installed during construction. Provisions for installation shall be included at the time of construction.

3.1.8 Operation

The discharge valves shall be locked at all times, except during operation or testing by authorized personnel. Upon completion of operation or testing, the operator shall check to see that the valves are locked prior to leaving the site. Operation and testing shall be done only by authorized personnel of the California Regional Water Quality Control Board Central Valley Region.

Prior to opening a valve, all personnel and equipment shall be clear of the line of discharge. This a high pressure system and will discharge at a high velocity and pressure. The valves shall be opened and closed at a slow and constant rate.

A warning sign shall be posted at the valves listing the above procedures.

3.2 Discussion of Alternatives

Effective permanent abatement of the flow of AMD from the Walker Mine could require up to four stages of control measures, each stage increasing the degree of confidence in the effectiveness of the solutions to the problem. These stages and comments on the rationale behind their conception are:

1. Installation of a concrete bulkhead plug in the 700 Level Main Access Adit.

   This measure will effect an immediate halt to the contaminating emissions from the mine, but, in the absence of any additional precautions, the halt might be only temporary. If water in the workings was able and permitted to rise until it could overflow through the

Piute shaft, the problem might simply be transferred from Dolly Creek to the Middle Fork of Ward Creek after a hiatus of up to ten years. The means by which such a transfer can be avoided are detailed in Section 5.2.

The optimum site for this plug is in the Access Adit, as close to the mine workings as possible. This site is indicated in Figures 3 and 4, and detailed in Figure 16. An alternate, less favorable site has been identified closer to the portal, about 250 ft from the end of the timbered section of the adit. This site could be used to replace the original bulkhead should that ever become necessary.

2. Establishment of diversion ditches above subsidence slumps over the Central and Piute Orebodies.

Evidence derived from examination of seasonal flow records for the 700 Level Adit suggest that a large part of the outflow of AMD consists of surface runoff, principally spring snowmelt which enters the mine workings through subsidence slumps. Adequate control of this inflow, combined with stoppage of the outflow by means of a plug in the 700 Level Adit, could allow the inflow of groundwater to reach equilibrium at a level below the next point of egress above the 700 Level, i.e. the Piute Shaft Landing Tunnel.

Much of the excavation necessary to divert flows in the upper catchment of the South and Middle Forks of Ward Creek around subsidence slumps has been done. A conservative estimate of the cost of additional upgrading of the diversion system has been based on observations on site during June, 1985. Unlike the concrete bulkhead plug, the diversion ditch system will require periodic inspection and maintenance, which might be timed to

coincide with availability of personnel and equipment near the site.

3. Isolation of the Piute Section of the mine workings.

Isolation could be achieved by construction of a concrete bulkhead plug in the 700 Level Haulage between the Piute and 712 Sections. The site of this plug is indicated in Figures 3 and 4. Its effect would be to compartmentalize the mine workings and permit groundwater to reach equilibrium at different levels in two separate sections of the mine workings, probably below the level at which water would overflow to surface from the flooded workings.

Construction of an internal (Piute) plug would be undertaken through the 700 Level Adit and Haulage. This would require rehabilitation of the haulage for a distance of about 6,000 feet to the extent that the rail track was clear and sound enough to permit passage of a locomotive and flat cars or concrete mixer cars for about 20 trips during plug construction. The alternative of gaining access to the internal plug site through the Piute Shaft has been rejected on the basis of evident unsafe conditions close to the collar, and Mr. Donato's reported observation of the severe deterioration and collapse of timbering in the shaft. Rehabilitation would be both slower and more expensive than cleaning out the 700 Level Haulage. Remote placement of a grouted plug through surface boreholes has been rejected because an effective seal could not be assured without thorough preparation of the rock surface at the plug site, and this would require almost as much rehabilitation work in the 700 Level Haulage as would be needed for conventional construction.

There is an indication on one sketch, prepared to indicate ventilation flows during an underground fire in the Walker Mine in 1940, that there might be a second drift on the 700 Level, parallel to the Main Haulage connecting the 712 and Piute Sections. Underground inspection does not support this possibility.

The very high cost of isolating the Piute Section is considered excessive in view of the low risk that it might be required, and the availability of other, lower-cost alternatives (see Section 2.2).

4. Construction of a seal in the Old Sawmill Adit.

This adit is the highest artificial outlet for water from the mine workings below the large openings provided by subsidence slumps over the Central Orebody. As such, it is the highest point at which a seal could be attempted in the event that groundwater did not reach equilibrium level at a lower elevation following isolation of the Piute Section. It is considered very unlikely that groundwater inflow could cause an overflow from the flooded mine workings through the slumps. Only under exceptional circumstances would heavy surface inflows raise the water level in the flooded workings to overflow level, and then only brief flows of minimally contaminated water could be expected to enter Ward Creek.

The Old Sawmill Adit Portal appears to have collapsed naturally and would probably permit passage of water overflowing from the mine workings. Insufficient information is available to design or estimate accurately the cost of a seal in this adit should it be needed some twenty years or so after construction of the 700 Level plugs.

3.3 Construction Consideration and Cost Estimate

3.3.1 Construction Considerations

It is generally more difficult to stop leakage past a bulkhead than it is to make the bulkhead strong enough to resist the total thrust due to hydrostatic pressure. Even if an impermeable plug or seal is effectively placed within the tunnel opening, the permeability of the contact between the plug material and the surrounding rock can be a weak link in the total performance of the plug. It has been noted in South Africa that leakage is likely along the floor and the roof, even at low pressure, where mud and air pockets commonly weaken the concrete-rock contact. This type of behavior has likewise been observed in tunnel plug construction at the Nevada Test Site. Construction practices have been developed to circumvent such undesirable behavior.

Several things can be done to reduce the likelihood of leakage along the plug perimeter. The first step in obtaining a good contact between the plug material and the surrounding rock is to have the rock thoroughly cleaned after final excavation and before placement of the plug material. This involves not only cleaning of the rock surface, but also spraying the rock surface with a concrete adhesive or a sodium silicate grout material and then spraying a fine-grained angular sand upon this adhesive material. It has been found that such a pre-treatment of the rock surface enhances and promotes the final bond between the concrete plug and the surrounding rock.

During actual placement of the concrete, bulkheads must be constructed at the two ends of the plug. These bulkheads must be strong enough to withstand the pressure

of the fluid concrete. Provisions must be made prior to concrete placement to allow air escape at the upper portion of the zone to be filled with concrete. It has been found useful, when topping off the concrete plug, to drill two six-inch diameter holes from outside of the bulkhead to the uppermost point of the void to be filled with concrete. Small pipes are then grouted into these two holes. As a topoff mechanism, the uppermost portion of the concrete is grouted by injection of grout in one of the two topoff pipes until grout flows from the second topoff pipe. At this point, the ejection pipe is shut off with a valve, the pressure on the injection pipe is increased to some predetermined value and then it is shut off. It has been found in tunnel plug construction practice, that placement of concrete at a minimum slump of 7½ inches increases the workability and flow characteristics of the fluid concrete within the tunnel plug forms. Even so, additional provisions must be made to promote the complete flow of concrete against both the tunnel form and the rock surface, to eliminate the possibility of honeycombing and void development at the concrete-rock interface.

It has been found in both South Africa and Nevada Test Site practices that leakages around tunnel plugs can be sealed acceptably by at least one stage if not multiple stages of grouting. The critical points to grout are at the top of the structure where topoff procedures may possibly not have completely filled the void, and the lower portion of the structure where sediment may have been allowed to collect. In grouting these areas, grout holes approximately two feet apart and intersecting the rock-concrete interface are suggested. This pressure grouting has been accomplished at pressure levels of a few hundred psi in South Africa.

It is extremely important that horizontal cold joints in the concrete plug be avoided by all means. Such cold joints can be crucial to the permeability of the concrete plug, and can make the entire plug ineffective if permeability through the plug is allowed. It has also been suggested that standard commercial grade expansive agent additives be employed to promote expansion of the concrete during curing, and thus to help seal any voids that may have a tendency to develop. Placement of plugs up to 30 ft long at the Nevada Test Site has not experienced any problems in thermal cracking and associated crack permeability. It should be noted however, that in these plugs concrete is placed at temperatures no higher than 55°F. This procedure ensures that all hydration takes place within the forms, and that excessive temperatures do not develop.

Due to the chemistry of the mine waters that the bulkheads are intended to confine, sulfate resistant cement should be used in construction. In addition, it is recommended that a 3000 psi, 28-day strength concrete be used.

3.3.2 Cost Estimates

The level of accuracy of cost estimates is approximately -20%, +30%.

A. MAIN ACCESS ADIT PLUG

Activity Description	Labor	Equipment	Materials	Sub-Contract	Total
1. Mobilization	3,900	1,800	-	6,200	11,900
2. Site Service	5,300	8,700	-	-	14,000
3. Site Preparation	14,400	6,600	-	-	21,000
4. Plug Construction	15,700	7,300	36,600	-	59,600
5. Demobilization	6,600	3,000	-	6,100	15,700
6. Diversion Works	-	-	7,500	5,400	12,900
7. Management/Q-C	14,300	-	-	-	14,300
TOTAL	60,200	27,400	44,100	17,700	149,400
Plus 10% Contingency					14,900
Estimated Construction Cost					$164,300

For budgeting purposes:

- Total Estimated Construction Cost = $165,000
- Duration of Construction Activities = 35 days or 6 weeks

Activities itemized in the Cost Estimate include:

1. Transport of personnel and equipment from source to site, and set up.
2. Installation or extension of compressed air and water lines, ventilation fan and ducting, and rail track on surface, as well as generator, compressor and pumps.
3. Construction of cofferdam and bypass pipe, lifting track at plug site, excavation of invert, and barring/hammering/washing entire plug site to sound, clean rock. Best quote for concrete batched at portal is $180.00 per cu yd for 100 cu yd required.
4. Construction of bulkhead formwork, installation of reinforcing, pipes, valves and instrumentation, and grouting.
5. Stripping pipelines (fan and ducting left in place) and removal of equipment and personnel.
6. Five days of dozer work with supporting hand labor, and approximately 300 cu yd riprap.
7. Site supervision, inspection and certification by professional engineers.

B. PRELIMINARY AND ONGOING COSTS

1. Water Balance Survey:

Engineering time	$ 4,300
Equipment and materials	1,000
Travel and subsistence	1,200
Total estimated cost	$ 6,500

2. Discharge Treatment Plant Specifications:

Engineering time	$ 6,500

3. Routine Maintenance:

Inspection and gauge reading	-	(Board staff)
Equipment	$ 2,000	
Labor	500	
Materials (riprap, etc)	1,000	
Total estimated cost	$ 3,500/year	

C. ADDITIONAL COST FOR INTERNAL/PIUTE PLUG
(Assumed constructed immediately prior to Main Adit Plug)

Rehabilitation at 700' Level Haulage	$130,000
Concrete at Portal	17,000
Plug construction	60,000
Contingency @10%	20,000
Total estimated cost	$227,000

D. COST OF PLUGS IN MINOR ADITS
(Assumed constructed immediately after the Main Adit Plug)

1. Piute Landing Tunnel Plug:

Site Access and Cleanup	$ 12,000*
Plug construction	11,000
Estimated cost of plug	$ 23,000

2. Old Sawmill Adit Plug:

Site Access and Cleanup	$ 9,000*
Plug Construction	11,000
Estimated cost of plug	$ 20,000

*Tentative estimates as portals are caved.

E. POSSIBLE FUTURE TREATMENT PLANT.
(Subject to B.2)

1. Construction of a facility for short-term treatment (estimate) $250,000

2. Operation of AMD treatment facility, allowing for materials and minimal supervisions $ 5,000/year

4.0 MONITORING

Three factors relating to the effectiveness of abatement procedures at the Walker Mine will have to be monitored:

- The water level in the flooded mine workings and, hence, the rate at which the workings fill up following installation of a seal;

- The development of surface springs or seepage indicating escape of mine waters; and

- Precipitation, in order to determine a relationship between rainfall, snowmelt, rate of filling of mine workings, and possible surface seepage.

4.1 Water Level in Mine Workings

Continuous pressure head readings will be taken at the main adit plug to monitor water level. This will be accomplished by the remote continuous recording station specified in Section 4.7 of Addendum 1 to this report. Data should be collected from the recording as near to quarterly as possible. As the adit will be a dead-end after installation of the plug, the remote reading and recording instruments will be set inside the portal immediately inside the steel door so observers will not need to enter the adit. The instrument station will be set sufficiently far back from the door to avoid adverse effect on the power supply due to low temperatures during the winter months.

4.2 Surface Springs and Seepage

During the construction period, a survey of seeps, springs, and drainage channels (wet or dry) will be made around the area of the mine. Following completion of the main plug, these areas should be inspected visually on a quarterly basis to see that no new seeps are developed as the mine fills. If additional seepage is noted at

any time, water quality samples should be taken to assess the impact of the mine filling on that water source. In addition, quarterly observations of the mine adit to check leakage from around the plug should also be made.

4.3 Precipitation and Temperature

A rain gauge and temperature recorder should be installed between Middle and South Forks of Ward Creek. Data from these recorders should be collected during the scheduled site visits. This data would then be used to compare the mine filling with precipitation/snow to the extent to which mine filling can be related to direct infiltration. It can also be used to determine the effectiveness of the installed diversion system and whether or not modifications or remedial work are warranted.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Observations

5.1.1 Achievement of Primary Objective

The installation of a concrete bulkhead seal in the main 700 Level Access Adit to the Walker Mine at an elevation of approximately 6,200 ft is technically feasible, and would be effective in sealing off the main source of copper contamination to the Dolly and Little Grizzly Creeks, assuming there are no other hitherto unidentified outlets below the level of the Piute Shaft Landing Tunnel (approximately 6,585 ft elevation).

5.1.2 Potential Adverse Effects

Under present conditions of incomplete control of spring runoff entering subsidence sinkholes over the Central and Piute Orebody workings, there is a remote possibility that the back-up of water caused by a seal in the main Access Adit at the 700 Level could rise to the level of the Piute Shaft Landing Tunnel within 10 years. A reduced flow of AMD, of a quality similar to that presently flowing from the 700 Level Access Adit, would then discharge through the Piute Shaft into the Middle Fork of Ward Creek. It is very unlikely that the average volume discharged would be more than 10 gpm.

5.1.3 Mitigation of Adverse Effects

Rehabilitation and regular maintenance of a system of diversion ditches, designed to keep surface runoff in the catchments of the Middle and South Forks of Ward

Creek out of the subsidence slumps, and consequently out of the mine workings, would substantially increase the time it would take to flood the old workings up to the level at which discharge could occur. This remedial action could be expected also to reduce the probability of any flow out of the Piute Shaft to insignificant levels. See Section 5.2.(5) for further possible precautions.

5.1.4 Maximum Security Option

In addition to installation of a primary seal in the main 700 Level Access Adit and establishing effective diversion ditches around slumps, isolation of the Piute Section by installing a concrete bulkhead in the 700 Level haulage (the only connection between the Piute Section and the remainder of the mine to the south) could be expected to reduce the volume of any possible outflow of AMD through the Piute Shaft by about 90%.

The mine workings in the Piute Section would flood to the level of the natural water table. Only snowmelt or rain in the immediate catchment of the Piute subsidence slumps would enter the workings and, if the water table was close to overflow level, run out of the Piute Shaft Landing Tunnel at approximately 6,580 ft elevation. Minimal mixing with and contamination by the stagnant water in the flooded Piute workings would occur.

The South, Central, North and 712 sections of the mine would also flood to the level of the natural water table in each section. If this level should be above the Old Sawmill Adit (6,770 ft elevation at its intersection with the mine workings), it might be necessary to clean out this adit portal and install a bulkhead capable of withstanding the maximum head of 110 ft of water that would be developed if the workings were to fill with

water to the level of the subsidence slumps above the Central Section workings. As in the case of the Piute Section described above, only local snowmelt or rain runoff could be expected to enter the upper part of the workings and possibly overflow, without significant contamination by the stagnant water in the mine workings.

The time required for flooding in the mine workings to reach equilibrium in this worst-case scenario is estimated to be in excess of 15 to 20 years after two bulkhead seals had been installed.

5.1.5 Critical Appraisal of Maximum Security Option

Rehabilitation of the 700 Level haulage to gain access to the site of a possible internal plug would be more expensive and time-consuming than expected prior to visual inspection. Costs have been estimated on the basis of sluicing sludge with a jet of water pumped from flooded lower workings. Suspended solids would settle in the large sump of the Central and South Orebody workings below the 700 Level. Any residual turbidity emerging from the adit would be settled in the existing ponds below the portal.

Items leading to higher costs included:

a) Sludge cover on the floor of the haulage, which was generally deeper than expected, up to 18 inches in places.

b) The collapse of timber stope draw point chutes which has caused significant blockages with 30 to 50 tons of rock and timber lying in the haulage at four points, which would require tedious hand labor for clearing.

c) Deterioration of timber sets, which has exposed potentially dangerous bad ground at two locations and would require re-timbering to permit safe passage of personnel and equipment.

d) Clearing of timber and other materials buried in the sludge, which would require considerable manual labor.

e) Track in sections of the haulage that pass over shafts or rock-passes, which is supported on timber that might not now support the weight of a locomotive and concrete cars without reinforcement.

f) Rails that showed signs of corrosion and were absent over several hundred feet through the Central Section.

g) 5 x 10 ton Bilby-type mine cars parked in the haulage in the North Orebody Section, which would have to be removed. The condition of their wheel bearings could not be determined.

h) Collapse of the northern-most stope drawpoint chute in the 712 Orebody Section (Chute No. 208), which has almost blocked the haulage with 150 to 200 tons of broken rock and timber. Stulls and platforms loaded with broken rock could be seen in the open stope above the drawpoint, making conditions hazardous for removal of the blockage.

i) It was possible to crawl over the blockage at drawpoint No. 208 and continue northward on the 700 Level haulage. Up to 3'-6" of a thick, opaque, azure blue colloidal suspension was backed up behind the blockage. The volume held back was estimated at 90,000 to 100,000 gallons.

The investigating team did not proceed more than 300 ft beyond the No. 208 drawpoint, but selected and measured tunnel dimensions at a suitable site for a plug about 150-ft north of No. 208 drawpoint. The time required for taking measurements, the 39^{0} F "water", and the need to return to the portal within the predicted 5½ to 6 hours precluded further progress into the Piute Section.

Accurate measurement of water flow in the 700 Level haulage was not possible. A portable direct-reading flowmeter was used to determine flow velocity at points where the cross-sectional area of the channel could be estimated reasonably. From these measurements it was inferred that, of about 560 gpm flowing into the workings above the 700 Level, less than 300 gpm were being discharged through the main 700 Level Adit. The balance is presumed to return as recharge to the groundwater system.

Observation of the rock mass quality between the 712 and Piute Orebodies and calculation of the permeability of the pillar between the stoped out areas in these orebodies indicate that, although a plug in the 700 Level haulage between the 712 and Piute Sections would initially halt a potential 10 gpm outflow through the Piute Shaft, a flow of up to 1 gpm could be established through the pillar after a few years.

5.2 Conclusions

1. Installation of a plug in the 700 Level Adit, some 2,700 ft from the portal, would stop the discharge of Acid Mine Drainage (AMD) from the Walker Mine.

2. Water backed up in the mine workings would probably reach equilibrium below the 6,500 ft elevation, as the increasing head could be expected to increase the rate of recharge of the groundwater system.

3. Recharge of the groundwater system would be dispersed over the full strike length of the workings, maximizing the attenuation effect on AMD re-entering the surrounding rock mass. No seepage has been located which can be identified as a point at which water recharged from the mine workings eventually reaches surface.

4. The cost of rehabilitation of the 700 Level haulage and installing an internal plug between the 712 and Piute Section is considered excessive for insurance against the low risk of AMD emission through the Piute Shaft (see Section 3.2 (3)).

5. A more cost-effective back-up to a single plug in the 700 Level Adit would be:

   a) Rehabilitation and maintenance of diversion channels around surface sinkholes, to minimize inflow of runoff from rain or snowmelt.

   b) Regular monitoring of water level in the mine workings, by means of pressure gauges at the plug with remote-reading facilities at the portal.

   c) The facility to open valves on the 4-inch diameter pipes through the plug, to relieve any excessive build up of water in the workings. Two 4-inch diameter pipes, 30 ft long, could pass over 2,400 gpm under 400 ft head, equivalent to the peak expected instantaneous rate of inflow.

d) Adequate notice of impending overflow of water accumulating in the mine, through the Piute Shaft, would be available to permit construction of a small treatment plant at the portal of the 700 Level Adit.

By these means, the small and short-duration release of any possible excess inflow into the mine could be neutralized without risk of contaminating an unaffected catchment (Ward Creek).

e) The cost of such a treatment facility (should it ever be needed) would be less than the total cost of the internal plug and would be deferred for probably not less than ten years (see Section 3.3).

f) This proposal provides for a means to direct any possible emission of AMD from the Walker Mine, under controllable conditions, through a neutralizing facility, provided the build up of water pressure behind a plug did not divert excessive quantities of AMD through natural outlet(s), which could deliver it to surface without adequate natural attenuation of its acid and metal content.

6. Installation of a plug in the main adit of the Walker Mine need not necessarily sterilize the mine for future exploitation. Should it become feasible at some future time to mine the known mineral resource, the valves on pipes through the plug could be opened and the mine water drained in less time than it took to enter the workings. The workings could be drained at a controlled rate during the period required to plan mining operations and secure the relevant permits. The AMD could be treated at a rate of, say, 500 to 800 gpm and discharged to surface waters. It is not possible to comment on or endorse the economic feasibility of such a course of action without knowledge of the potential ore reserves.

5.3 Recommendations

Immediately:

1. Undertake minor rehabilitation of diversion channels around Central Orebody sinkholes;

2. Undertake minor rehabilitation of diversion channels around the southern sinkholes above the Piute Orebody and establish a diversion channel around the northern end; and

3. Conduct a flow and water quality balance study on water movements from the mine workings above 700 Level, along 700 Level Haulage and Adit, entering and leaving the workings below 700 Level, and in the Dolly Creek from the mine portal to its confluence with Little Grizzly Creek.

Then, subject to the findings of 3:

4. Install a single plug in the 700 Level Adit approximately 2,700 ft from the portal;

5. Monitor water levels in the mine workings by means of gauges reading pressure behind the plug; and

6. Prepare a contingency plan for future construction and operation of a small treatment plant at the 700 Level Adit Portal, to neutralize AMD that might have to be discharged periodically (several years after installation of the plug) to relieve any excessive build up of water that might threaten to overflow out of the Piute Shaft.

Note: Implementation of Item 3 would require:

a. Channelization of drains and construction of simple flow measurement stations at up to six points in the 700 Level Haulage and Adit;

b. Establishment of up to five flow measurement stations between the 700 Level Adit portal and the Dolly Creek's confluence with Little Grizzly Creek; and

c. Careful measurement of water flow quantity and quality at each measuring station, to determine the entire flow pattern between Walker Mine workings above 700 Level and Little Grizzly Creek.

6.0 GLOSSARY

Where used in this report, the following terms will be defined as follows:

Adit: A horizontal or nearly horizontal passage driven from the surface for the working or drainage of a mine;

Aquaclude: A geologic formation that prevents the passage of gound water in significant amounts;

Asperities: Protrusions forming roughness or jaggedness on the surfaces of the walls, roof and floor of a tunnel/adit;

Bulkhead: (i) A wall or partition erected to resist ground or water pressure; (ii) A tight partition of wood, concrete or metal used for retainment of fluids in a tunnel or channel; also used for protection against gas or fires in mines;

Bullnose: The narrow-angled corner formed where the walls of two tunnels intersect at less than 90^{0};

Haulage: Underground level either along and inside an orebody or closely parallel to it, usually in the footwall. On this level, the mineral drawn from stopes is transported to a shaft for hoisting or to surface through an adit. Haulage ways include levels and connecting passage ways (crosscuts) and are also used to transport supplies, waste rock, and for movement of personnel;

Portal: Any entrance to a mine, more usually the surface entry to an adit; and

Stope: An excavation from which ore has been extracted in a series of steps usually applied to steeply inclined or vertical veins.

APPENDIX I
CONCRETE MIX DESIGN RECOMMENDATIONS

by
Mr. Robert F. Adams, P.E.
Consulting Concrete Engineer

ROBERT F. ADAMS, P.E.
CONSULTING CONCRETE ENGINEER
5971 ANNRUD WAY
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(916) 428-9121

NOV 1985

12 NOVEMBER 1985

Mr. Don Poulter
Steffen Robertson & Kirstan
7510 W. Mississippi Ave., Suite 210
Lakewood, CO 80226

Dear Mr. Poulter:

Subject: Concrete for Tunnel Plug, Walker Mine
Your Project No. 06901

I have reviewed your Draft Final Feasibility and Design Report for the Walker Mine pollution abatement project. You requested that I furnish my recommendations for concrete for the tunnel plug, the key feature of this project. This reports my recommendations for materials for concrete and concrete for the tunnel plug. A discussion gives the reasons for some of the recommendations and other matters pertaining to construction of the tunnel plug.

The low pH 4.1 of the acid mine water makes the concrete requirements of more concern than usual. Had the pH been above 5, there would have been less concern.

MATERIALS FOR CONCRETE

Aggregate shall meet the requirements of ASTM 633 for use in a severe weathering region. The sand shall be a natural sand. The coarse aggregate shall be a crushed limestone Size 57 (1 inch to No. 4) or Size 67 (3/4 inch to No. 4). The amount of flat and elongated particles in the coarse aggregate not exceed 15 percent. (Corps of Engineers Test CRD-C119). The sand and coarse aggregate may be rejected if the specific gravity, saturated surface dry basis, is less than 2.60.

Portland Cement shall be Type II, low alkali, meeting the requirements of ASTM C150.

Pozzolan shall be Class N,, natural or F, fly ash, meeting the requirements of ASTM C618. If a fly ash, Class F, pozzolan is used, the ignition-loss shall be less than one percent.

Air Entraining Admixture shall meet the requirements of ASTM C260.

Water Reducing-Retarding Admixture shall be an unmodified lignosulfonate meeting the requirements of ASTM C494, Type D, supplied as a 40 percent solution.

Silica Fume shall be EMSAC F-100 as supplied by Elkem Chemicals, Inc., Pittsburgh, Pennsylvania.

Water- Use good quality water for mixing water. Do not use mine water. Sulfates should not exceed 1500 ppm and chlorides should not exceed 2000 ppm. The water should not contain oil or material that would affect the setting of portland cement.

CONCRETE PROPORTIONS AND PROPERTIES

Cement Content:

Portland cement - 450 pounds per cubic yard
Pozzolan - Class N - 150 pounds per cubic yard
or Class F - 200 " " " "

Air Content: 5+1 percent

Slump: 4 to 7 inches

Water-Reducing Admixture: Use 8 fluid ounces of water-reducing admixture per 100 pounds of cementing material.

Silica Fume: Use EMSAC F-100 at dosage of 2 gallons per 100 pounds of portland cement.

Design Strength of Concrete: 3000 psi at 28 days. (The strength of concrete as specified above should far exceed the design strength under normal conditions.)

DISCUSSION

The following gives some of the reasons for some of the above recommendations and other discussion and recommendations pertaining to the job.

Low permeability of the concrete is one big factor in reducing aggressive chemical attack on concrete such as that caused by sulfates and acids. Lower permeability is achieved by lower water-cement ratio (which means higher cement content, other things being equal), air entrainment, use of pozzolans and use of silica fume (a rather special pzzolan).

The rather low sulfate content of the mine water, 146 ppm (in your Table 2) does not justify the use of Type V portland cement, a premium price cement. The use of Type II portland cement with pozzolans provides protection from sulfates, if needed, equivalent to a Type V portland cement alone, except in the most severe sulfate conditions.

The use of a limestone coarse aggregate is recommended as a sacrificial aggregate for the acid water. Limestone coarse aggregate is frequently used in concrete pipe for sanitary sewers where acid conditions sometimes form. The closest commercial source of limestone coarse aggregate known to me is Sierra Rock Co., Placerville, a distance of about 150 miles from the jobsite.

Another advantage to limestone aggregate concrete is that it has a lower coefficient of thermal expansion, hence less thermal volume change.

The tunnel plug, being 12 by 12 by 15 feet in section is "mass concrete" for which there is sometimes concern about temperature rise in the concrete and temperature differences which sometimes cause cracking. It is believed that with the cement contents recommended there will be no problem because the concrete is placed against rock in a rather stable temperature environment and is not exposed. Another reason for using a pozzolan is to lower the temperature rise of the concrete substantially.

My recommendations have included the use of silica fume, a "super" pozzolan which reduces the permeability of concrete by up to two orders of magnitude. Silica fume is recommended because of this, and your report notes a 100 year expected life for the job. Unfortunately, the particular silica fume recommended is rather expensive and will increase the cost of the concrete some 30 to 50 dollars per cubic yard, a small amount considering the total cost of the job and believed to be justified for this job. (See attached sales literature for EMSAC silica fume.)

Your report mentions the use of an expansive agent in the concrete. This has not been recommended because the expansion comes at the wrong time in this kind of job. This in grout would be OK. The use of shrinkage-compensating cement has not been recommended either because of some problems with this cement.

The closest ready mix producer is in Portola, some 25 to 30 miles away - over a dirt road part of the way at least. If concrete is to come from this source, the cement, pozzolan and admixtures should not be added until the ready mix truck gets to the jobsite. It would seem very desirable to bring in a very small portable batch plant to batch at the jobsite. Such plants are available in the area.

Your report mentions rock cleanup prior to concreting. This is a must. The floor particularily should be cleaned of all loose rock, mud, debris, etc. etc.

It is suggested that vibration of the concrete in the lower portion of the plug be required, particularly on the floor and against rock and forms and around the pipe - and lower slump concrete, 4 to 5 inches, can and should be used here. In the crown, more slump is required - 5-1/2 to 7 inches slump.

The pump slickline should be kept buried in the crown, pumping to refusal to fill in the arch as well as possible, and backing out the slickline as the arch is filled.

Grouting the arch will be necessary. And from your experiences, grouting the sides appears to be necessary also. It is suggested grouting wait at least a month to allow the plug to cool and stabilize dimensionally. The peak temperature might occur at about 5 to 7 days.

Wood forms would be better than steel forms because they would provide more insulation.

Limited trial mixes should be made to establish a recommended starting mix. This should be done after the Contractor has selected his material sources.

Job inspection and quality control should be done to insure that the requirements of the specifications are followed and that good construction practices are followed. Most importantly, the air content of the concrete should be controlled by tests.

This report was reviewed by a colleague, Mr. Lewis H. Tuthill who concurred with my recommendations.

Please advise if you have any questions or I can furnish further information or help.

Sincerely,

Robert F. Adams

Robert F. Adams, P. E.

Some Addresses

Source of EMSAC F-100. Hill Brothers Chemical Co., 410 Charcot Avenue, San Jose, CA 95131. Phone 408-263-3131

Small jobsite concrete plant - Engineered Concrete Placement, Box 51333, Middletown, CA 95461, Phone 707-987-0151.

Source of Class N Pozzolan - Lassenite Industries, Inc., produced this at Hallelujah Junction about 35 miles East of Portola. Believe this still being produced. Office for this company now believed to be in Oroville, or Yuba City, California. Phone might be 800-221-3134.

Limestone Aggregate - Sierra Rock Co., 1845 Quarry Road, Placerville, CA 95667, Phone 916-622-8571.

White Cap Ready Mix, Portola, Bob Higgins, 916-832-4225

ADDENDUM 1

TO

WALKER MINE PROJECT

FINAL

FEASIBILITY AND DESIGN REPORT

CONTRACT NO. 4-051-150-0

WALKER MINE PROJECT
700 LEVEL ADIT PLUG
AND
SURFACE DIVERSION DITCHES
TECHNICAL SPECIFICATIONS

Prepared for:

California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, California 95816

Prepared by:

Steffen Robertson and Kirsten (Colorado) Inc.
3232 South Vance Street, Suite 210
Lakewood, Colorado 80227

November, 1985

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION

1.1 General
1.2 Definitions
1.3 Permits

2.0 CONTRACTOR'S RESPONSIBILITY

3.0 INSPECTION OF WORK

4.0 PLUG SPECIFICATIONS

4.1 Plug Location and Dimensions
4.2 Site Preparation

4.2.1 Access
4.2.2 Mine Water Diversion
4.2.3 Plug Site

4.3 Formwork
4.4 Concrete

4.4.1 General
4.4.2 Applicable Codes of Specifications
4.4.3 Cement
4.4.4 Water
4.4.5 Concrete Aggregates
4.4.6 Admixtures
4.4.7 Curing Aids and Coating
4.4.8 Handling and Storage of Materials

4.4.8.1 Aggregate
4.4.8.2 Cement

4.4.9 Proportioning
4.4.10 Batching of Concrete Mixture

4.4.10.1 Cement and Aggregate Measurements
4.4.10.2 Water Measurement
4.4.10.3 Moisture Content
4.4.10.4 Admixture Measurement
4.4.10.5 Batching Plant

4.4.11 Mixing and Transportation of Concrete

4.4.11.1 Mixing Equipment
4.4.11.2 Mixing and Delivery
4.4.11.3 Control

TABLE OF CONTENTS (con't)

Page No.

4.4.11.4 Retempering

4.4.12 Testing of Concrete

4.4.12.1 Strength Tests
4.4.12.2 Slump Tests
4.4.12.3 Tests for Entrained Air

4.4.13 Enforcement of Strength Requirements

4.4.13.1 Definition of Failure
4.4.13.2 Failure of Test Specimens

4.5 Piping
4.6 Grouting
4.7 Instrumentation
4.8 Cleanup

5.0 DIVERSION DITCHES

5.1 Scope
5.2 Definitions
5.3 Clearing and Grubbing

5.3.1 General
5.3.2 Protection
5.3.3 Extent of Removal
5.3.4 Disposal
5.3.5 Timing

5.4 Riprap Materials
5.5 Riprap Bedding Material
5.6 Existing Ditches
5.7 New Ditches

1.0 INTRODUCTION

1.1 General

In the following paragraphs, technical specifications are presented for the various work items noted. Specific items concerning contractual agreements, environmental controls, and health and safety requirements that must be complied with by the Subcontractor, have not been included as part of these specifications.

The work to be performed under these specifications is the construction of a concrete plug with drains in the 700 Level Adit of the Walker Mine, diversion of mine waters during plug construction, remedial work on the diversion ditches around the subsidence above the Piute and Central Orebodies and construction of a new ditch around the Piute Orebody. Also included in the work is the reclamation of the disturbed areas resulting from the construction of these facilities. This includes the replacement or repair of portal doors which are currently in place.

The structures specified herein are to be constructed to the lines and grades shown in the construction drawings to meet the technical requirements in these specifications.

While every effort has been made to have specifications and construction drawings free of error and ambiguity, the Subcontractor is responsible for bringing any such points to the attention of the Owner's representative before execution of the work to allow correction and/or interpretation.,

For any discrepancy or ambiguity in the specifications, construction drawings, codes, standards, or regulations, it is the intent of these specifications that the most restrictive interpretation shall apply unless intepreted otherwise by the Engineer.

1.2 Definitions

a) "Agency", when referred to, shall be understood to mean a duly authorized representative of the California Regional Water Quality Control Board - Central Valley Region.

b) "Engineer", when referred to, shall be understood to mean a duly authorized representative of Steffen Robertson and Kirsten (Colorado) Inc. (SRK); SRK is a subcontractor to the Agency.

c) "Contractor", when referred to, shall be understood to mean the party which has executed a contract agreement for the work with the Agency.

d) "Regulatory Agencies", when referred to, shall be understood to mean duly authorized representatives of such public agencies that have jurisdiction over this project in addition to the Agency.

e) "Drawings", when referred to, shall be the 06901 series drawings for Contract No. 4-051-150-0.

1.3 Permits

All permits required to execute and complete the work under these specifications shall be the responsibility of the Contractor. This includes, but is not limited to permits required for 1) mobilization and demobilization of equipment of the site, 2) execution of underground work, and 3) access and clearing for construction of the diversion ditches, and 4) any permits required by Regulatory Agencies.

The Agency will provide the permit for right of entry to the property on which the mine portal is located.

2.0 CONTRACTOR'S RESPONSIBILITY

The Contractor shall carefully examine all of the technical specifications and construction drawings, and the site of the work. He shall fully inform himself as to the character of all conditions at the site, local and otherwise, affecting the execution of the work, including those conditions to which Federal, State, and local safety and/or health laws and regulations may be applicable. Failure to comply with the requirements of this section shall not relieve the Contractor of responsibility for complete performance of the work.

It shall be the sole responsibility of the Contractor to determine and satisfy himself, by such means as he considers necessary or desirable, as to all matters pertaining to this work including, but not limited to:

- The location and nature of work;
- Climatic conditions;
- The nature and conditions of the terrain;
- Geologic conditions at the site;
- Transportation and communication facilities;
- Location and nature of construction materials available for use in the work;
- Other construction or operation in the project area that may be underway simultaneously with the construction work for the adit plug or diversion ditches; and
- All other factors that may affect the cost, duration, and execution of the work.

Before accepting the work, the Contractor shall acknowledge in writing that he has inspected the site and determined the characteristics of the work and the conditions indicated above.

Technical and other information relating to the site of the work is available in the following reports:

1) "Walker Mine Project, Feasibility and Design Report", Contract NO. 4-051-150-0 (SRK, 1985); and
2) Open file data through the Agency.

This report and data are provided for the Contractor's information and convenience. Neither Agency nor SRK will assume any responsibility for the Contractor's interpretation of, or conclusions reached from, examination of such data.

The performance of items specified to be submitted for review and comment by the Engineer remain the responsibility of the Contractor.

3.0 INSPECTION OF WORK

Full-time inspection of all construction activities under this work shall be as defined in the contract documents between the Agency and their subcontractors. Inspection of all work shall be carried out by the Engineer while such work is in progress. Notwithstanding such inspection, the Subcontractor shall be held responsible for the acceptability of the finished work.

The Engineer and/or his representatives shall at all times have access to the work whenever it is in preparation of progress. The Contractor shall fully cooperate with the Engineer to facilitate inspection. The Contractor shall give the Engineer ample notice of readiness of the work for inspection to see that the work is performed in accordance with the requirements set forth in the technical specifications and construction drawings. All work done by the Contractor shall meet the approval of the Engineer, but the detailed manner and methods of doing work shall be the responsibility of the Contractor.

If any work should be covered up without prior review or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination and be properly restored at the Contractor's expense.

It is the intent of these specifications that all materials will be inspected and tested by the Engineer before final acceptance of the work. Test data will be made available to the Contractor for inspection at his option. Any part of an item of work which is found not to comply with the specification requirements or which is improperly located or constructed shall be removed and replaced to the satisfaction of the Engineer, at the Contractor's expense.

4.0 PLUG SPECIFICATIONS

4.1 Plug Location and Dimensions

The plug shall be located as shown in the drawings. The approximate coordinates of the plug center are 12,950 N, 11,420 E. The actual location will be field sited by the Engineer. The plug site shall be surveyed and recorded by a Contractor for the Agency. The plug shall be 15 ft in length.

4.2 Site Preparation

4.2.1 Access

Access and remedial work required to maintain access to the plug site during construction shall be the responsibility of the Contractor. Ventilation in the adit and working area shall remain in-place and in working order upon completion of construction. All work shall be done in accordance with the required mine health and safety regulations.

4.2.2 Mine Water Diversion

Mine waters running through the plug site shall be diverted such that the plug (including form work) is constructed in the dry. The diversion system shall be maintained until such time that water against the plug will not adversely effect the completion of the concrete placement. The method of diversion and schedule shall be submitted to the Engineer for approval prior to construction. Such approval does not relieve the Contractor from the responsibilities for the performance or adequacy of the diversion system.

4.2.3 Plug Site

The plug site shall be cleared and prepared to ensure an adequate bond between the rock and concrete plug. All loose rock within the plug site shall be spawled off to sound, intact rock. The rock surface shall be cleaned of all loose and fine materials. Limits of the site preparation shall extend a minimum of 5 ft past either end of the plug limits.

Methods of site preparation shall be proposed by the Contractor and submitted for review and comment by the Engineer. This in no way relieves the Contractor from his responsibility to accomplish the required site preparation in an efficient and timely manner. The prepared site shall be approved by the Engineer prior to placement of concrete.

4.3 Formwork

The formwork for the bulkheads shall be the responsibility of the Contractor. It shall be constructed of good quality material and in such a manner as to provide an efficient seal for containment of the concrete and any grout that may be injected. The design of the formwork shall be in accordance with ACI 347, "Recommendated Practice for Concrete Formwork", and of sufficient strength to withstand the fluid pressure of the concrete and any increased pressures due to grouting or concrete placement. A reference design is provided in the drawings.

The Contractor shall be responsible for the design and safety of form work. Completed forms in place will be approved by the Engineer prior to concrete placement to check all lines, grades, and tolerances as shown in the drawings. A reference design showing drain pipe locations is provided in the drawings.

4.4 Concrete

4.4.1 General

Contained in the following sections are concrete materials specification, recommended mix specifications, and handling requirements for the concrete plug. Concrete mixing, delivery and placement shall be in accordance with ACI Standards and Specifications.

The selected method and procedures for mixing, transportation and placing the concrete shall be submitted to the Engineer for review and comment prior to construction mobilization.

All material testing shall be done to ASTM specifications where applicable or unless otherwise specified. Under no circumstances shall delivery scheduling or placement methods be such that a cold joint will be formed in the plug.

The Contractor shall locate and supply all materials and equipment necessary for this work, including water, concrete aggregate, additives, and vehicles for transport of concrete to the plug location. Once all materials have been located, the Contractor shall prepare a trial mix for testing to check the adequacy of the mix design. The mix design and test results shall then be submitted to the Engineer prior to construction.

Before any concrete is placed, the mix design shall have been approved by the Engineer, formwork and the prepared site shall have been inspected by the Engineer, and tests of all materials and mechanical operation of all equipment shall have been completed.

4.4.2 Applicable Codes of Specifications

The following publications of the latest edition are a part of this specification, except as noted within this specification.

American Society for Testing and Materials

ASTM C-31	Specification for Making and Curing Concrete Test Specimens in the Field
ASTM C-33	Specification for Concrete Aggregates
ASTM C-39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C-94	Specification for Ready-Mixed Concrete
ASTM C-143	Method of Test for Slump of Portland Cement Concrete
ASTM C-150	Specification for Portland Cement
ASTM C-171	Specification for Sheet Materials for Curing Concrete
ASTM C-172	Method of Sampling Fresh Concrete
ASTM C-231	Test for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C-260	Specification for Air Entraining Admixtures for Concrete
ASTM C-309	Specification for Liquid Membrane - Forming Compounds for Curing Concrete
ASTM C-494	Specification for Chemical Admixtures for Concrete

American Concrete Institute Publications

ACI 211.1	Recommended Practice for Selected Proportions for Normal and Heavy Weight Concrete
ACI 214	Evaluation of Strength Test Results of Concrete
ACI 304	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 306	Recommended Practice for Curing Concrete
ACI 309	Recommended Practice for Consolidation of Concrete
ACI 311	Recommended Practice for Concrete Inspection
ACI 347	Recommended Practice for Concrete Formwork

4.4.3 Cement

Cement shall be an approved brand of Portland Cement complying with all the requirements of ASTM C-150, Type II.

4.4.4 Water

The water used for mixing concrete will be clean and free from oils and other substances deleterious to concrete. Sulphates shall not exceed 1,500 ppm and chlorides shall not exceed 2,000 ppm. Mine water is not acceptable for use in the concrete mix.

4.4.5 Concrete Aggregates

Aggregate shall meet the requirements of ASTM 633

for use in a severe weathering region. The sand shall be a natural sand. The coarse aggregate shall be a crushed limestone Size 57 (1 inch to No. 4) or Size 67 (3/4 inch to No. 4). The amount of flat and elongated particles in the coarse aggregate not exceed 15 percent. (Corps of Engineers Test CRD-C119). The sand and coarse aggregate may be rejected if the specific gravity, saturated surface dry basis, is less than 2.60.

4.4.6 Admixtures

The following admixtures shall be used in the design mix:

1. Pozzolan shall be Class N, natural or F, fly ash, meeting the requirements of ASTM C618. If a fly ash, Class F, pozzolan is used, the ignition loss shall be less than one percent.
2. Air Entraining Admixture shall meet the requirements of ASTM C260.
3. Water Reducing-Retarding Admixture shall be an unmodified lignosulfonate meeting the requirements of ASTM C494, Type D, supplied as a 40 percent solution.
4. Silica Fume shall be EMSAC F-100 as supplied by Elkem Chemicals, Inc., Pittsburgh, Pennsylvania, or equivalent.

4.4.7 Curing Aids and Coating

All materials used for curing shall conform to ASTM C-309. All materials used for coating shall conform to ASTM D-977. These apply to the front face of the plug once the formwork is removed.

4.4.8 Handling and Storage of Materials

4.4.8.1 Aggregate

Stored aggregate shall be handled in such manner as to prevent segregation of sizes and to avoid the inclusion of dirt and/or foreign materials in the concrete. Material shall be removed from stockpiles in approximately horizontal layers.

4.4.8.2 Cement

Cement in sacks or barrels shall be stored under a weather-tight cover with the floor raised at least one-half foot above the ground. Cement that has hardened or partially set shall be removed from the site and not used.

Bulk cement shall be stored in airtight and weatherproof bins with access for inspection.

4.4.9 Proportioning

It is the intent of this specification to secure, for every part of the work, concrete of homogeneous structure which, when hardened, will have the required strength, impermeability and resistance to chemicals and weathering.

Proportions shall be selected to produce concrete with a minimum 28-day compressive strength of 3,000 psi. The recommended design mix is as follows:

1. Cement Content:
   Portland cement - 450 pounds per cubic yard
   Pozzolan - Class N - 150 pounds per cubic yard
   or Class F - 200 pounds per cubic yard
2. Air Content: 5 + 1 percent
3. Slump: 4 to 7 inches (see Appendix I of SRK Feasibility and Design Report for explanation).
4. Water-Reducing Admixture: Use 8 fluid ounces of water-reducing admixture per 100 pounds of cementing material.
5. Silica Fume: Use EMSAC F-100 at dosage of 2 gallons per 100 pounds of Portland cement.

4.4.10 Batching of Concrete Mixture

The measurement of materials for concrete batching shall be in accordance with ASTM Specification C-94, Sections 6 and 7. After the equipment is set in operating position, the batching plant shall be inspected by an authorized agency and scales checked for accuracy. An inspection seal or tag properly documented shall be attached to the equipment.

4.4.10.1 Cement and Aggregate Measurements

The Contractor shall measure cement and aggregate by weighing only. Weighing shall be accurate to within 1.0 percent of the required weight. Cement may be measured in standard bags, however, no fraction of a bag shall be used unless weighed.

4.4.10.2 Water Measurement

The Contractor shall measure the water by

volume or by weight. The device for the measurement of the water shall be readily adjustable and under all operating conditions shall have an accuracy within 1.0 percent of the quantity of water required for the batch.

4.4.10.3 Moisture Content

The Contractor shall provide a moisture meter to measure the amount of free water in fine aggregates within 0.3 of a percent. The Contractor shall compensate for varying moisture contents of fine aggregates and change batch weights of materials if necessary before batching.

4.4.10.4 Admixture Measurement

Admixtures shall be used strictly in accordance with manufacturer's recommendations. All admixtures shall be added to the concrete mixture with dispensing equipment furnished by the manufacturer.

4.4.10.5 Batching Plant

Bins

Bins with adequate separate compartments for fine aggregates and for each required size of coarse aggregate shall be provided in the batching plant. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper. Means of control will be provided so that, as the quantity desired in the weighing hopper is approached, the material

may be added slowly and shut off with precision. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully.

Scales

The scales for weighing aggregates and cement shall be of either the beam type of the springless dial type. Scales shall be accurate within 1.0 percent under operating conditions.

4.4.11 Mixing and Transportation of Concrete

Concrete shall be mixed and transported in equipment approved by the Engineer in a manner which will deliver uniform and homogeneous concrete to the forms. Mixing and transporting shall be in accordance with the appropriate ACI and ASTM codes. Revisions to applicable codes to accomodate field conditions shall be approved by the Engineer prior to construction.

4.4.11.1 Mixing Equipment

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers or truck agitators. Truck mixers shall be equipped with revolution counters and water meters. Stationary mixers shall be equipped with a timing device that will not permit the batch to be discharged until the specified mixing time has elapsed.

Each unit shall have attached thereto, in a prominent place, a metal plate or plates on which are plainly marked, the various uses for

which the equipment is designed, the capacity of the drum or containers in terms of volume of mixed concrete and the speed of rotation of the mixing drum, blades, or paddles.

4.4.11.2 Mixing and Delivery

Concrete shall be mixed and delivered alongside the forms by one of the methods listed below. It should be noted that transport equipment from the portal to the plug site will be rail mounted.

Central Mixed

The materials completely mixed in a stationary mixer and transported to the delivery point in a truck agitator, a truck mixer operating as a truck agitator, a non-agitating truck approved by the Engineer or by pumping through a pipeline.

Shrink Mixed

The materials partially mixed or blended in a stationary mixer and the mixing completed in a truck mixer enroute to the job. This shall only be allowed provided the stationary mixer is located at the mine portal.

Transit Mixed

The materials placed into the truck mixer and all mixing done in the truck mixer.

4.4.11.3 Control

The Engineer will make slump tests from

samples taken at approximately the one-quarter and three-quarter points of the load. When the above pairs of slumps differ by more than two inches, the truck or agitator shall not be re-used until the condition causing the non-uniformity has been corrected.

The Engineer will make air content measurements at the beginning and approximately the one-half points of the load. When the air content is measured to be outside the limits of the specified content, the remainder of the load shall be refused. Subsequent loads will be tested prior to placement, and as above, to see that the problem has been corrected.

4.4.11.4 Retempering

Water shall not be added to mixed batches of concrete to increase the slump without specific written approval of the Engineer.

4.4.12 Testing of Concrete

The following tests will be performed by the Engineer on work performed under this Specification.

4.4.12.1 Strength Tests

During the course of construction, tests will be made to determine whether the concrete, as being produced, complies with the standards of quality specified in Section 4.4.9. The actual testing will be performed by an approved testing laboratory.

Preparation of Test Specimens

The concrete for test specimens will be sampled in accordance with ASTM C-172. The specimens will be cast and cured in accordance with ASTM C-31 and will be tested in accordance with ASTM C-39. Each test specimen will be tagged with the location of the sampled batch in the structure, the mix proportions or number, the slump and the type and brand of cement.

Number of Test Specimens

Not less than three (3) test specimens will be made for each 40 cubic yards, or portion thereof, of concrete placed in any one shift.

Age of Test Specimens

One or more test specimens will be broken at seven (7) days and the remaining specimens will be broken at twenty-eight (28) days.

4.4.12.2. Slump Tests

Slump tests will be made in accordance with ASTM C-143.

4.4.12.3 Tests for Entrained Air

The entrained air content of fresh concrete will be determined in accordance with ASTM C-231.

4.4.13 Enforcement of Strength Requirements

4.4.13.1 Definition of Failure

Cast Specimens

The test specimens cast in the field shall be considered to have failed the strength requirements when the average of all the strength tests or the average of any five consecutive strength tests is less than the specified strength or when more than one test in ten has an average value less than 90 percent of the specified strength. A strength test shall be the average strength of at least two companion cylinders.

Cored Specimens

The concrete represented by cored specimens shall be considered to have failed the strength requirements when the average strength of three specimens falls below 85 percent of the specified strength.

4.4.13.2 Failure of Test Specimens

When test specimens are made, cured, and tested in accordance with Section 4.4.12 of this specification, fail as defined above, the Engineer may require the following action be taken:

Testing of Cored Specimens

Specimens shall be secured, prepared and tested in accordance with ASTM C-42.

The Engineer will specify the location where each core specimen shall be secured. No more than three cores shall be taken from each portion of the structure for which cast test specimens have failed, as defined in Section 4.4.13.1 above.

Cored specimens shall be tested no later than sixty (60) days after the concrete was placed unless otherwise approved by the Engineer.

Where cored specimens fail as defined in Section 4.4.13.1 above, the Contractor shall strengthen or replace the structure in accordance with a plan approved by the Engineer.

4.5 Piping

Two drain pipes through the concrete plug shall be installed as shown in the drainings. The pipes shall be 4-inch diameter stainless steel pipes. The values shall be as specified in the drawings or equivalent. The valve types and materials are subject to approval by the Engineer prior to installation.

Rubber water stops shall be placed around the pipes as shown in the drawings. If pipe connections are required within the concrete plug, they shall be threaded joints unless otherwise approved by the Engineer. Pipe connections shall be sufficiently tight to withstand up to 600 psi pressure.

4.6 Grouting

Grouting shall be done in areas where ever needed to provide a tight seal between the rock and concrete. Grout tubes shall be placed such that air entrapment does not occur in voids. A return line shall be installed at each location to provide a means of determining total void filling with grout. Placement of the grout lines is subject to the approval of the engineer.

Grouting may not be done within the first seven days after concrete emplacement. Grout pressures shall not exceed 1,500 psi. The grout shall be of a neat mix using sulfate resistant Portland cement. Chemical grouts may be used upon approval of the Engineer.

4.7 Instrumentation

A pressure gage shall be installed on one drainpipe and connected to a data logger as shown in the drawings. The equipment required is specified below. Installation and connection of the equipment shall be done as specified by the supplier. Routing of the readout lines shall be such as to protect them from damage.

The instrumentation installed shall be as listed below or equivalent. The supplier of the equipment itemized below is available upon request.

- Wekslar Gage - No. AA4-4-2
- TERRATRAC Model T/1015 Data Logger with 2,000 reading capacity; int. clock; in portable heavy-duty, gasketed case; battery-pak; signal connectors.
- Extended Operation Battery Pack (6 mo. of daily readings)
- Battery Charger (120VAC)
- HP-41CX Advanced Calculator (with programming for Interrogation; Extended Memory Module; HP-IL Module)
- Precision Pressure Transducer (SENSOMETRIC Series 97, 250 psig)

- Instrument Signal Cable (non-direct burial, 3 conductor and 100% shield)

Unless otherwise arranged and agreed to by the Agency, the Contractor shall be responsible for the selection, procurement and installation, operation of the above or equivalent instrumentation system.

Also, the Contractor shall be responsible to see that the instrumentation system is maintained in good condition and is properly operating at the time of acceptance of the work by the Agency. The Contractor shall also provide an operating warranty of the equipment for one full year following acceptance of the work by the Agency.

4.8 Cleanup

All materials used during construction and not built into the plug shall be removed from the adit and portal area, including the formwork at the face of the mine plug. Any support placed in the adit by the Contractor will be left in place.

The portal, the portal doors, and immediately surrounding area shall be left in a safe and operable condition. Reclamation of disturbed areas outside the portal shall consist of removal of all equipment and unused or discarded materials. The site shall be graded to re-establish original drainage conditions.

5.0 DIVERSION DITCHES

5.1 Scope

The work under this specification includes clearing, grubbing, and excavation for a diversion ditch as shown in the drawings, and remedial work for existing ditches.

5.2 Definitions

1) Clearing is defined as the cutting near ground level of trees and brush, and the removal of such cut material along with downed timber, rotten wood, rubbish, any other vegetation, and objectionable material.

2) Grubbing is defined as the removal from below the surface of the natural ground of stumps, vegetation, and roots 1-inch diameter and larger.

3) Excavating is defined as the removal of soil, soil-rock or rock materials within the limits shown on the construction drawings or specified by the Engineer.

5.3 Clearing and Grubbing

5.3.1 General

Clearing and grubbing shall be done along the alignment of new diversion ditches. Only clearing shall be done along access routes to the work area. Clearing along access shall be kept to a minimum. Prior to clearing, access routes shall be approved by the Engineer and the Regulatory Agencies.

5.3.2 Protection

1) Trees and vegetation beyond the specified limits for the diversion ditch and access route shall not be removed or damaged without the approval of the Engineer.

2) Beyond the clearing and grubbing limits, the following activity is not permitted:

   a) Compaction of root area by moving trucks or heavy motor equipment, or by storage of heavy equipment, supplies, gravel, and earthfill.
   b) Damage by trucks and motor equipment bumping into trees, leaning equipment, lumber, pipes, and other supplies against trees.
   c) Nailing or bolting objects to trees, using trees as temporary support posts, power poles, or sign posts.
   d) Strangling trees by tying ropes, guy wires, power lines to trunks or large branches of trees.
   e) Poisoning trees by pouring paint thinner, paint, solvents, oil, gasoline, dirty water, and other expendable materials on or around trees and roots.
   f) Burning of foilage and branches by burning trash under trees or so near that wind-blown heat damages tree leaves.
   g) Cutting of roots by utility ditching, foundation digging, placement of curbs and benches, and other miscellaneour excavation.
   h) Damaging of branches and foliage by temporary overhead power and telephone lines, swinging of power crane booms, cherry pickers, or driving too-tall van trucks under trees.

i) Cutting off branches, to allow for construction, by improper pruning methods such as peeling bark down the truck.

5.3.3 Extent of Removal

Clearing and grubbing shall be done for a maximum distance of 5 ft beyond the limits of the ditch excavation and grading; and 3 ft beyond the limits required for equipment access.

Blasting of stump removal shall not be permitted.

5.3.4 Disposal

a) If applicable, branches and brush shall be put through a chipper and the residue spread in designated areas to retard erosion and provide for dust control.

b) Larger trees and limbs shall be disposed of as proposed by the Contractor and approved by the Engineer, or as specified in a separate contract with the Agency.

5.3.5 Timing

Clearing and grubbing shall not be permitted during the rainy season unless proper sediment control structures have been installed to limit erosion and to prevent an increase in sediment loads in the streams. All runoff and sediment control measures shall be submitted to the Engineer in detail for comment and review. All waters discharged from the sediment control area shall be in compliance with State of California water quality control standards and discharge permit requirements.

5.4 Riprap Materials

Riprap may be required to provide protection against excessive erosion of the diversion ditches. It is anticipated that this material will be available from a local supplier. Suitable material may exist outside the mine portal and could be used subject to the Engineer's approval.

Riprap shall be as specified below.

Riprap with $*d_{50}$ = 6 inches

Intermediate Rock Dimension	Percent smaller than given size by weight
24 inch	100
15 inch	70-100
12 inch	40-60
9 inch	20-40
6 inch	10-20
2 inch	2-10

$*d_{50}$ = median particle size

5.5 Riprap Bedding Material

Riprap bedding material is not anticipated to be available at the site and will be obtained from commercial sources. Samples of the materials proposed for bedding shall be provided for testing and approval by the Engineer prior to use. Specifications for bedding are listed below.

Riprap Bedding Material

U.S. Standard Sieve	Percent Finer by Weight
3 inch	90-100
3/4 inch	20-90
No. 4	0-20
No. 200	0-3

5.6 Existing Ditches

Existing ditches requiring remedial work shall be regraded to their original geometry. Areas showing excessive erosion shall be regraded and protected from addtional erosion. Details for such protection are shown in the drawing.

Areas requiring additional work shall be field located by the Engineer in conjunction with the Contractor.

Acceptance of the completed work shall be subject to the approval of the Engineer.

5.7 New Ditches

New ditches to be installed shall be excavated and graded to the lines and grades or shown in the drawings. Areas which may be susceptible to excessive erosion under normal flow conditions will be protected as shown in the drawings.

Final alignment of the diversion ditch(es) will be field located and approved by the Engineer.

ADDENDUM 2

FLOW EVALUATION WITHIN THE WALKER MINE
ADDENDUM REPORT TO WALKER MINE PROJECT
FINAL FEASIBILITY AND DESIGN REPORT

FLOW EVALUATION WITHIN THE WALKER MINE
ADDENDUM REPORT TO WALKER MINE PROJECT
FINAL FEASIBILITY AND DESIGN REPORT
CONTRACT NO. 4-051-150-0

Prepared for:
California Regional Water Quality Control Board
Central Valley Region
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January, 1986

1.0 INTRODUCTION

On December 6, 1985, an inspection of the Walker Mine was made by Steffen Robertson and Kirsten (SRK) staff for the purposes of evaluating the mine flow system and of resolving the question as to whether there is currently any water which flows into the mine that does not pass out through the portal adit. This information is critical to the prediction of the post-sealing performance of the mine, particularly with respect to the question as to the likelihood of copper-laden water from the mine ever entering the Ward Creek catchment via the Piute Shaft.

The personnel participating in this phase of the work and the preparation of this report were Adrian Brown and Mark Logsdon of Terra Therma, Inc. and Colin Smith, associate consultants to SRK. As geohydrologist on the team, Adrian Brown was the lead engineer responsible for the data interpretation and preparation of this report.

2.0 ACTIVITIES

The mine was visited on Friday, December 6, 1985. The SRK team entered the adit at about 1000 hours and progressed from the portal to the rockfall between the Piute and 712 sections, taking water quality samples and flow measurements at appropriate locations on the way. The party returned to the portal at about 1715 hours. The water samples were filtered that evening, and carried to Denver the following morning for analysis.

3.0 RESULTS

3.1 Field Measurements

The results of the field measurements of flow and water quality are summarized on Table 1.

TABLE 1
SUMMARY OF RESULTS OBTAINED FOR FLOW ON THE 700 LEVEL

LOCATION	FLOW (gpm)	TEMP (^{o}C)	pH (units)	COND (umho)
Flow in the adit	21	7.3	5.25	340
South end of South orebody	1	5.9	3.29	289
South end of Central orebody	41	4.0	6.23	221
South end of North orebody	55	3.7	8.40	208
South end of 712 orebody	46	3.4	8.28	231
South end of Piute orebody	40	3.4	8.58	198

The pH results are questionable due to a malfunction of the pH probe resulting from the difficult conditions encountered underground. It should be noted that other readings were taken during the trip; the values presented above are the key values with respect to the question which was of primary interest during this visit.

The water level in the lower workings was visible at a few locations, and the distance below track grade was measured using a tape at these points. The results are indicated in Table 2.

TABLE 2
ELEVATIONS OF WATER LEVELS IN WORKINGS BELOW THE 700 LEVEL

LOCATION	CHAINAGE (feet)	TRACK ELEVATION (feet)	DEPTH TO WATER (feet)	WATER ELEVATION (feet)
North end of adit	-1900	0.0	0.0	0.0
Center of Center Orebody	- 500	7.0	5.0	2.0
Center of North Orebody	800	13.5	14.5	-1.0

Note: Elevations are relative to the elevation of the north end of adit. Elevation of the track is computed on the assumption that the track gradient is 0.5 percent. This is the gradient computed from plans.

Given the relatively low precision of the measurements, it is considered that the water elevations are the same; that is, the water level in the South, Central, and North orebody workings below the 700 level is the same, and is about equal to the elevation of the adit discharge point.

3.2 Laboratory Results

Seven water quality samples were collected in conjunction with the flow measurements in the mine, and a water quality sample of the outflow from the adit was also collected. Table 3 presents the laboratory analytical data for the samples.

All eight samples were analyzed for pH, specific conductance, and TDS, as indicators of the overall chemistry, and for copper (Cu), the heavy metal of principal concern. The water exiting the adit was analyzed for a full suite of major and minor species, primarily to allow correlation of these data with other sampling sessions. Copies of the laboratory report are attached.

TABLE 3

WATER QUALITY DATA, WALKER MINE - DECEMBER, 1985

PARAMETER	UNITS	SAMPLE NUMBER AND LOCATION							
		1	2	3	4	5	6	7	8
		S. end South ext.	S. end Central	S. end North	Inflow from roof, S. end North	S. end of 712	N. end of 712	S. end of Piute	Outflow from adit
pH	umho/cc	4.05	7.41	7.46	3.44	7.21	7.58	5.43	5.31
Conductivity	mg/l	346	242	217	436	222	203	167	256
TDS	mg/l	235	88	153	244	155	149	117	195
Alkalinity	mg/l $CaCO_3$				<1		73	11	12
Ca	mg/l				17		25	13	23
Mg	mg/l				5.5		5.1	3.1	6.2
Na	mg/l				1.87		3.6	1.81	3.1
K	mg/l				2.21		1.11	1.51	1.39
HCO_3	mg/l				<5		72	<5	<5
CO_3	mg/l				<1		<1	<1	<1
OH	mg/l				<.5		<0.05	<0.05	<0.05
SO_4	mg/l				135		45	73	111
Cl	mg/l				.5		0.5	0.5	0.6
Al	mg/l								0.4
As	mg/l								<0.01
Ba	mg/l								<0.1
Cd	mg/l								<0.01
Cr	mg/l								<0.01
Cu	mg/l	11.5	.33	.54	12.1	.73	1.00	10.4	8.7
Fe	mg/l				12.1		<0.05	0.21	0.10
Pb	mg/l								<0.01
Mn	mg/l				5.3		0.90	1.59	2.52
Hg	ug/l								<0.3
Ni	mg/l								<0.05
Se	mg/l								<0.01
Ag	mg/l								<0.01
Zn	mg/l				.96		0.24	0.40	0.65

4.0 DISCUSSION

These results quite clearly indicate that water which enters the mine does not all leave by the adit. The main inflow at the time of the visit was from the Piute area. In the 712 mine section, and to a lesser extent in the North orebody, there was some evidence of inflow from above. However, the two largest of the observed flows were measured and found to be of the order of 2 gallons per minute. It is estimated that, at the time of the visit, less than 10 gallons per minute of flow was observed coming from the workings above 700 level adit. There may, however, have been inflow to this level in sections which were not visible to the party, due to being in other segments of the drive system.

The available maps of the mine indicate that there is no mined connection between the Piute and the 712 orebody below the 700 level. Similarly, there is no known connection between the 712 orebody and the North orebody below the 700 level. Thus, it is not surprising to find that the flow on the 700 level increases from the south end of the Piute orebody to the south end 712 orebody.

There is believed to be connection below the 700 level between the North, Central and South orebody workings. The flow values reflect this, as the flow in the drain on the 700 level reduces in this stretch, presumably because of leakage to the lower workings. During the recent inspection trip, the flow could be seen to be disappearing from the 700 level adit drain into the lower workings at a number of locations, particularly in the South orebody area. The drain was essentially dry at the point where the 700 drive intersects the exit adit. Flow in the exit adit comes from the south extension, and is presumably return flow from the deeper mined area, which collects water from the entire mine.

The water level information indicates that there is a connection between the North, Central and South orebody workings below the 700 level. Water is presumably flowing into the lower workings from the 700 level, and moving towards the adit exit through the conduits provided by

the workings. This effect did not appear to be significant in the North orebody at the time of the visit. However, on the previous visit where this location was inspected, a considerable flow was observed to be dropping into the deeper portion of the North orebody workings at the location where the water level was measured this time.

The chemical parameters indicate regular changes from the input areas to the outflow areas. As the field readings were taken in winter, the water was entering the mine colder than the mine rock temperature. As a result, the water was warmed by the rock, which clearly shows in the field results.

The laboratory values for conductivity (and related TDS) are consistent with the field measurements - both generally increased from inflow to outflow points within the mine. The laboratory pH values (which were not subject to the vicissitudes of measurement under highly adverse field conditions) have a very strong correlation with TDS ($r = -0.78$). The correlation is even higher for copper, the metal of greatest interest ($r = -0.96$) for zinc and sulfate, the correlation factors are -0.93. These correlations clearly indicate that the dissolved load of the waters, particularly the concentrations of heavy metals is dependent primarily on pH.

The correlation of copper concentration with pH offers a ready explanation for why flow from the mine to the natural groundwater system has not introduced significant quantities of copper into the surface water system. The acid drainage in the mine system is the result of oxygenated waters reacting with the sulfide ores. When the water in the mine system flows out of the mine workings and into the country rock, it flows away from the concentrated sulfide zone, and along many flow paths through the granodiorite (and potentially other units) before it discharges to surface waters. During this flow, the acid produced in the ore zone is neutralized by water-rock reactions (primarily with the feldspars), and the copper initially carried in solution is precipitated and/or scavenged by clays, oxyhydroxides, and other phases that are present in the country rock.

The importance of the observation that there is a loss of a considerable amount of water from the mine to the groundwater system under natural conditions is as follows:

1. The loss from the mine will presumably increase as the mine fills after flooding, due to the higher driving head;
2. The increased flow loss from the mine makes it highly unlikely that water will ever rise high enough in the workings to cause a discharge from the Piute area, and into the presently unaffected catchment of Ward Creek; and
3. The losses have presumably been going on since the closing of the mine, and to date there is no evidence of a stream of copper-laden water egressing from the groundwater system to the surface water system via the natural flow system. Based upon the data collected in the mine, it is expected that as the water enters the groundwater, it is neutralized and the copper is precipitated from solution. Therefore, no increases in copper-ladened waters are expected to occur in the surface water system as a result of plugging the mine.

5.0 CONCLUSIONS

The conclusions of the evaluation are as follows:

1. The flow in the mine is a clearly identifiable hydraulic and geochemical system; water moves from the 700 level drive to the lower workings where it can, and discharges from the deep workings to the deep groundwater system, to the adjacent downgradient mine workings (when they are connected), or to the main exit adit and thence to the portal;
2. There is clearly loss of water from the mine which is a result of discharge of water from the deep mined workings to the natural groundwater system. At the time of the visit, about 40 percent of the influent water was appearing at the proposed plug location as flow in the adit drain, and approximately 60 percent of the inflow to the mine was discharging into the bedrock from the deep mine workings;

3. Based on these results, it is considered highly unlikely that copper-rich water could flow from a plugged mine to the catchment of Ward Creek via the Piute Shaft; and
4. There is a low probability that copper from the mine will emerge from the groundwater system once a plug has been installed in the mine and the water pressure in the mine has increased. In fact, the production of acid drainage will gradually decrease in importance to the extent that inflow of oxygenated surface water can be reduced (by reducing the flow into the surface shafts, particularly the Piute) and as the water stored in the plugged mine consequently becomes less oxidizing over time.

CORE LABORATORIES, INC.
ANALYTICAL REPORT

ANALYTICAL REPORT

W85884

TERRA THERMA INC.

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

CLIENT IDENTIFICATION

JOB NO.:6307-W35884
COMPANY: TERRA THERMA, INC.
JOB/GROUP REMARKS:

IDENTIFICATION	IDENTIFICATION
1) 1285-04	2) 1285-06
3) 1285-07	4) 1285-08
5) 1285-01	6) 1285-02
7) 1285-03	8) 1285-05

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
DATE/TIME SAMPLED	12-06-85/1415	12-06-85/1515	12-06-85/1530	12-06-85/1730
DATE/TIME RECEIVED	12-09-85/	12-09-85/	12-09-85/	12-09-85/
DATE/TIME ANALYZED	12-10-85/	12-10-85/	12-10-85/	12-10-85/
CHEMIST: RIF/DRH				
LOCATION: AURORA, CO				

LAB pH (@ 25 deg. C)	3.44	7.58	5.43	5.31
LAB COND. (as umhos/cm @ 25C)	436	203	167	256

--ALL VALUES REPORTED ON A DISSOLVED BASIS (MG./L.) UNLESS INDICATED OTHERWISE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85881 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
MAJOR CATIONS				
CALCIUM (Ca)	17 (0.85)	25 (1.25)	13 (0.65)	23 (1.15)
MAGNESIUM (Mg)	5.5 (0.45)	5.1 (0.42)	3.1 (0.26)	6.2 (0.51)
SODIUM (Na)	1.87 (0.08)	3.6 (0.16)	1.81 (0.08)	3.1 (0.13)
POTASSIUM (K)	2.21 (0.06)	1.11 (0.03)	1.51 (0.04)	1.39 (0.04)
SUM OF MAJOR CATIONS (me/l)	(1.44)	(1.86)	(1.03)	(1.83)
SUM OF TOTAL CATIONS (me/l)	(2.69)	(1.93)	(1.44)	(2.27)
MAJOR ANIONS				
BICARBONATE (HCO3)	<5 (0.00)	72 (1.18)	<5 (0.00)	<5 (0.00)
CARBONATE (CO3)	<1 (0.00)	<1 (0.00)	<1 (0.00)	<1 (0.00)
HYDROXIDE (OH)	<0.5 (0.00)	<0.5 (0.00)	<0.5 (0.00)	<0.5 (0.00)
SULFATE (SO4)	135 (2.81)	45 (0.94)	73 (1.52)	111 (2.31)
CHLORIDE (Cl)	0.5 (0.01)	0.5 (0.01)	0.5 (0.01)	0.6 (0.02)
SUM OF MAJOR ANIONS (me/l)	(2.82)	(2.13)	(1.53)	(2.33)
SUM OF TOTAL ANIONS (me/l)	(2.82)	(2.13)	(1.53)	(2.33)

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
GENERAL PARAMETERS				
TOTAL DISSOLVED SOLIDS (CALC.)	244 (193)	149 (118)	117 (106)	195 (158)
*TOTAL ALK. (pH 3.7 as CaCO3)	<1	73	11	12

*--FILTERABLE

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CORE LABORATORIES, INC.
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7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
DISSOLVED METALS				
ALUMINUM (Al)				0.4
ARSENIC (As)				<0.01
BARIUM (Ba)				<0.1
CADMIUM (Cd)				<0.01
CHROMIUM (Cr)				<0.01
COPPER (Cu)	12.1	1.00	10.4	8.7
IRON (Fe)	12.1	<0.05	0.21	0.10
LEAD (Pb)				<0.01
MANGANESE (Mn)	5.3	0.90	1.59	2.52
MERCURY (Hg)--ug./l.				<0.3
NICKEL (Ni)				<0.05
SELENIUM (Se)				<0.01
SILVER (Ag)				<0.01
ZINC (Zn)	0.96	0.24	0.40	0.65

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
DATE/TIME SAMPLED	12-06-85/1100	12-06-85/1210	12-06-85/	12-06-85/
DATE/TIME RECEIVED	12-09-85/	12-09-85/	12-09-85/	12-09-85/
DATE/TIME ANALYZED	12-10-85/	12-10-85/	12-10-85/	12-10-85/
CHEMIST: RIF/DRH				
LOCATION: AURORA, CO				

LAB pH (@ 25 deg. C)	4.05	7.41	7.46	7.21
LAB COND. (as umhos/cm @ 25C)	346	242	217	222

--ALL VALUES REPORTED ON A DISSOLVED BASIS (MG./L.) UNLESS INDICATED OTHERWISE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
GENERAL PARAMETERS				
TOTAL DISSOLVED SOLIDS	235	88	153	155

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
DISSOLVED METALS				
COPPER (Cu)	11.5	0.33	0.54	0.73

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WALKER MINE PROJECT
FINAL
FEASIBILITY AND DESIGN REPORT
CONTRACT NO. 4-051-150-0

Prepared for
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, California 95816

Prepared by
Steffen Robertson and Kirsten (Colorado) Inc.
3232 South Vance Street, Suite 210
Lakewood, Colorado 80227

November, 1985

TABLE OF CONTENTS

	Page No.
EXECUTIVE SUMMARY	
1.0 INTRODUCTION	1
1.1 Location and History	1
1.2 Statement of the Problem	2
1.3 Scope of Work	3
1.4 Constraints	4
2.0 STUDIES AND RESULTS	6
2.1 Site Visits	6
2.2 Hydrology	9
2.2.1 Introduction	9
2.2.2 Available Information	10
2.2.3 Setting	11
2.2.3.1 The Mine	11
2.2.3.2 Hydrology	13
2.2.3.3 Water Quality	14
2.2.3.4 Flows Within the Mine	15
2.2.4 Evaluation of Current Conditions	17
2.2.4.1 Conceptual Flow Model	17
2.2.4.2 Groundwater Inflow to Mine	19
2.2.4.3 Surface Water Inflow to the Mine	19
2.2.4.4 Discharge to Deep Rock System	20
2.2.5 Summary of Present Mine Flow System	22
2.2.6 Evaluation of Remedial Actions	23
2.2.6.1 Do Nothing Alternative	23
2.2.6.2 Effects of Installing a Seal in the 700 Level Access Adit	23
2.2.6.3 Additional Plugging to Isolate Piute Section	24
2.2.7 Conclusions	25
2.3 Geology and Geotechnical Considerations	27
2.3.1 Condition of Main Access	27
2.3.2 Rock Mass Classification	28
2.3.2.1 General	28
2.3.2.2 Rock Mass Rating	29

TABLE OF CONTENTS (cont'd)

		Page No.
	2.3.3 Site Characterization	30
	2.3.3.1 Geology	30
	2.3.3.2 Material Properties - Strength	31
	2.3.4 Bulkhead Design	35
	2.3.4.1 Location	35
	2.3.4.2 Design	36
	2.4 Results	39
3.0	PLUG SPECIFICATION AND CONSTRUCTION CONSIDERATIONS	41
	3.1 Plug Specifications	41
	3.1.1 Location and Dimensions	41
	3.1.2 Site Preparation	41
	3.1.3 Formwork	41
	3.1.4 Concrete	42
	3.1.5 Piping and Valves	42
	3.1.6 Grouting	43
	3.1.7 Monitoring	43
	3.1.8 Operation	44
	3.2 Discussion of Alternatives	44
	3.3 Construction Consideration and Cost Estimates	48
	3.3.1 Construction Considerations	48
	3.3.2 Cost Estimates	50
4.0	MONITORING	54
	4.1 Water Level in Mine Workings	54
	4.2 Surface Springs and Seepage	54
	4.3 Precipitation and Temperature	55
5.0	CONCLUSIONS AND RECOMMENDATIONS	56
	5.1 Observations	56
	5.1.1 Achievement of Primary Objective	56
	5.1.2 Potential Adverse Effects	56
	5.1.3 Mitigation of Adverse Effects	56
	5.1.4 Maximum Security Option	57
	5.1.5 Critical Appraisal of Maximum Security Option	58
	5.2 Conclusions	60
	5.3 Recommendations	63

TABLE OF CONTENTS (cont'd)

	Page No.
6.0 GLOSSARY	65
APPENDIX I - CONCRETE MIX DESIGN RECOMMENDATIONS	
ADDENDUM 1 - CONCRETE AND EARTHWORK FOR WALKER MINE 700 LEVEL PLUG AND DIVERSION DITCHES	

LIST OF TABLES

TABLE 1 ESTIMATE OF VOIDS AS MINED
TABLE 2 TYPICAL SELECTED WATER QUALITY PARAMETERS (Kaback, June, 1978)
TABLE 3a ESTIMATED MINE FLOWS (September 20, 1984)
TABLE 3b ESTIMATED MINE FLOWS (June 19, 1985)
TABLE 4 AVERAGE ANNUAL FLOW TO SINKHOLES (GPM)

LIST OF FIGURES

FIGURE 1 PROJECT LOCATION
FIGURE 2 SITE PLAN AND TOPOGRAPHY
FIGURE 3 APPROXIMATE PLUG LOCATIONS PLAN VIEW
FIGURE 4 VERTICLE PROJECTIONS SHOWING MINE WORKINGS
FIGURE 5 MINE OUTFLOWS
FIGURE 6 COPPER CONCENTRATION FROM PORTAL
FIGURE 7 CATCHMENT AREAS
FIGURE 8 MAIN PORTAL SECTION
FIGURE 9 TYPICAL ROCK MASS CLASSIFICATION RATING FOR GRANODIORITE
FIGURE 10 TYPICAL ROCK MASS CLASSIFICATION RATING FOR HORNFELS SCHIST
FIGURE 11 COMPRESSIVE STRENGTH vs. APPLIED STRESS FOR SQUARE TUNNELS
FIGURE 12 PRINCIPAL STRESS RELATIONSHIPS
FIGURE 13 ESTIMATED SHEAR STRENGTH OF ROCK MASS
FIGURE 14 VERTICAL SECTION THROUGH MAIN ACCESS DRIFT SHOWING ASPERITIES
FIGURE 15 DISTRIBUTION OF PEAK FRICTIONAL STRENGTH
FIGURE 16 MAIN ADIT PLUG LOCATIONS PLAN AND SECTIONS
FIGURE 17 TYPICAL DRAIN PIPE DETAILS

EXECUTIVE SUMMARY

I STATEMENT OF PROBLEM

The Walker Mine discharges acid- and heavy metal-laden water from an adit and mine waste dump into Dolly Creek which is a tributary to Little Grizzly Creek. The discharge from the mine is reported to have totally eliminated aquatic life in Dolly Creek, and in Little Grizzly Creek for a distance of approximately ten miles downstream from the mine.

The primary goal of the California Regional Water Quality Control Board (the Board) is to restore Little Grizzly Creek and Dolly Creek to a condition capable of supporting a diversity of aquatic life.

The first objective of the studies forming the subject of this report is to evaluate the effectiveness and feasibility of sealing the Walker Mine adit in such a manner as to prevent a direct discharge of acid- and heavy metal-laden water from the underground workings. The second objective is to design and estimate construction costs for such a seal, should it prove to be warranted.

II SCOPE OF WORK

A. Feasibility

Steffen Robertson and Kirsten's (SRK) studies have been directed towards evaluating the feasibility of sealing the actual and potential portals through which acid mine drainage (AMD) might discharge by:

1) Performing a hydrologic assessment of the underground mine and its environs;

2) Examining available maps of the underground workings, surface features, and fault systems;

3) Examining available data to assess general groundwater movement and the potential for the escape of mine waters through surface springs or seepage; and

4) Identifying possible alternative outlets for mine water, when it is prevented from following its present course by sealing of the 700 Level Adit.

B Design Criteria

1) Concrete bulkheads have been designed to seal the main Access Adit on the 700 Level and to minimize the potential for the escape of mine water through other outlets.

Site selection for seals was made to:

- Minimize the potential for seepage around the seal;
- Maximize the structural integrity of the seal; and
- Permit future replacement of the seal, if necessary.

2) Seal design has taken into account:

- The maximum possible head of water to be held behind the seal;

- Installation of pipes through the seal to permit future dewatering of the mine in case that should become necessary;

- Materials and construction techniques appropriate to the environment in which the seal is to be located, and the objective of a design life in excess of 100 years; and

- Installation of a pressure gauge to monitor the head of water behind the seal.

C. Reporting

All feasibility studies and plug design will be submitted to the Board for review and approval.

D. Construction

Following the Board's approval of plug feasibility and design, and authorization for construction, the approved structures will be installed.

III STUDIES AND CONCLUSIONS

Data available from the Board's records and previous studies were evaluated, and related to current conditions through site visits during the weeks of September 17, 1984 and June 17, 1985. The physical conditions of accessible underground workings on the Main 700 Level from the portal to the Piute Section (a distance of approximately 8,000 ft.) were observed, and all accessible surface outlets from the mine workings were visited. Potential sources of surface inflows to the mine were also observed.

The results of site observations indicated that a single concrete bulkhead plug in the 700 Level Adit, at a point close to the South Orebody workings, would effectively stop the discharge of AMD from the Walker Mine Adit. Minor improvements and additions to the existing system of diversion ditches, around surface subsidence over the underground workings, would further minimize inflow of water to the workings.

Consideration was given to the possibility that water would rise in the mine workings behind the proposed plug and might eventually discharge through the next-lowest outlet, the Piute Shaft Landing Tunnel. The studies described in this report demonstrate the strong probability that water would not rise to the level of the Piute Shaft Landing Tunnel: equilibrium between inflow to the workings and outflow

as recharge to the groundwater system would probably be reached below that level.

The cost of constructing an internal plug to compartmentalize the mine workings and protect against the remote possibility that water might rise to a level at which it could discharge, was found to be unjustifiable. Insurance against any possible discharge through the Piute Shaft could be provided by monitoring the level of water in the mine workings. If, at any time in the future, as a result of excessive precipitation or snowmelt, the water should approach the overflow level, a controlled flow of AMD could be released through a valve in the 700 Level Adit plug, treated to acceptable standards, and discharged into Dolly Creek. The costs of proposed remedial measures, and of rejected alternative courses of action were estimated. A treatment system was found to be more cost efficient than the alternative of an internal plug.

IV RECOMMENDATIONS

The following course of action is recommended:

1. Rehabilitate and extend the existing diversion ditches around surface subsidence sinkholes, to minimize inflow of surface water to the underground mine workings.

2. Conduct a water flow and quality balance survey along the 700 Level Haulage and Adit, through the abandoned plant site area, and along Dolly Creek to its confluence with Little Grizzly Creek.

3. Install a single plug in the 700 Level Adit approximately 2,700' from the portal.

4. Monitor water levels in the mine workings by means of gauges reading pressure behind the plug.

5. Prepare a contingency plan for future construction and operation of a small treatment plant at the 700 Level Adit Portal, to treat AMD that might have to be discharged periodically (in the order of ten or more years after installation of the plug) to relieve any excess buildup of water that might threaten to overflow out of the Piute Shaft.

V COSTS

The cost of the recommended course of action, in 1985 dollars to the nearest $500, would be:

Rehabilitation of Diversion Ditches	$ 14,000
Water Balance Survey	6,500
Main Adit Plug Construction	150,000
Discharge Treatment Plant Specifications	6,500
Total Initial Cost of Abatement	$177,000

Future work associated with the recommended course of action would be:

Routine Monitoring	$ 1,000/year
Maintenance of Diversion Ditches	2,500/year
Total On-going Cost of Abatement	$ 3,500/year

Possible future costs could include:

Build Discharge Treatment Plant	$250,000
Operate Discharge Treatment Plant	5,000/year

The additional cost of rejected precautions, over the recommended course of action, is estimated as:

Internal 712/Piute Plug (minimum)	$227,000
Piute Landing Tunnel Plug	23,000
Sawmill Adit Plug	20,000
Total Cost of Rejected Precautions	$270,000

1.0 INTRODUCTION

1.1 Location and History

The Walker Mine is an inactive copper mine located some 20 miles east of Quincy, in Plumas County, California, approximately 20 miles by road from Portola. Access is by well-graded gravel road through the Plumas National Forest from California Highway 70 at Portola. Situated in hilly country at an altitude of between Elev. 6,000 and 7,000 ft, the mine site is subject to heavy snowfall in winter and is generally inaccessible to motor vehicles between November and April.

Copper ore was first discovered at the Walker Mine site in 1904. Production commenced in 1916, continuing until 1932 and again from 1935 to 1941, when it was closed down by the operator, Walker Mining Company, a subsidiary of Anaconda Copper Company. Mining started on the 200 Level (approximately 6,670 ft elevation) near the outcrop of the Central Orebody, but the Main Haulage Tunnel on the 700 Level (approximately 6,200 ft elevation) was driven in the early 1920's. The Main Access Adit on the 700 Level was driven as an adit from the millsite at Dolly Creek, cross-cutting north by northeast some 3,000 ft to intersect the South Orebody. From there, the haulage was driven north by northwest, following the vein through the Central, North, 712 and Piute Orebodies. Approximately 10,000 ft from the portal, the Piute Shaft was raised in the vein from the 700 Level to surface in 1927/28. The portal of the 700 Level Main Access Adit remains the lowest point at which the underground workings reach the surface.

No stoping was done below the 700 Level until the 1930's. The deepest level from which ore was mined was the 1000 Level (approximately 5,720 ft elevation) and the deepest exploration winze was sunk to below the 1200 Level (approximately 5,400 ft elevation) on the Central Orebody.

A total of 5,319,000 tons of ore was mined between 1916 and 1941, from which 83,890 tons of copper were recovered (an average recoverable grade of 1.58% Cu with 0.03 oz/ton gold and 0.68 oz/ton silver recovered as by-products).

Soon after cessation of mining in November, 1941, all the mining equipment was removed and the surface plant was dismantled. When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage (AMD) water flowing from the main Access Adit Portal on the 700 Level began to affect the Dolly Creek and the Little Grizzly Creek. Increasing concern over the detrimental effects of the AMD prompted the California Regional Water Quality Control Board (the Board) to commission several investigations, including the studies forming the subject of this report.

1.2 Statement of the Problem

The Walker Mine discharges acid- and heavy metal-laden water from an adit and mine waste dump into Dolly Creek which is a tributary to Little Grizzly Creek. The discharge from the mine is reported to have totally eliminated aquatic life in Dolly Creek downstream from its confluence with mine drainage water, and in Little Grizzly Creek downstream from its confluence with Dolly Creek for a distance of approximately ten miles downstream from the Walker Mine.

The primary goal of the Board is to restore Little Grizzly Creek and Dolly Creek to a condition capable of supporting a diversity of aquatic life.

The first objective of the studies forming the subject of this report is to evaluate the effectiveness and feasibility of sealing the Walker Mine adit in such a manner as to prevent a direct discharge of acid- and heavy metal-laden water from the underground workings. The second objective is to design and estimate construction costs for such a seal, should it prove to be warranted.

1.3 Scope of Work

In terms of Contract No. 4-051-150-0, signed on August 20, 1984, and the subsequent order to proceed given on September 5, 1984, Steffen Robertson and Kirsten (Colorado) Inc. (SRK), has pursued the following scope of work:

A. Studies have been directed towards evaluating the feasibility of sealing all actual and potential portals through which AMD might discharge by:

1) Performing a hydrologic assessment of the underground mine and its environs;

2) Examining available maps of the underground workings, surface features, and fault systems;

3) Examining available data to assess general groundwater movement and the potential for the escape of mine waters through surface springs or seepage; and

4) Identifying possible alternative outlets for mine water, when it is prevented from following its present course by sealing of the 700 Level Adit.

B. Design Criteria

1) Concrete bulkheads have been designed to seal the main Access Adit on the 700 Level and to minimize the potential for the escape of mine water through other outlets.

The selection of sites for seals has been made to:

- Minimize the potential for seepage around the seal;
- Maximize the structural integrity of the seal; and
- Permit future replacement of the seal, if necessary.

2) Seal design has taken into account:

- The maximum possible head of water to be held behind the seal;

- Installation of pipes through the seal to permit future dewatering of the mine in case that should become necessary;

- Materials and construction techniques appropriate to the environment in which the seal is to be located, and the objective of a design life in excess of 100 years; and

- Installation of pressure gauges to monitor the head of water behind the seal.

C. Reporting

This report has been prepared to detail the observations and conclusions arising from the feasibility studies, and to specify the design of the proposed bulkhead plug.

D. Construction

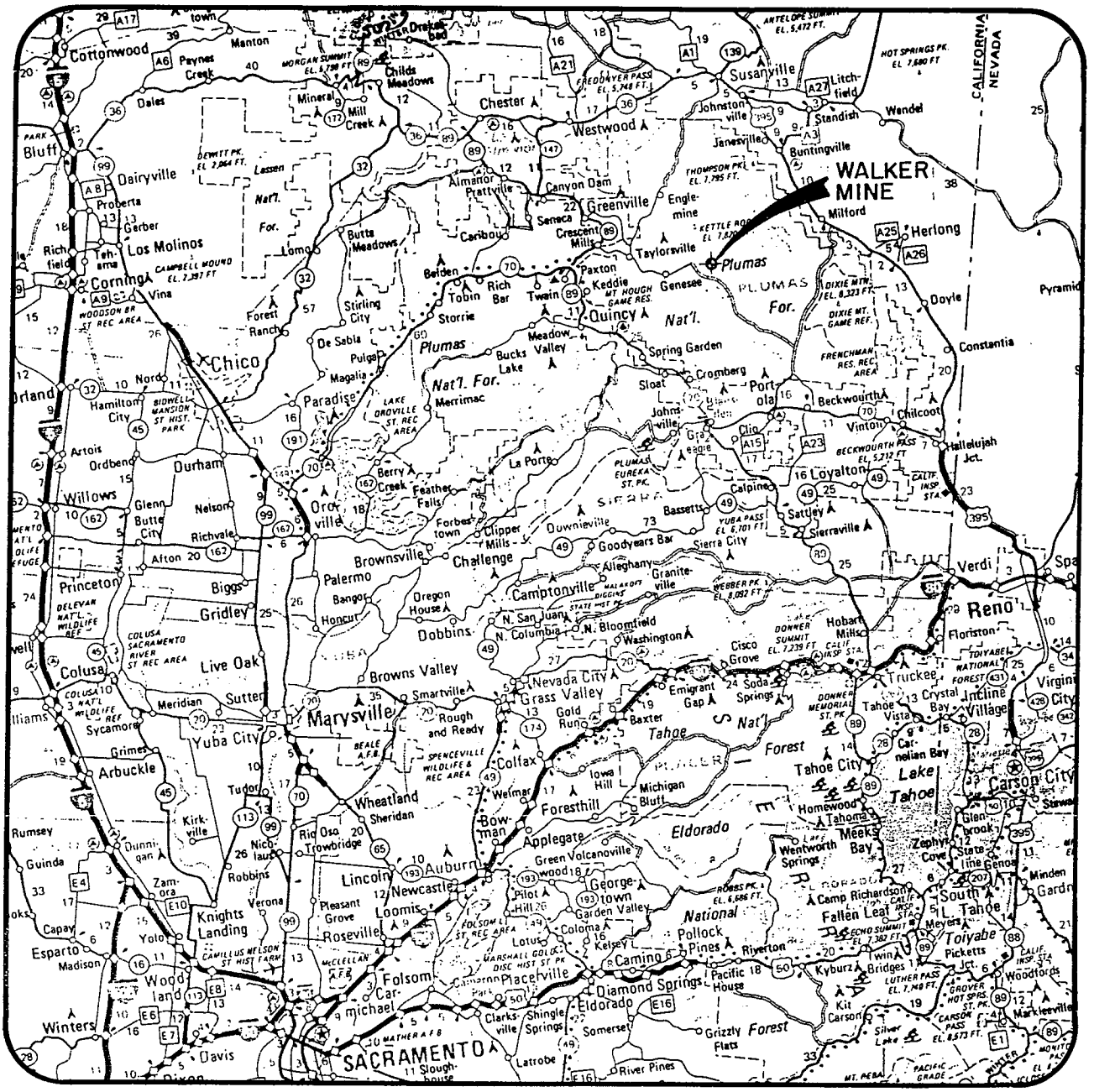
Following the Board's approval of plug feasibility and design, and authorization for construction, the approved structures will be installed.

1.4 Constraints

It must be emphasized that many of the opinions and conclusions recorded in this report are subjective and based on professional judgement. Assumptions have had to be made on the basis of limited or nonexistent data, to serve as a base on which professional experience and judgement can develop logical courses of action or events.

Certain information, such as underground plans showing the final extent of the mine workings and the locations of potential points (such as air raises or adits) for egress of water rising in the old workings, were not initially available. Research through the California Division of Mines and Geology discovered a vertical projection of the mine workings used to indicate ventilation flows at the time of an underground fire in 1940. Though incomplete and not necessarily indicating the full extent of the workings when mining stopped in 1941, this drawing has been used in the evaluation presented in this report.

Information regarding water flows and quality, both in surface streams and from the 700 Level Access Adit Portal, has been drawn from available sources. Time and restricted access have not permitted complete physical verification, but indirect checks have been applied. Water flows from the 700 Level were estimated by indirect measurements during the field visit by SRK in September, 1984 and June, 1985.

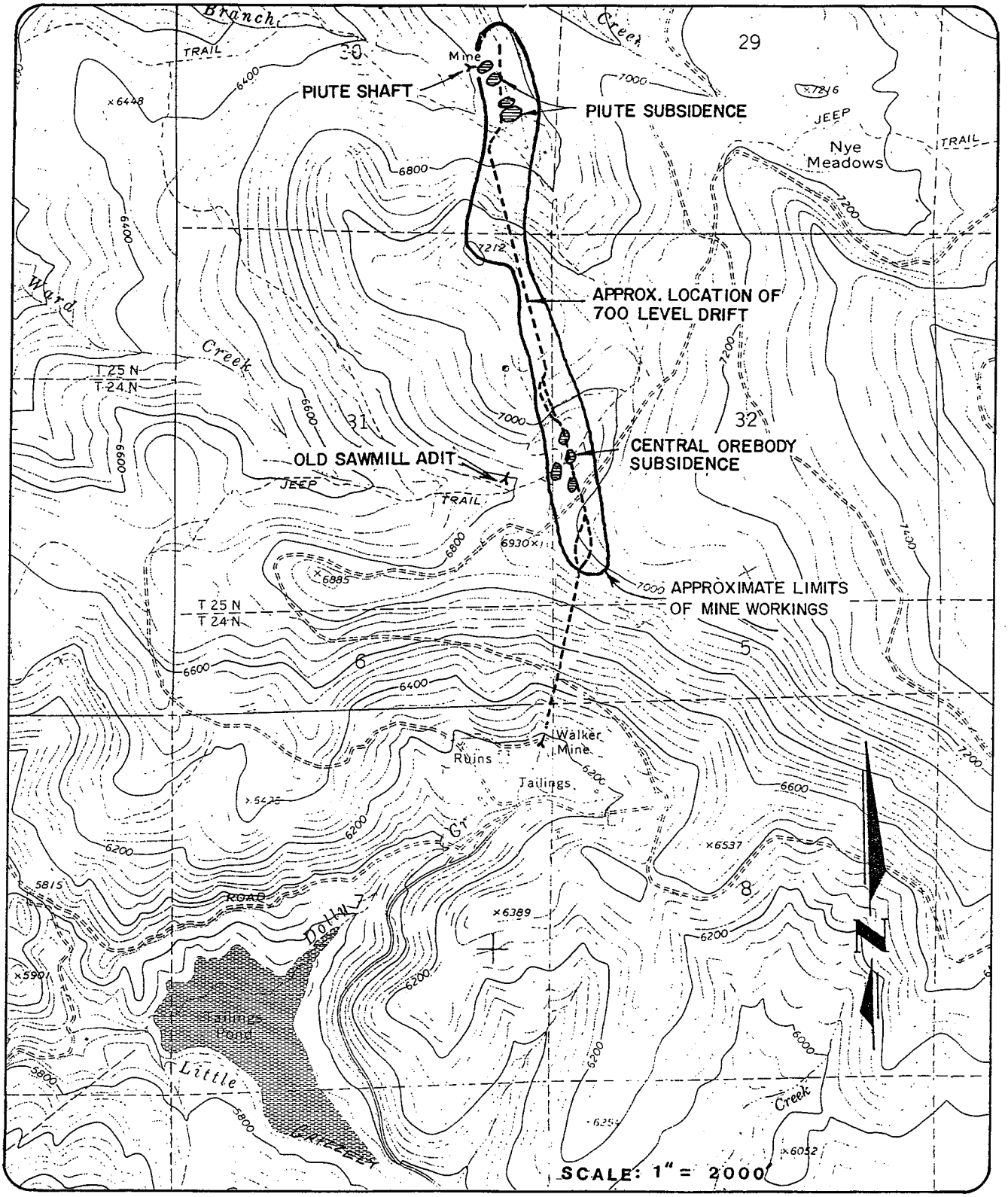


LOCATION OF MAP ABOVE

0 20 40
APPROX. SCALE IN MILES

N

PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 1
DATE 3/85		PROJECT LOCATION
REVISION NO. 0		



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 2
DATE 3/85		SITE PLAN AND TOPOGRAPHY
REVISION NO. 0		

2.0 STUDIES AND RESULTS

2.1 Site Visits

Unexpected delays were experienced by the Board in obtaining rights of access to the mine following signature of their contract with SRK. On September 5, 1984, a court order for entry onto the property was obtained, allowing SRK to examine the site and the accessible parts of the underground workings of the Walker Mine during a ten-day period between September 17 and 26. A site visit was arranged for the week of September 17 to enable all key members of the team to make a quick visual inspection of the mine workings and their environs.

Prior to the site visit, members of SRK's project team met with officials of the Board in Sacramento and studied the Board's project files relating to the Walker Mine. A composite underground plan of the main working levels at the Walker Mine, (at a scale of 1" = 200') was obtained, but no vertical projections or cross sections of the underground workings were available.

The 700 Level Main Access Adit was examined from its portal to the northern end of the Central Orebody workings. Data collected included:

- Observation and assessment of rock mass classification, noting evidence of permeability and orientation of fissures;

- Observation of the quantity and quality of water flow in the 700 Level tunnels at various locations from the Central Orebody workings to the adit portal;

- Measurement of tunnel profiles at selected alternative locations for a bulkhead seal in the 700 Level Main Access Adit, close to its intersection of the South Orebody; and

- Assessment of the transport and utility facilities available for construcion of a bulkhead seal.

All subsidence areas on surface were visited, as were the collars of the Main and Piute Shafts, and the portal area of the Sawmill Adit.

The effects of mine drainage from the Walker Mine 700 Level Adit were observed in the Dolly and Little Grizzly Creeks, and the tailings impoundment was examined visually. No evidence was found of seepage of mine drainage through outlets other than the 700 Level Adit, but it was recognized that this did not mean that seepage might not occur at other times of the year, at the same time in other years, or in other places.

Subsequent to the site visit, plans or other records concerning the underground workings and geology of the Walker Mine were sought from the Anaconda Minerals Company but, despite their generous cooperation, none could be found. However, valuable information in the form of a 1" = 200' scale vertical projection of the mine workings as of April, 1940 (shortly before the final cessation of operations) was obtained through the California Division of Mines and Geology.

Delays in obtaining access to the site did not allow more than a single cursory examination before the onset of winter prevented further access. This factor, combined with a paucity of documentary evidence of underground geological and mining features, and limited records of water flows and quantities up and downstream of the mine workings, forced the project team to base its preliminary conclusions on circumstantial evidence to a greater extent than it considered ideal.

Conclusions, drawn from available data and observations made during the first site visit led to a maximum security recommendation in SRK's Draft Feasibility and Design Report

presented in February 1985. This recommendation required the installation of a second, internal plug, between the 712 and Piute Sections, in addition to a main plug in the 700 Level Adit. This requirement was based on concerns that water, held back by a single plug in the main adit, might rise to a level at which it could overflow through the Piute shaft and pollute the hitherto uncontaminated catchment of Ward Creek. The high degree of uncertainty attached to this possibility mandated a very conservative approach.

The Regional Board suggested a second visit to further investigate several specific questions they presented in a letter to SRK dated May 31, 1985. It was considered that the information gathered would permit SRK to attach a higher degree of confidence to their recommendations.

A court order was obtained on June 13, 1985 permitting SRK to enter the mine between June 17 and June 31, 1985. After two days of delay awaiting the owner's representative who held the keys to the property and the adit door, forced entry was made on June 18, 1985.

The team made a one-day underground inspection on June 19, 1985, the last day available in the team's schedule. It took over 3 hours to reach the Piute Orebody Section along the 700 Level haulage, and about 2½ hours to return by the same route .

Tunnel dimensions were measured, and rock quality observed, at the site selected for a possible internal plug between the 712 and Piute Sections. The selected site was flooded to a depth of about 3'-6".

Approximate measurements of water flow rates were made where flow was sufficiently channelized to be measurable, to estimate a flow profile along the 700 Level haulage. The locations of major inflows to and losses from the haulage were listed.

The nature and volume of sludge, fallen timbers and rockfall in the haulage were observed and related to the work that would be required to remove them.

The presence or absence of rail track was checked by probing with a steel rod. The track's condition was noted at the few points where it was exposed and could visually be inspected.

Branches of the 700 Level haulage that could have led to another connection between the 712 and Piute Sections were checked and found to dead-end. The possibility of a connection at a higher level could not be checked as access into the 712 Orebody workings through the collapsed northern most stope drawpoint chute was considered unsafe on examination. In subsequent conversation with the owner's representative, Mr. Donato, he confirmed that he had descended through the Piute Shaft and workings to the 700 Level haulage, but had not ventured into the flooded part leading southward to the 712 Section. He had returned to surface up the Piute Shaft, checking the workings at each level for a connection to the 712 Section. No connection was found.

In addition to their underground inspection, SRK's engineers examined the diversion works around the sinkholes above the mine workings.

2.2 Hydrology

2.2.1 Introduction

This section of the report sets out the findings of a study of the hydrological effects of plugging the main access adit of the Walker Mine.

The mine has been generating and discharging acid drainage since its closure in 1941. The copper carried by

the water has reportedly rendered the receiving streams (Dolly Creek and Little Grizzly Creek) essentially barren of aquatic biota for about 10 miles downstream. In order to mitigate this impact, the Regional Board has proposed to install a plug in the mine portal. This section of the report comments on the effectiveness of this action to:

- Provide an immediate relief from the contaminated flow from the mine; and
- Build up the water level in the mine, thus reducing the volume of material capable of generating AMD,

and indicates the general order of magnitude of the effects to be expected following the installation of the mine plug. The anticipated results of this action are assessed in terms of:

- Effectiveness in achieving long-term improvement in water quality in the vicinity of the mine; and

- Extent and likelihood of possible undesirable side effects, and steps that can be taken to mitigate them.

2.2.2 Available Information

This study was performed entirely on the basis of existing information, together with field trips to the site in September, 1984 and June, 1985. The documents available were:

- Composite plan of the main levels of the mine, at a scale of 1" = 200', dated August 1, 1941;

- Vertical projection of mine workings at a scale of 1" = 200', as of early 1940;

- Report on "Plans to Proceed Toward Abatement of the Water Pollution Problems Incident to Water Emanating from the Walker Mine, Plumas County," California Division of Mines & Geology, August, 1972;

- Report on "Evaluation of Water Pollution Sources and Development of Conceptual Pollution Abatement Plans, Walker Mine, Plumas County, California", D'Appolonia Consultants, December, 1979;

- Water quality data from Conoco, for 1976 and 1977 (Pine, 1979), 1980 and 1981 (Hart, 1980 & 1981); and

- Water quality data from the California Regional Water Quality Control Board, Central Valley Region for 1977 and 1978 (Matteoli, 1977, and 1978; and Croyle 1985).

While this database is limited, particularly with respect to flows, it is considered to be adequate for the present evaluation. Little independent checking of the data was possible in the time available; however, consistency checks have been made when possible and some information has been omitted as a result.

2.2.3 Setting

2.2.3.1 The Mine

The Walker Mine is located in Plumas County,

California as shown in Figure 1. The workings strike approximately north-south, over a distance of nearly 1½ miles. The tabular orebody, 10 to 100 ft thick, was mined at an average stoping width of 35 ft, dipping to the east at about 60^{0} to 70^{0}. The mine excavations extended from surface above elevation 7,000 ft to below elevation 5,400 ft. A section through the mine is shown in Figure 4.

Rock containing sub-economic grades of copper was not mined, and remained in place. A study done during World War II estimated about 4 million tons of copper-bearing rock remained in the mine area. Subsequent exploration by several mining companies has failed to identify sufficient reserves to justify reactivation of mining.

The volume of voids resulting from mine excavations was estimated as a function of location based on Figure 4. In absence of transverse sections of the workings, an average stoping width of 35 ft was assumed throughout. The volume of rock excavated from the mine is estimated to be about 5,319,000 tons of ore plus an estimate of 680,000 tons of waste rock. Visual inspection of the mine suggested that the mine is still very stable and it is likely that little collapse of the hanging wall has taken place since the mining operation. It is assumed that the effective volume of the voids caused by mining is equivalent to the volume of rock excavated, i.e. some six million tons of rock or 543 million gallons of water. The estimated void volumes are shown in Table 1.

TABLE 1

ESTIMATE OF VOIDS AS MINED

SECTION	VOID VOLUMES (MILLION GALLONS)			
	Above 6600'	6200'-6600'	Below 6200'	Total
Piute	-	88	19	107
"712"	6	57	-	63
North	57	76	57	190
Central	44	63	50	157
South	-	13	13	26
Totals	107	297	139	543

2.2.3.2 Hydrology

The mine is located in the catchment area of Little Grizzly and Ward Creeks, both of which flow north to Indian Creek (Figure 2). Flow from the mine currently discharges out through a 3,000-ft long adit (700 Level Access Adit) at about the 6,200 elevation to the south of the mine. This flow varies considerably over the year, as shown in the data for 1978 (Figure 5). Much of the portal flow is believed to originate as surface flow, which is captured by sinkholes which connect the mine to the South and Middle Forks of Ward Creek. Remedial actions and diversions in recent years have probably reduced the peak flow below that shown in Figure 5.

Water from the adit flows into Dolly Creek, which flows to Little Grizzly Creek, which in turn flows to Indian Creek. Average flows in these creeks have been calculated to be of the order of 1.7 cubic feet per second per square mile of catchment (1.2 gpm/acre - Table 1 D'Appolonia, 1979).

2.2.3.3 Water Quality

The quality of water in local streams which are unaffected by the mine is excellent. The flow from the portal is, however, of low pH and high in copper and other dissolved metals, as shown in Table 2.

There is a seasonal variation in the copper concentrations measured in the water flowing from the portal of the mine. The available data are plotted in Figure 6. It is of interest to note that the copper concentration is highest during periods of greatest flow. This is a result of the spring flushing of acid generated in the mine all winter, which has a lower pH and a higher copper content than the flow later in the year. It is noteworthy that the total dissolved solids (TDS) of the mine water is low, indicating a low residence time in the ground and suggesting that the greater part of the flow is derived from surface inflow.

TABLE 2

TYPICAL SELECTED WATER QUALITY PARAMETERS

(Kaback, June, 1978)

Parameter	Unit	Portal	Streams
Ca	mg/l	24.5	5.8
Na	mg/l	2.7	2.8
K	mg/l	1.6	0.7
Mg	mg/l	6.4	2.2
SO_4	mg/l	146	5
HCO_3	mg/l	0	23
CO_3	mg/l	-	-
pH	Units	4.1	7.6
NO_3	mg/l	4.5	0.7
NH_3	mg/l	0.01	0.01
Cl	mg/l	1	-
Cu	mg/l	29	0.03
Zn	mg/l	0.93	0.01
Fe	mg/l	1.0	0.15

2.2.3.4 Flows Within the Mine

During the initial site visit, the flows in the southern part of the mine were measured using the floating object method. The results of these measurements are presented in Table 3a.

TABLE 3a
ESTIMATED MINE FLOWS (SEPTEMBER 20, 1984)

Location	Flow (GPM)	Comment
Between North and Central Orebodies	174	Location just south of north end of Central orebody
At junction of portal adit and the Central Orebody	229	-
At portal in timbered section	116	-

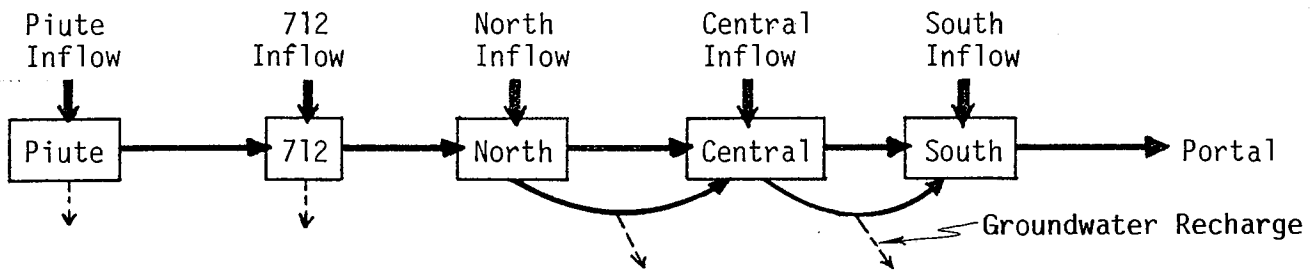
Based on these measurements, it was concluded that:

1. At the time there was apparent flow continuity in the southern portion of the mine, and
2. There appeared to be some flow loss along the portal adit.

Accordingly, it was considered wise to locate any adit plug remote from the portal. In addition, a more detailed flow survey was proposed to better defined in-mine flow.

During the second site visit, a portable direct-reading flow meter was used to determine flow velocity at points where the cross-sectional area of the channel could be estimated reasonably. Where no appropriate channel sections existed, flows were estimated by eye.

The results are presented in terms of flow from blocks of the mine, as indicated in the following sketch:



The results of the rough measurements are presented in Table 3b.

TABLE 3b
ESTIMATED MINE FLOWS (June 19, 1985)

Location	Flow (GPM)	Comment
Between Piute and 712 orebodies	130	Rough measurement.
Within 712 orebody	100	Visual estimate.
Flow on 700 Level at south end of North orebody	270	Rough measurement; does not include above 230 gpm, as this was observed to flow into lower mine workings.
Flow on 700 Level at south end of Central orebody	60	Rough measurement; does not include upstream flows, which entered lower workings.
Flow on 700 Level at south end of South orebody	215	Rough measurement.
Discharge from portal	275	Rough measurement.

Based on this set of readings (which do not cover the entire mine area due to measurement difficulties and shortness of time), it is concluded that, in all likelihood, the flows entering the mine exceed the flow entering the mine adit from the workings, suggesting a deep point of egress of inflow water within the mine.

2.2.4 Evaluation of Current Conditions

2.2.4.1 Conceptual Flow Model

In order to have a means of evaluating the probable behavior of the mine after remedial action, it is necessary to develop a conceptual model of the flow behavior of the mine system. The inflowing water is made up of the following components:

1. Surface water inflow. This enters from sinkholes near the Piute and Central orebody areas. As it is close to its source, quality is expected to be excellent.

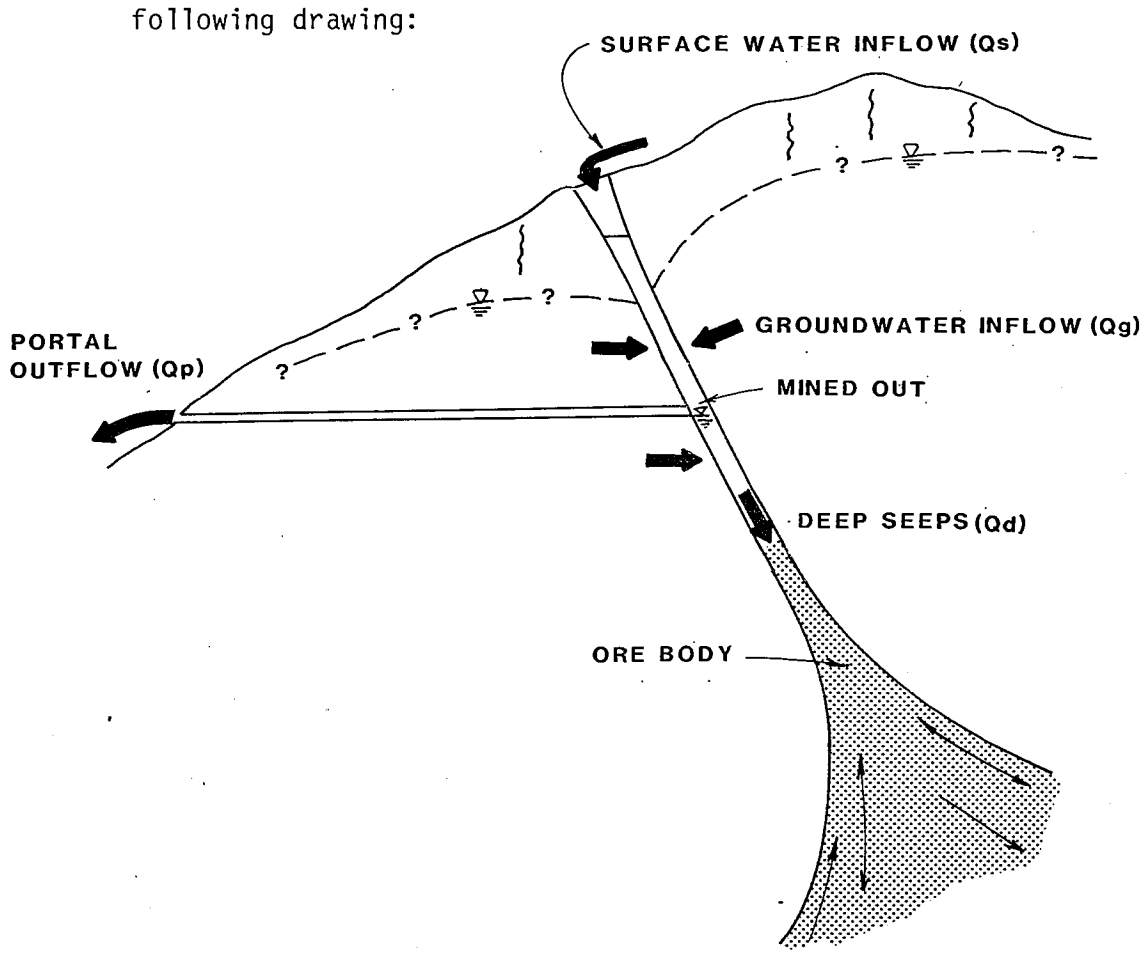
2. Groundwater inflow. The drainage of the mine has caused a groundwater sink in the vicinity of the mine. Local groundwater of (likely) moderate TDS and low metal content is flowing into the mine.

The outflowing water is made up of essentially two components:

1. Flow from the portal. This is essentially an overflow from the mine void, at the elevation of the intersection of the portal adit and the mine.

2. Discharge to deep groundwater system. As noted above, it is entirely possible that there is a deep conduit for flow from the mine. This conduit could allow discharge of water from the mine to the deep bedrock flow system via open pathways through the rock.

The total flow system is shown schematically in the following drawing:



Clearly the relationship between the flows shown for the steady state condition is

$$Q_s + Q_g = Q_p + Q_d$$

2.2.4.2 Groundwater Inflow to Mine

The portion of the measured flow due to groundwater influx to the mine is difficult to evaluate. The minimum low flow from the mine is an indication of the minimum groundwater inflow rate, on the assumption that there is no other outflow from the mine, and that the inflow from surface sources is negligible during low flow periods. The minimum inflow reported is zero (California Division of Mines and Geology, 1972) and 50 gpm (Kaback, 1979). That the flow due to groundwater is small, is further suggested by the low TDS of the Adit flow discussed in Section 2.2.3.3.

It is possible to check the reasonableness of this range of low flows. The groundwater inflow estimate can be used to back-calculate the average hydraulic conductivity of the host rock. Simple evaluation, based on Darcy's law, produces an average hydraulic conductivity of 10^{-5} cm/sec or less. Based on the observations of the rock mass made during the site inspection, this hydraulic conductivity is reasonable for the rock penetrated by the mine.

2.2.4.3 Surface Water Inflow to the Mine

The recorded flow from the mine adit has been as high as 3,000 gpm in the spring. This flow is presumed to be essentially surface water flow. This presumption may be checked by comparison with stream flows in the areas of the sinkholes above the mine.

The peak flow in 1978 presumably resulted from some stream capture at sinkholes in the Middle and South Forks of Ward Creek. As shown on Figure 7, the catchment area to the sinkholes at the Piute Shaft area is 234 acres,

while that to the central orebody sinkholes is about 212 acres. Applying flow/drainage relationships based upon local soil, vegetation, precipitation and runoff data, the total estimated average flow in these streams at these locations is given in Table 4.

This figure (525 gpm) compares well with the computed average flow of about 420 gpm in 1978, prior to much of the recent stream diversion activities.

TABLE 4
AVERAGE ANNUAL FLOW TO SINKHOLES (GPM)

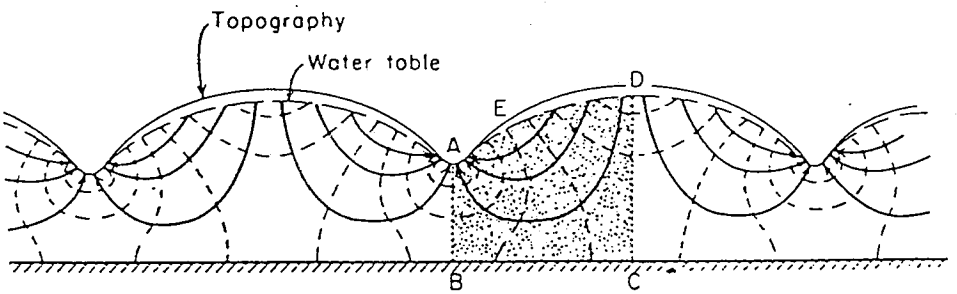
LOCATION	PIUTE	CENTRAL	TOTAL
Area (Ac)	234	212	546
Rate (GPM/Ac)	1.2	1.2	1.2
Flow (GPM)	275	250	525

2.2.4.4 Discharge to Deep Rock System

As noted above, it appears that more water currently flows into the mine than flows out via the 700 Level Adit. This suggests that water is being lost to the deep groundwater system using the mine as a conduit.

This process is possible under the following scenario. The area around the mine has high topographic relief. The current water level in the mine is Elev. 6,200 ft. The level of Grizzly Creek (about 2½ miles to the southwest) is around Elev. 5,000-5,500 ft, some 700-1,200 ft lower. The level of Indian Creek, some five miles to the northwest, is about Elev. 3,000 ft, some 2,400 ft lower. The hydraulic gradient to these two

possible regional groundwater receptors is about 0.1. Based on the evaluations of Toth et al (1963), it has become clear that deep groundwater circulation patterns differ from shallow patterns, because heads at depth are less dramatically influenced by topography. This effect is illustrated below by a figure from Freeze and Cherry.



GROUNDWATER FLOW NET IN A TWO-DIMENSIONAL VERTICAL SECTION THROUGH A HOMOGENIOUS, ISOTROPIC SYSTEM BOUNDED ON THE BOTTOM BY AN IMPERMEABLE BOUNDARY (after HUBBERT, 1940)

Accordingly, it is possible to have head conditions in the Walker Mine area which cause groundwater inflow to the mine near the surface, and flow out of the lower portions of the mine to the deep groundwater system.

It is possible to obtain an appreciation of the possible flow ranges which might occur by back-analyzing flow from the mine using some assumptions:

1. The head at an elevation of 4,000 ft (3,000 ft below surface at the mine) is 5,000 ft elevation (about half way between the mine water head and that at Indian Creek.
2. Flow is down the orebody fault zone only.
3. The fault zone in which flow occurs is 40-ft wide and 6,000-ft long.
4. Flow is downward.

Using these assumptions, the flows which result out of the mine are:

Hydraulic Conductivity (cm/s)	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}
Flow (gpm)	0.2	2	20	200	2000

A typical hydraulic conductivity for fractured rock is in the range of 10^{-4} cm/sec to 10^{-5} cm/sec. This suggests a reasonable flow estimate for present discharge from the mine to deep groundwater is about 20-200 gpm, which is in the same order as groundwater inflow to the mine.

2.2.5 Summary of Present Mine Flow System

A summary of the estimated mine inflow and outflow system is as follows:

Component	Winter (min)	Spring (max)
Surface Water	0	3000
Groundwater	50-200	50-200
Total Input	50-200	3050-3200
Deep Flow	20-200	20-200
Portal Flow	0-50	3000
Total Output	20-250	3020-3200

As can be seen, this is roughly in balance.

2.2.6 Evaluation of Remedial Actions

2.2.6.1 Do Nothing Alternative

In this alternative, the mine is allowed to flush of its own accord. Based upon continuing leaching of broken ore left in stopes and mineralized wall rocks fractured by mining, as little as 100,000 tons would continue to produce acidic, copper-bearing water at a concentration of 3 mg/l (Figure 6) for over a century. It appears clear that acid drainage can be expected to continue for a long time if unabated.

2.2.6.2 Effects of Installing a Seal in the 700 Level Access Adit

The proposed action is to install a seal in the main access adit which will cause the water level to build up in the mine. The mine water buildup will continue until inflow is equal to outflow in the mine system. The most probable effect of the water level rise in the mine will be to reduce groundwater inflow and increase the deep groundwater outflow. It is expected that the equilibrium water level will be considerably below the Piute Shaft outlet so no direct egress of the mine water to the surface is expected. The level to which the water will rise is a very strong function of the success of diverting surface water away from the Piute and Central Orebody sinkholes; therefore, it is difficult to estimate the final level. In addition, this level will fluctuate in the mine on a seasonal basis.

It is possible, but extremely unlikely, that there is no significant deep groundwater discharge from the mine. If this extreme condition were to occur, the water level would probably rise to the next exit from the mine (apparently the Piute Shaft at elevation 6,600 feet), or until the inflow is equalled by the outflow from the mine into the containing host rock.

The minimum time that it would take for the water level to rise up to the level of the Piute Shaft Landing Adit can be estimated by assuming no flow from the mine into the rock, and this calculation is presented below:

Volume to be filled = 297,000,000 gal (Table 1)
Time at 420 gpm = 1.3 years
Time at 50 gpm = 11.3 years

It would appear that refill to the level of the Piute Shaft collar could take between 5 and 10 years, given reasonable success diverting flows around the sinkholes, and <u>given the extreme assumption of no groundwater outflow within the mine workings</u>.

Flow could possibly occur from the Piute Shaft area under this scenario. This flow is expected to be no higher than 10 gpm because the head driving the inflow of groundwater would reduce as the water level rose in the mine workings, provided the diversion of the South Fork of Ward Creek around the Central Section sinkhole area was adequately maintained.

This flow would probably be of a similar quality to the water currently discharging from the main adit, as acid generation will continue in the un-submerged parts of the North, Central and 712 Orebodies, and it is mainly this water which would pass down through the 700 Level haulage connection and flow out of the Piute Shaft.

2.2.6.3 Additional Plugging to Isolate Piute Section

An alternate remedial strategy to avoid flow from the Piute Shaft after sealing the main portal is to isolate the Piute Section. This could be achieved by plugging the only connecting drift between the Piute and

712 Sections on the 700 Level at Elev. 6,200 ft. This could be done in two ways:

1. Before sealing the main adit, using conventional methods. This would require rehabilitating the 700 Level haulage to the plug location and installing the plug. It would provide a positive seal in this location.

2. After sealing the main adit, using a seal implaced via boreholes. This would be done from surface, and might be less effective than the conventional seal due to extreme difficulty of hitting the small target drift and ensuring an effectively watertight seal.

If a plug were successfully emplaced in this location, and if inflows were not balanced by net flows recharging the groundwater systems, the entire mine would likely refill with water, thus eliminating further acid generation through exclusion of oxygen.

2.2.7 Conclusions

The conclusions of this hydrologic evaluation are:

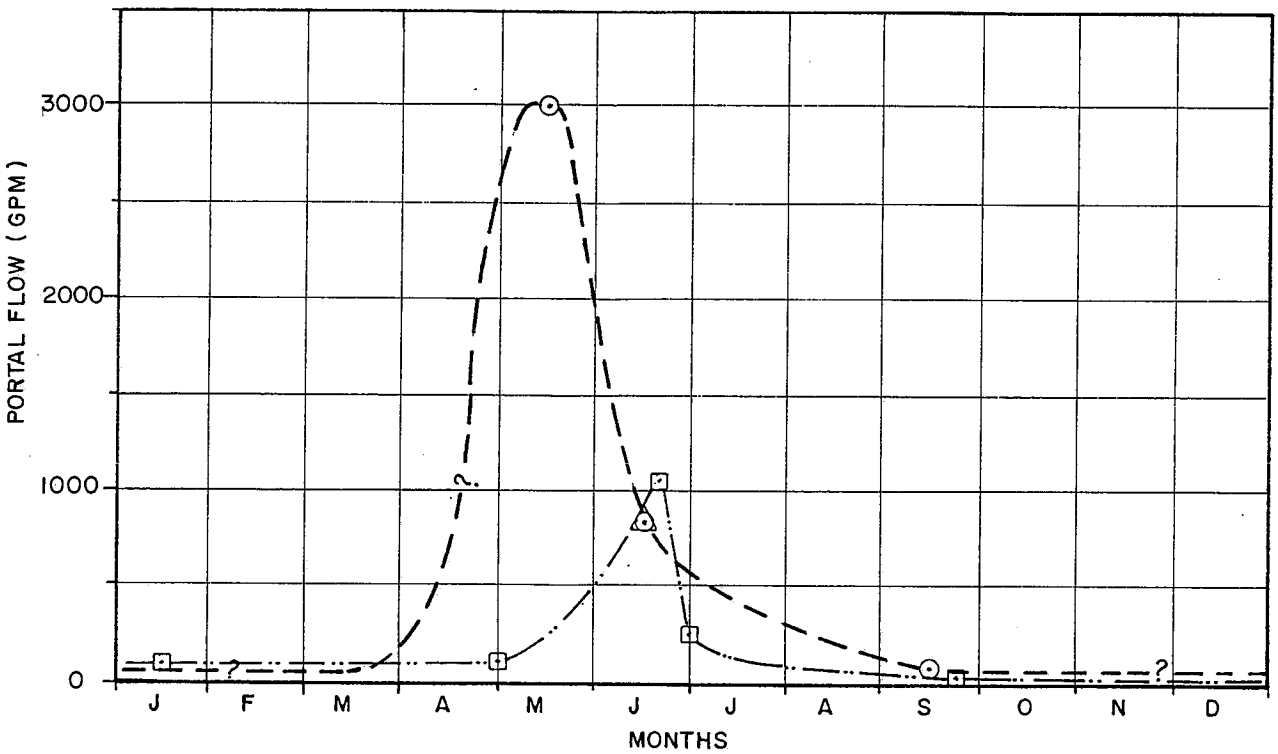
1. Sealing the main 700 Level Adit of Walker Mine will effectively remove the main source of copper contamination from Little Grizzly Creek, assuming there are no other, as yet unidentified outlets. The possibility of seepage of acid mine water from the flooded workings to surface in the catchment of Dolly Creek is considered to be extremely remote.

2. There is only a remote chance that a small flow of acidic water containing dissolved copper could ultimately occur from the Piute Shaft area, as a result of the single-plug strategy.

3. The remote chance of possible flow from the Piute Shaft could be minimized, and probably eliminated, by emplacement of another seal to separate the main mine from the Piute Section in addition to diverting surface water from the mine. This precaution would be extremely expensive, and is considered to be unjustified in view of alternative precautions and the low risk of flow.

4. Observations indicating a significant recharge of the groundwater system through outflow from the mine workings add substantially to confidence that equilibrium will be reached before the level of water in the mine workings rises to the level of the Piute Shaft Landing Tunnel (6,585 ft elevation).

5. The magnitude of the outflow inferred from the lower workings suggests a deep groundwater flow path from the mine. The orientation of regional faults (which appear from underground observation to be aquacludes) runs perpendicular to the direct path from the workings to the valley of the Little Grizzly Creek, and would tend to inhibit flow in this direction. Visual observation revealed no seepage into the valleys of the Dolly or Little Grizzly Creeks which could be identified as groundwater recharged from the Walker Mine workings.



⊙ 1978 (KABACK, 1978)

△ 1978 (MATTEOLI, 1978)

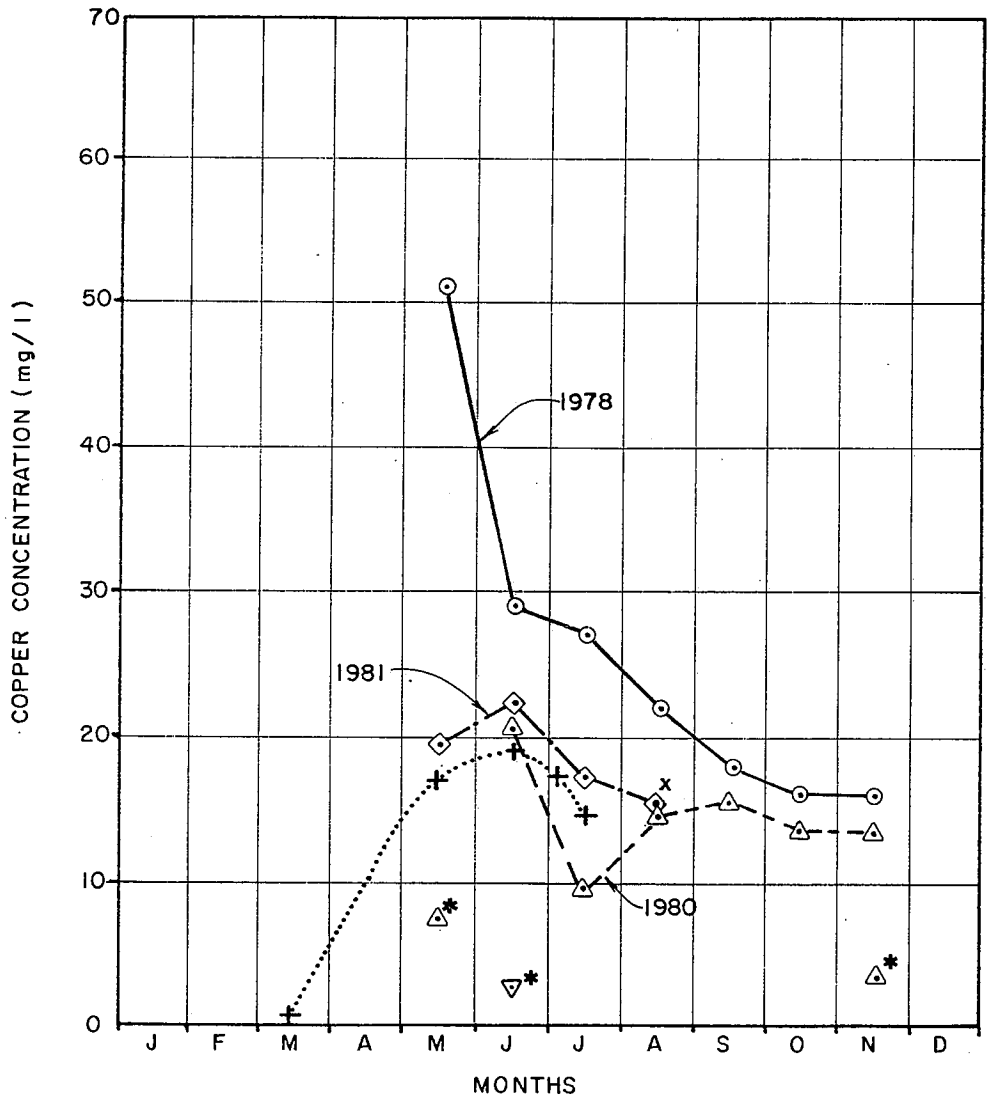
⊡ 1985 (CROYLE, 1985)

PROJECT NO. 6901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 5
DATE 3/85	Consulting Engineers	MINE OUTFLOWS
REVISION NO. 0		

⊡ 1977 (MATTEOLI, 1977)
⊙ 1978 (KABACK, 1978)
▽ 1978 (MATTEOLI, 1978)
◇ 1980 (HART, 1980)
△ 1981 (HART, 1981)
x 1984 (CRAWFORD)
+ 1985 (CRONE)

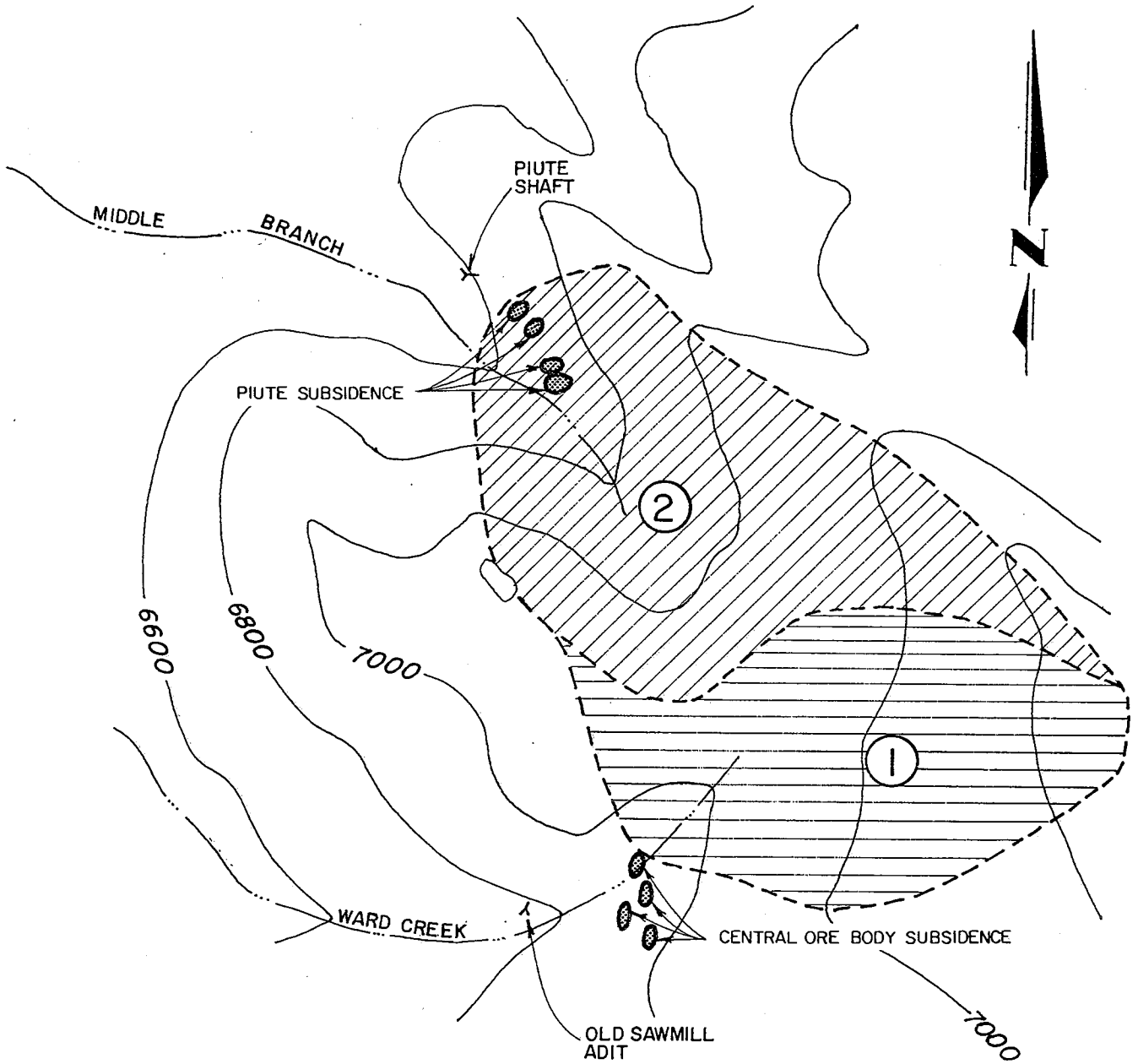
NOTE

DATA FROM AMAX LABS NOT INCLUDED AS Cu ≃ 0 mg/l



* pH ≃ 6-7, UNACIDIFIED SAMPLE ?

PROJECT NO. 6901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 6
DATE 3/85		COPPER CONCENTRATION FROM PORTAL
REVISION NO. 0		



AREA (1) = 212 ACRES

AREA (2) = 234 ACRES

0 1500
SCALE IN FEET

PROJECT NO. 6901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 7
DATE 3/85		CATCHMENT AREAS
REVISION NO. 0		

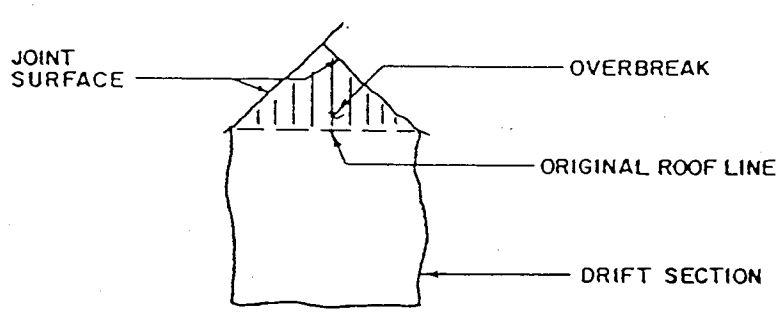
2.3 Geology and Geotechnical Considerations

2.3.1 Condition of Main Access

The main access drive was examined in order to determine its condition and its suitability as a site at which to install a bulkhead. Figure 8 shows schematically the main drive.

The first 1,300 ft of the drive from the mine portal is heavily supported. Timber square sets on approximately 3 ft centers are used, together with timber lagging. The surrounding ground is highly weathered granodiorite which has, in places, a soil-like consistency.

Beyond 1,300 ft from the portal, ground conditions are excellent. There is no installed support, little indication of blast damage, and no indication of any stress-induced failure. Due to the blocky nature of the ground, overbreak had been experienced during the original driving. The overbreak was generally in the roof as shown below:



The overbreak was a result of falls of ground along intersecting joint planes. The nature of the overbreak indicates a general lack of confinement on the rock mass

which, in turn, implies that a high in situ stress field does not exist.

A number of faults and shear zones were observed. These zones generally transect the drift at approximately right angles. The zones consisted of a composite of sheared and altered granodiorite and clay gouge. Due to the presence of the clay gouge, it is considered that such zones will act as regional groundwater barriers.

With the exception of the poor ground adjacent to the mine portal, the main access drift was essentially dry.

2.3.2 Rock Mass Classification

2.3.2.1 General

In order to summarize key geological and geotechnical data and to provide a tool for decision making during design, a system of rock mass classification and rating has been used. This type of classification makes use of measurable parameters in an attempt to minimize judgemental bias. This gives an effective quantitative method of rock mass description. The suggested method of rock mass description developed by the International Society for Rock Mechanics (1977), lists the following parameters:

- Number of joint sets;
- Orientation;
- Spacing (block size);
- Condition of joint walls;
- Joint roughness;
- Joint persistance;
- Joint opening; and
- Water seepage.

All of these parameters can either be directly measured or scaled against carefully calibrated descriptive scales.

To summarize these parameters into a single value, a rock mass classification system is used. The system considered appropriate to the bulkhead design at the Walker Mine was developed by Barton et al. (1974) and subsequently modified by Kirsten (1983). Rock mass quality (Q) is related to the parameters described above by the following expression:

$$Q = \frac{RQD}{Jn} \cdot \frac{Jr}{Ja} \cdot \frac{Jw}{SRF}$$

where RQD is the Rock Quality Designation, a measure of joint spacing, Jn the number of joint sets present, Jr the joint roughness, Ja joint alteration, Jw a measure of water pressure, and SRF a measure of the in situ stress condition.

2.3.2.2 Rock Mass Rating

Two important parameters relating to bulkhead design are rock mass strength, which in part will control the position and length of the bulkhead, and rock mass permeability, which will control the risk of leakage past the bulkhead. These parameters are both functions of rock mass quality.

An initial rock mass quality rating has been estimated from a number of observations and measurements carried out in the main access drive. Figure 9 shows the results of the observations made in granodiorite (the dominant rock type) while Figure 10 shows the results obtained in the hornfels schists that occur adjacent to

the orebody. The figures give the ratings obtained using the Q-system proposed by Barton et al (1974). For corroboration purposes, the CSIR system developed by Bieniawski (1973) was also undertaken.

The ratings from both systems indicated that the rock mass in the main access drive (granodiorite) can be regarded as good quality (Q-system) or very good quality (CSIR-system). The hornfels schists adjacent to the orebody are of slightly lesser quality, being rated as fair quality (Q-system) and good quality (CSIR-system).

The ratings estimated are in agreement with the observed conditions of the main access drive and the footwall drives visited which have stood unsupported for periods in excess of 40 years without deterioration.

2.3.3 Site Characterization

2.3.3.1 Geology

The Walker Mine is situated in a series of metasediments that have been metamorphosed by the intrusion of the Sierra Nevada Batholith. At the southern end of the mine, the hornfels and intruding diorite are unconformably overlain by flat-lying volcanic and clastic rocks.

The ore deposits consist of a series of vein-like pods with mineralization occurring in or adjacent to granitoid veins in hornfels and diorite. Major ore minerals include chalcopyrite, pyrrhotite, pyrite, cubanite, magnetite and sphalerite.

Structures in the mine area include cleavage, joints, and faults. The D'Appolonia report (1979) states

that the orientation of cleavage in the hornfels above the mine is northwest-trending and dips 53° to the southwest (approximately the same strike as the orebody). Jointing was observed in the main access drive and generally two sets, in addition to the cleavage, are present. Faulting is also evident in the main access drive and, according to the D'Appolonia report (1979), has been mapped on surface. The dominant fault set trends north to northwest and dips 50° to 80° east to northeast. A subordinate and apparently conjugate set trends northeast to east and dips 50° to 80° southeast to south. A more complete description of regional and local geology is given by D'Appolonia (1979).

2.3.3.2 Material Properties - Strength

The bulkhead and the surrounding rock can be regarded as a discontinuum consisting of a series of blocks of intact rock and concrete, separated by various planes of weakness. The behavior of this system will be controlled by both the strength and deformation moduli of the intact material and the strength and stiffness along the planes of weakness.

Values for these various components of strength have been evaluated from a number of simple field observations and measurements and from published data.

Intact Rock Strength

Intact rock strength was estimated from a series of simple field measurements. These indicated that the uniaxial compressive strength of the granodiorites is in the range of 22,000 to 29,000 psi. The hornfels schist is weaker with an estimated uniaxial compressive strength in the range of 12,000 to 17,000 psi.

A cross-check on these estimated strengths was carried out with the aid of the relationship between uniaxial compressive strength, vertical stress and tunnel condition given by Hoek and Brown (1980). The relationship is shown in Figure 11. The access tunnel and the footwall drifts were found to be in a stable condition (i.e. $p_2/\sigma_c = 0.1$ in Figure 11). It has been assumed that the vertical stress is equivalent to the overburden load of approximately 1,450 psi. Entering this value on Figure 11 and projecting up to the $p_2/\sigma_c = 0.1$ line, the minimum uniaxial compressive strength can be read off. This value is 16,000 psi and compares well with estimates done from field measurement.

Rock Mass Strength

Hoek (1983) has developed a failure criterion that can be used to predict rock mass strength. A series of approximate equations were derived that allow Mohr's strength envelopes to be constructed for different rock types and quality.

The rock mass classification outlined in the previous section was used to determine the appropriate strength equations as shown in Figure 12. From these equations, failure envelopes were constructed and are shown in Figure 12 for both the granodiorite and hornfels schist.

Strength at Rock-Bulkhead Interface

The strength along the rock/bulkhead contact is dependent upon the following parameters:

- Rock/concrete frictional and adhesion properties;

- The roughness and size of asperities along the rock surface;
- The condition of the rock; and
- The stress acting across the contact.

Strength estimates have, therefore, been based upon a series of field observations and tests, and published data.

The roughness and size of asperities found along a potential shear surface have a major influence on the shear strength of that surface. Patton (1966) has demonstrated that the roughness angle (i) can be combined with the base friction angle ($\emptyset_b$) of the surface to obtain an estimate of the peak frictional strength available along the surface.

Observations in the main access drift indicate that at least two orders of asperities exist. These are illustrated in Figure 14. The first order asperities reflect the roughness along individual joint planes and have been termed the roughness factor. The second order of asperities are at a greater scale and arise due to the intersection of joints with different orientations. This has been called the step factor.

For failure to occur along the rock/bulkhead interface, the following sequence of events must take place:

- The base frictional properties between the concrete and the rock must be exceeded;

- Shear through or dilation over the first order asperities (roughness factor); and

- Shear through or dilation over the second order asperities (step factor).

The peak strength of the contact (τ_p) is, therefore, a function of

$$\tau_p = f\ (\tau_b, \tau_r, \tau_s)$$

where τ_b is the strength component attributable to the base frictional properties, τ_r the strength component attributable to the roughness factor and τ_s the strength component attributable to the step factor.

An estimate of base frictional strength of the two principal rock types can be made from published data. Figure 15 shows a composite of results obtained by Einstein et al, 1979. The granodiorite rocks fall within the Group IV rock (Figure 15) while the hornfels schist falls within the Group III rock (Figure 15).

From Figure 15, it is estimated that the base frictional strength of the granodiorite is 30° and that of the hornfels schist 25°.

A number of observations were made underground on joint roughness. These observations indicate that some 2° can be added to the base frictional strength to account for surface roughness.

As can be seen from Figure 14, the walls of the access drive comprise a series of large rock steps. The average relief change over one of these steps is approximately 8 inches. Any shear surface along a bulkhead/rock contact must either pass through the rock mass or dilate over the step. To account for this effect, the peak frictional strength can be increased. Based upon

results given by Robertson (1971), it is considered that 15° can be added to the base friction angle to account for the stepped rock surface.

Based upon the above discussion, the peak frictional strength available along the rock/bulkhead is estimated to be:

$$\tau_p = \tau_n \tan (30^{o} + 2^{o} + 15^{o}),$$

where τ_n is the normal stress acting across the contact.

2.3.4 Bulkhead Design

2.3.4.1 Location

Two bulkhead positions have been considered. The first is in the main access drive and is intended to block the main discharge point of mine water. However, this will in turn cause the mine water to backup within the old workings until it might eventually issue out of the Piute Shaft. In order to minimize the consequences of this, a second bulkhead could be located between the 712 Orebody and the Piute Orebody. As indicated in Section 2.2.7.3, the installation of an internal plug is not recommended. Consideration of its technical feasibility and the cost of its construction is necessary for an effective evaluation of its merits on a cost/benefit basis.

The approximate locations of the two bulkheads is shown in Figures 3 and 4. The main bulkhead is positioned approximately 2,700 ft from the mine portal. Figure 16 shows the profile of the roof, floor and walls. The position was specifically chosen for its geometry; the narrowing of the drive at that point will greatly enhance the stability of the bulkhead.

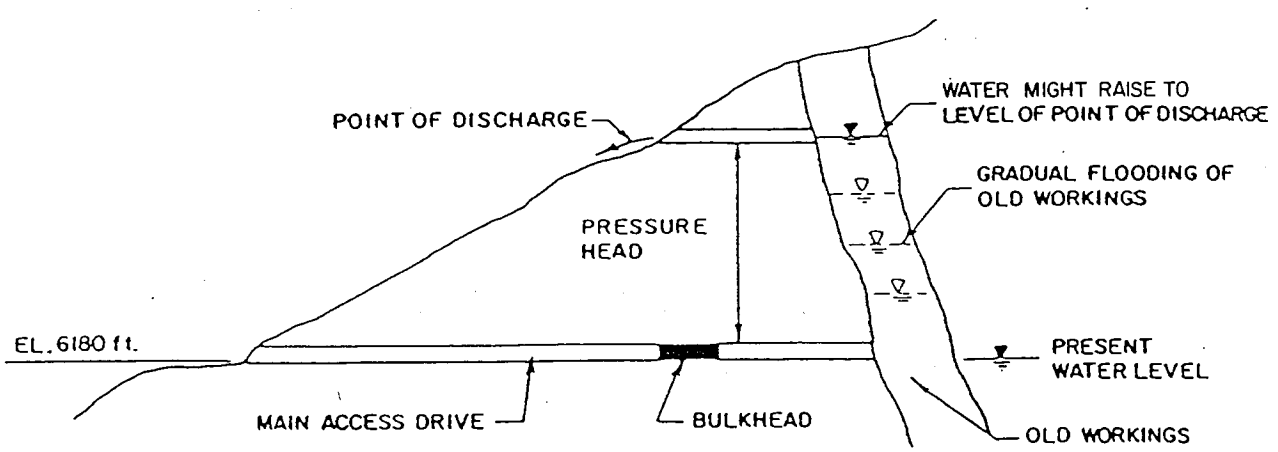
2.3.4.2 Design

The stability of a bulkhead will depend upon several factors. These include:

- The water pressure applied to the bulkhead;
- The strength of the bulkhead;
- The strength of the surrounding rock; and
- The strength along the bulkhead/rock interface.

Pressure on Bulkhead

The water pressure on a bulkhead is dependent on the head of water maintained behind it. As the flow of water is stopped by the bulkhead, the water will gradually back up through the mine until equilibrium is reached or a higher exit point is encountered. The difference in elevation between the higher exit point and the bulkhead elevation represents the pressure head the bulkhead has to resist. This is shown on the following drawing.



Two bulkhead locations have been studied, namely the main bulkhead and the Piute bulkhead. Examination of old mine records and plans indicate that with only the main bulkhead in place, the next point of egress for mine water will be the Piute Shaft. The difference in elevation between the Piute Shaft Landing Tunnel and the main bulkhead is approximately 390 ft. However, with both the main and Piute bulkheads in place, the point of egress for water contained between the two bulkheads will be the Old Sawmill Adit where it exits from the caved area above the Central Orebody. The pressure head in this instance is 570 ft. It should be noted that the water contained beyond the Piute bulkhead could still exit from the Piute Shaft.

For design purposes, it has, therefore, been assumed that the higher head acts against both bulkheads. In addition, a factor of safety of 2.5 has been applied to this head giving a design pressure head of 1,400 ft.

Bulkhead Dimensions

The water retained behind a bulkhead exerts a load on the bulkhead. This load is transferred to the surrounding rock in the form of shear stresses. It has been assumed, for design purposes, that the stress distribution is uniform over the length of the bulkhead.

Based upon the above assumptions, the bulkheads can be dimensioned by using the following relationship (Garret and Pitt, 1961):

$$l = \frac{p \cdot a \cdot b}{2(a + b)\, f_s}$$

where:

p = pressure applied to the bulkhead

a = width of bulkhead

b = height of bulkhead

l = length of plug

f_s = safe average shear stress

The two bulkheads would be placed in approximately 12 ft x 12 ft drifts. By using the pressure head established in the previous section, the relationship can now be written as:

$$l = \frac{1400 \times (0.434)\ (12 \times 12)\ (12 \times 12)}{2\ (12 + 12)\ (12)\ fs}$$

$$= \frac{21874}{f_s} \text{ units in } \frac{lb/in}{lb/in^2}$$

F_s, the safe average shear stress can be estimated from Section 2.3.3.2, Material Properties. In this section, it was shown that, due to the roughness and stepped nature of the tunnel walls, any shearing along the bulkhead/tunnel interface will result in either dilation over the surface or shear through the rock mass.

The shear strength of the rock mass can be estimated from the curves shown in Figure 13. For design purposes, it has been assumed that there is little or no normal load acting across the bulkhead/rock interface. The design shear stress used is, therefore, the intercept on the shear stress axis. By using the value at $\sigma_n = 0$ (i.e. assuming no normal load across the interface; a conservative assumption), the estimated length of the bulkheads is:

granodiorite = 10 ft

hornfels schist = 14 ft

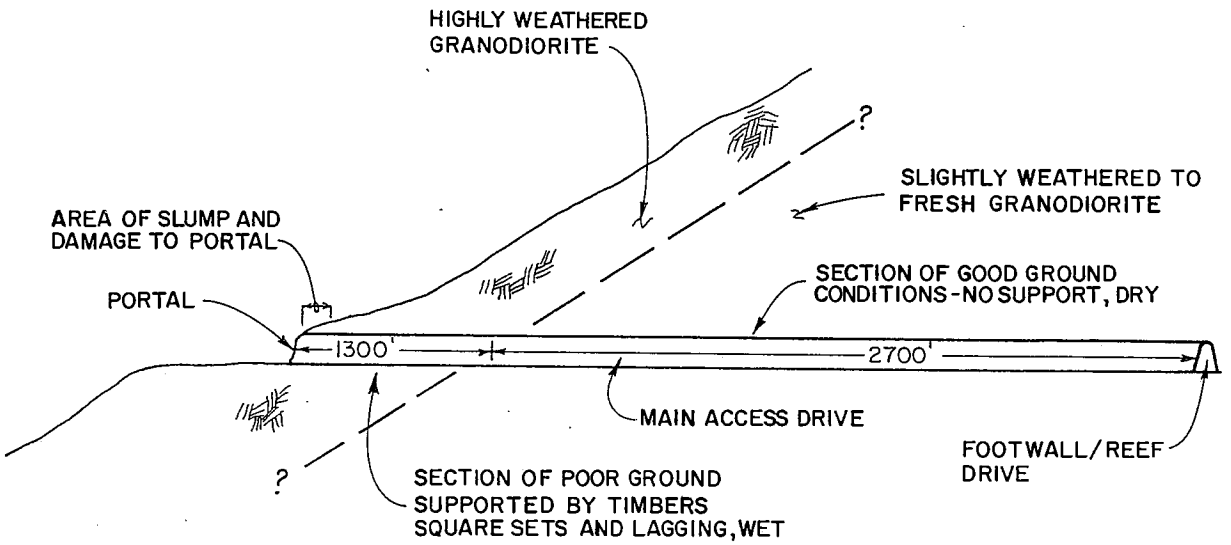
If dilation occurs, shearing has to occur within the plug. Therefore, a similar exercise was carried out by using an appropriate f_s value for concrete. The strength of concrete was taken as 2000 psi at 28 days. Some 10 ft of bulkhead length was found to be sufficient to preclude shear failure through the concrete. Therefore, to ensure the stability of the bulkhead, minimum bulkhead lengths of 10 ft in fresh granodiorite rocks and 14 ft in hornfels schists are required.

Practical experience gained in high pressure bulkheads used in South African gold mines has indicated that it is generally more difficult to stop leakage around a bulkhead than to make it strong enough to resist thrust. Recommendations put forward by Cummins and Given (1973) indicate that the pressure gradients along the plug should be moderate and experience has proven that gradients of up to 40 psi per ft are effective (though in a number of cases, gradients of up to 400 psi per ft have been achieved). By using the design pressure head of 1,400 ft (608 psi), the bulkhead length necessary to obtain the required pressure gradient is 15 ft. This value is in excess of the length necessary for bulkhead stability. It is, therefore, recommended that both the main bulkhead and the Piute bulkhead be 15-ft long.

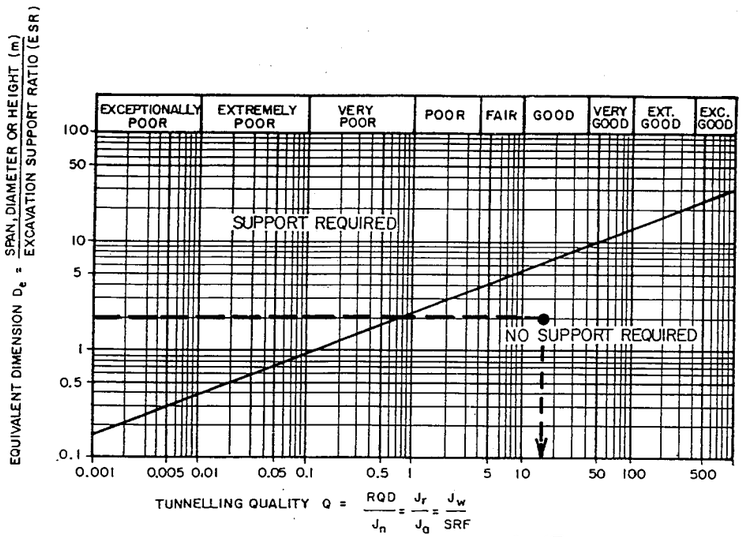
2.4 Results

Observations on surface and underground at the Walker Mine provided substantial confirmation of hydrological and geotechnical data derived from previous reports, relevant literature and the SRK team's past experience. Confidence in the available and derived data was sufficient to permit design and specification of the concrete bulkheads considered as seals in the 700 Level tunnel between the Piute and 712 Sections, and in the Access Adit close to its intersection of the South Orebody.

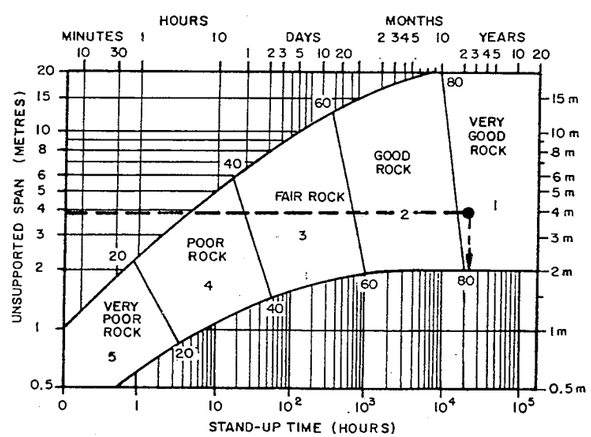
Observation of the condition and dimensions of the 700 Level Adit provided sufficient information to permit fairly accurate (-10% to +25%) estimates of construction costs for the proposed main (Adit) bulkhead seal. The 700 level Haulage had not been cleaned beyond the South Orebody at the time of the site visits, but the work required to clear it sufficiently to permit access for construction of an internal plug between the 712 and Piute Sections was estimated on the basis of visual inspection on June 19, 1985.



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 8
DATE 3/85	Consulting Engineers	MAIN PORTAL SECTION
REVISION NO. 0		



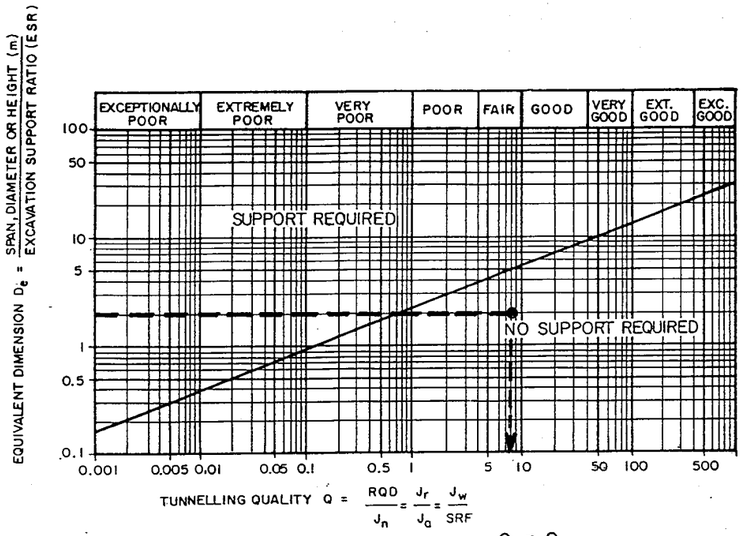
Q = 17



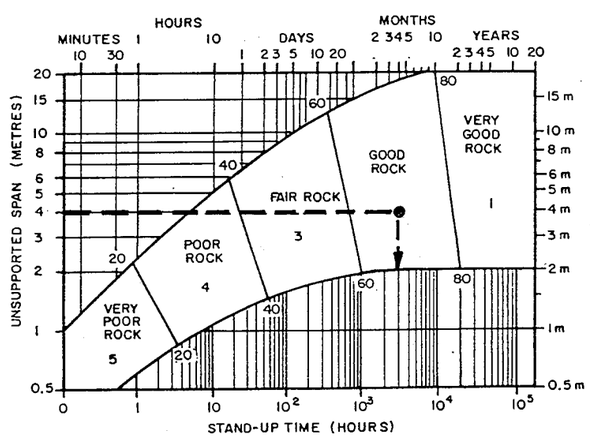
RMR = 81

CSIR Classification System		NGI Classification System	
Parameter	Rating	Parameter	Rating
Strength	12	RQD	100
RQD	20	Joint Set No.	6
Spacing	20	Joint Roughness No.	1.0
Condition	20	Joint Alteration No.	1.0
Groundwater	7	Joint Water Reduction	1.0
Orientation	—	Stress Reduction	1.0
Rock Mass Rating (RMR)	81	Tunneling Quality (Q)	17
Comments			

PROJECT NO. 06901	PREPARED BY STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 9
DATE 3/85		TYPICAL ROCK MASS CLASSIFICATION RATING FOR GRANODIORITE
REVISION NO. 0		



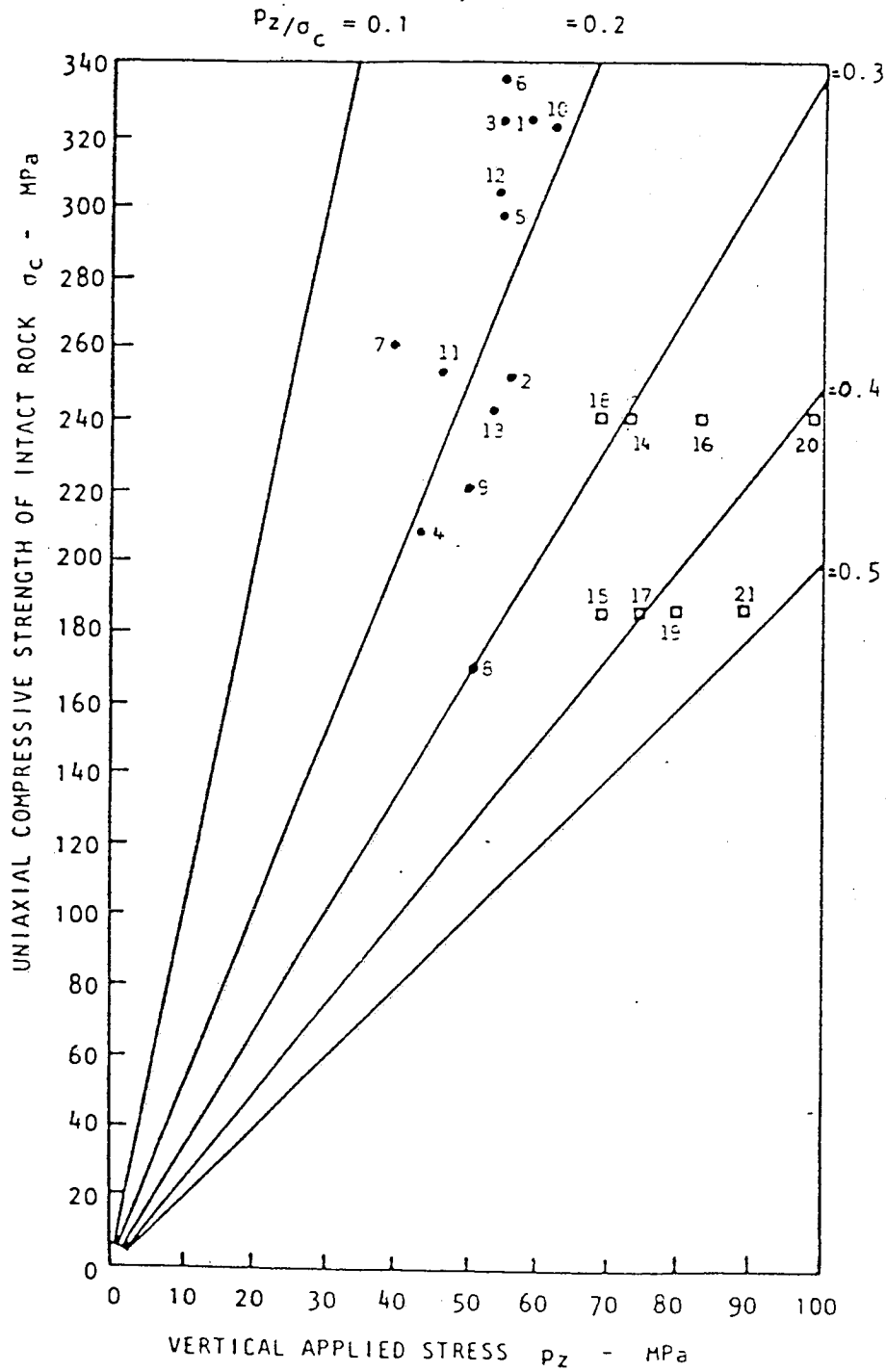
Q = 8



RMR = 64

CSIR Classification System		NGI Classification System	
Parameter	Rating	Parameter	Rating
Strength	7	RQD	70
RQD	15	Joint Set No.	9
Spacing	20	Joint Roughness No.	1.0
Condition	15	Joint Alteration No.	1.0
Groundwater	7	Joint Water Reduction	1.0
Orientation	—	Stress Reduction	1.0
Rock Mass Rating (RMR)	64	Tunneling Quality (Q)	8
Comments			

PROJECT NO. 06901	PREPARED BY STEFFEN ROBERTSON & KIRSTEN	FIGURE 10
DATE 3/85	Consulting Engineers	TYPICAL ROCK MASS CLASSIFICATION RATING FOR HORNFELS SCHIST
REVISION NO. 0		



p_z/σ_c = 0.1 - stable unsupported tunnel.

p_z/σ_c = 0.2 - minor sidewall spalling.

p_z/σ_c = 0.3 - severe sidewall spalling.

p_z/σ_c = 0.4 - heavy support required.

p_z/σ_c > 0.5 - possible rockburst conditions.

NOTE: 1 MPa = 145 PSI

PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 11
DATE 3/85	Consulting Engineers	COMPRESSIVE STRENGTH vs. APPLIED STRESS FOR SQUARE TUNNELS
REVISION NO. 0		

APPROXIMATE EQUATIONS FOR PRINCIPAL STRESS RELATIONSHIPS AND MOHR ENVELOPES FOR INTACT ROCK AND JOINTED ROCK MASSES

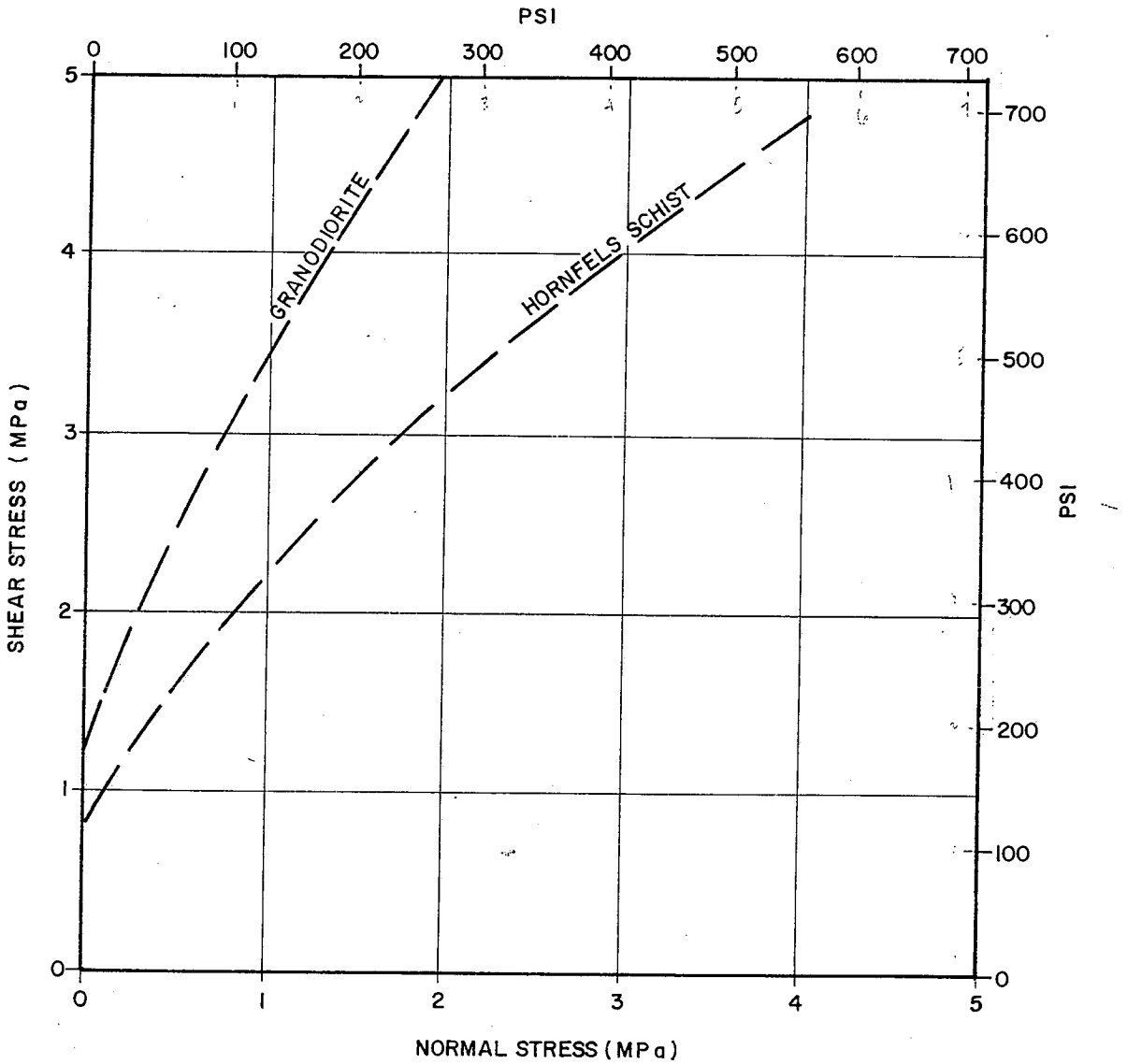
	CARBONATE ROCKS WITH WELL DEVELOPED CRYSTAL CLEAVAGE *dolomite, limestone and marble*	LITHIFIED ARGILLACEOUS ROCKS *mudstone, siltstone, shale and slate (normal to cleavage)*	ARENACEOUS ROCKS WITH STRONG CRYSTALS AND POORLY DEVELOPED CRYSTAL CLEAVAGE *sandstone and quartzite*	FINE GRAINED POLYMINERALLIC IGNEOUS CRYSTALLINE ROCKS *andesite, dolerite, diabase and rhyolite*	COARSE GRAINED POLYMINERALLIC IGNEOUS AND METAMORPHIC CRYSTALLINE ROCKS *amphibolite, gabbro, gneiss, granite, norite and quartz-diorite*
INTACT ROCK SAMPLES *Laboratory size rock specimens free from structural defects* *CSIR rating 100+, NGI rating 500*	$\sigma_{1n} = \sigma_{3n} + \sqrt{7\sigma_{3n} + 1.0}$ $\tau_n = 0.816(\sigma_n + 0.140)^{0.658}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{10\sigma_{3n} + 1.0}$ $\tau_n = 0.918(\sigma_n + 0.099)^{0.677}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{15\sigma_{3n} + 1.0}$ $\tau_n = 1.044(\sigma_n + 0.067)^{0.692}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{17\sigma_{3n} + 1.0}$ $\tau_n = 1.086(\sigma_n + 0.059)^{0.696}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{25\sigma_{3n} + 1.0}$ $\tau_n = 1.220(\sigma_n + 0.040)^{0.705}$
VERY GOOD QUALITY ROCK MASS *Tightly interlocking undisturbed rock with unweathered joints spaced at ± 3 metres* *CSIR rating 85, NGI rating 100*	$\sigma_{1n} = \sigma_{3n} + \sqrt{3.5\sigma_{3n} + 0.1}$ $\tau_n = 0.651(\sigma_n + 0.028)^{0.679}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{5\sigma_{3n} + 0.1}$ $\tau_n = 0.739(\sigma_n + 0.020)^{0.692}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{7.5\sigma_{3n} + 0.1}$ $\tau_n = 0.848(\sigma_n + 0.013)^{0.702}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{8.5\sigma_{3n} + 0.1}$ $\tau_n = 0.883(\sigma_n + 0.012)^{0.705}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{12.5\sigma_{3n} + 0.1}$ $\tau_n = 0.998(\sigma_n + 0.008)^{0.712}$
GOOD QUALITY ROCK MASS *Fresh to slightly weathered rock, slightly disturbed with joints spaced at 1 to 3 metres.* *CSIR rating 65, NGI rating 10*	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.7\sigma_{3n} + 0.004}$ $\tau_n = 0.369(\sigma_n + 0.006)^{0.669}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{1.0\sigma_{3n} + 0.004}$ $\tau_n = 0.427(\sigma_n + 0.004)^{0.683}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{1.5\sigma_{3n} + 0.004}$ $\tau_n = 0.501(\sigma_n + 0.003)^{0.695}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{1.7\sigma_{3n} + 0.004}$ $\tau_n = 0.525(\sigma_n + 0.002)^{0.698}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{2.5\sigma_{3n} + 0.004}$ $\tau_n = 0.603(\sigma_n + 0.002)^{0.707}$
FAIR QUALITY ROCK MASS *Several sets of moderately weathered joints spaced at 0.3 to 1 metre.* *CSIR rating 44, NGI rating 1.0*	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.14\sigma_{3n} + 0.0001}$ $\tau_n = 0.198(\sigma_n + 0.0007)^{0.662}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.20\sigma_{3n} + 0.0001}$ $\tau_n = 0.234(\sigma_n + 0.0005)^{0.675}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.30\sigma_{3n} + 0.0001}$ $\tau_n = 0.280(\sigma_n + 0.0003)^{0.688}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.34\sigma_{3n} + 0.0001}$ $\tau_n = 0.295(\sigma_n + 0.0003)^{0.691}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.50\sigma_{3n} + 0.0001}$ $\tau_n = 0.346(\sigma_n + 0.0002)^{0.700}$
POOR QUALITY ROCK MASS *Numerous weathered joints spaced at 30 to 500mm with some gouge filling / clean waste rock* *CSIR rating 23, NGI rating 0.1*	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.04\sigma_{3n} + 0.00001}$ $\tau_n = 0.115(\sigma_n + 0.0002)^{0.646}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.05\sigma_{3n} + 0.00001}$ $\tau_n = 0.129(\sigma_n + 0.0002)^{0.655}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.08\sigma_{3n} + 0.00001}$ $\tau_n = 0.162(\sigma_n + 0.0001)^{0.672}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.09\sigma_{3n} + 0.00001}$ $\tau_n = 0.172(\sigma_n + 0.0001)^{0.676}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.13\sigma_{3n} + 0.00001}$ $\tau_n = 0.203(\sigma_n + 0.0001)^{0.686}$
VERY POOR QUALITY ROCK MASS *Numerous heavily weathered joints spaced less than 50mm with gouge filling / waste rock with fines* *CSIR rating 3, NGI rating 0.01*	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.007\sigma_{3n} + 0}$ $\tau_n = 0.042(\sigma_n)^{0.534}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.010\sigma_{3n} + 0}$ $\tau_n = 0.050(\sigma_n)^{0.539}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.015\sigma_{3n} + 0}$ $\tau_n = 0.061(\sigma_n)^{0.546}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.017\sigma_{3n} + 0}$ $\tau_n = 0.065(\sigma_n)^{0.548}$	$\sigma_{1n} = \sigma_{3n} + \sqrt{0.025\sigma_{3n} + 0}$ $\tau_n = 0.078(\sigma_n)^{0.556}$

LEGEND

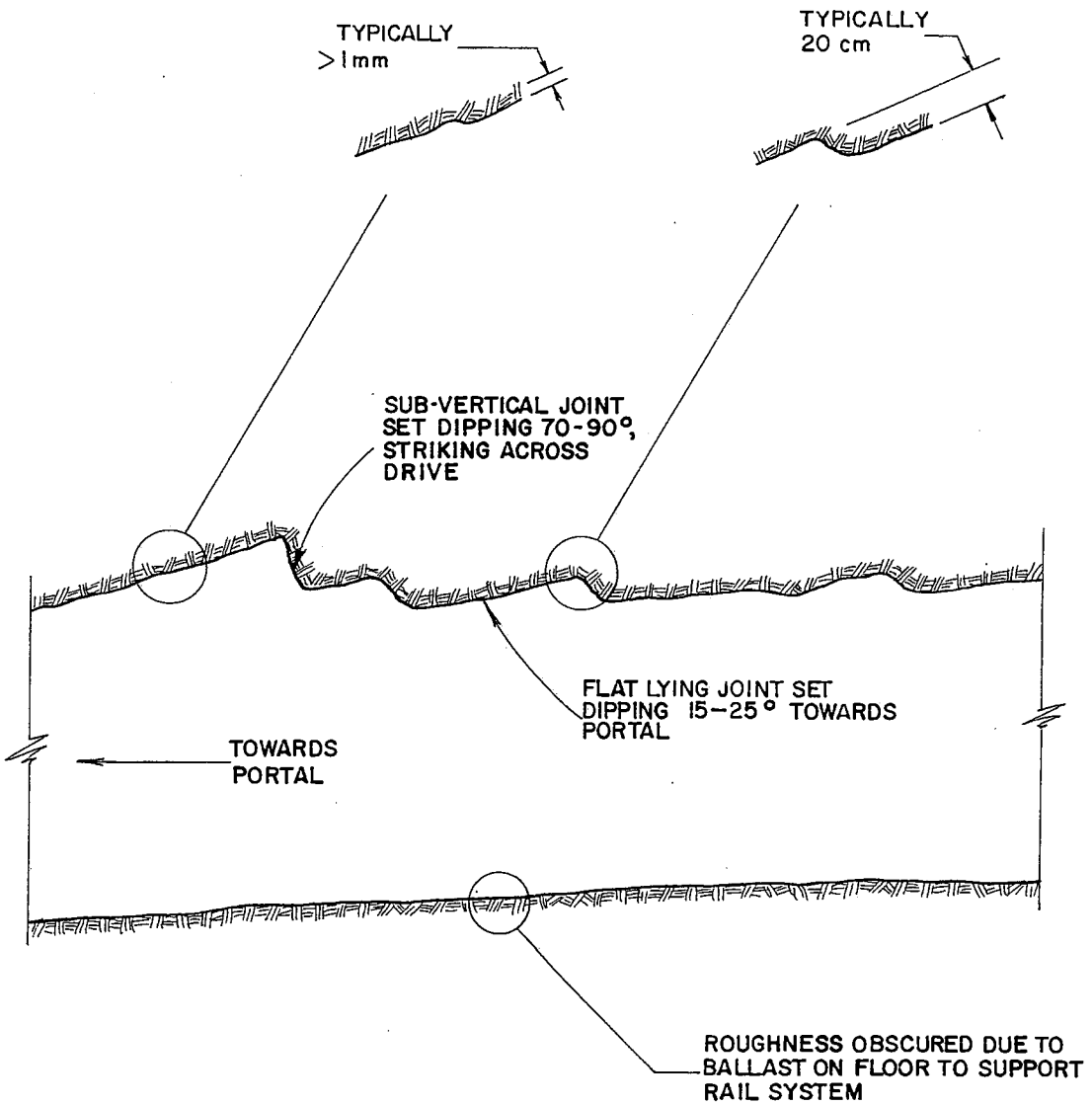
HORNFELS SCHIST

GRANODIORITE

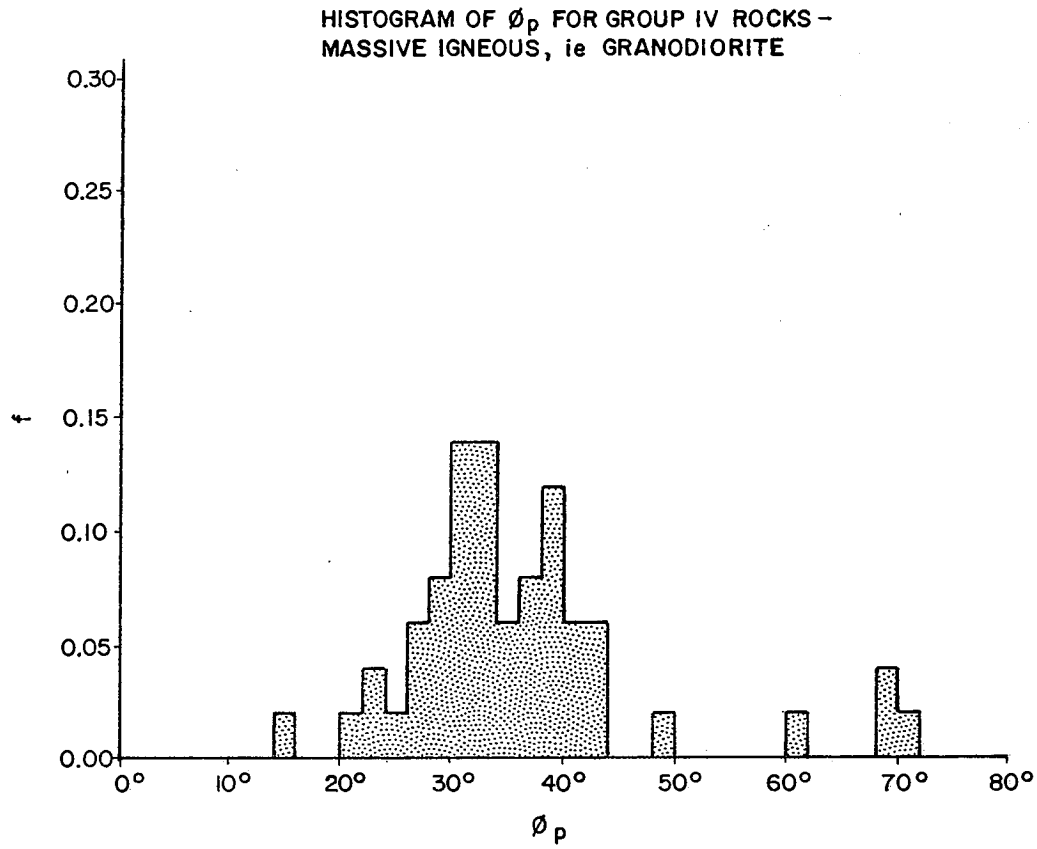
PROJECT NO. 06901	PREPARED BY STEFFEN ROBERTSON & KIRSTEN	FIGURE 12
DATE 3/85	Consulting Engineers	PRINCIPAL STRESS RELATIONSHIPS
REVISION NO. 0		

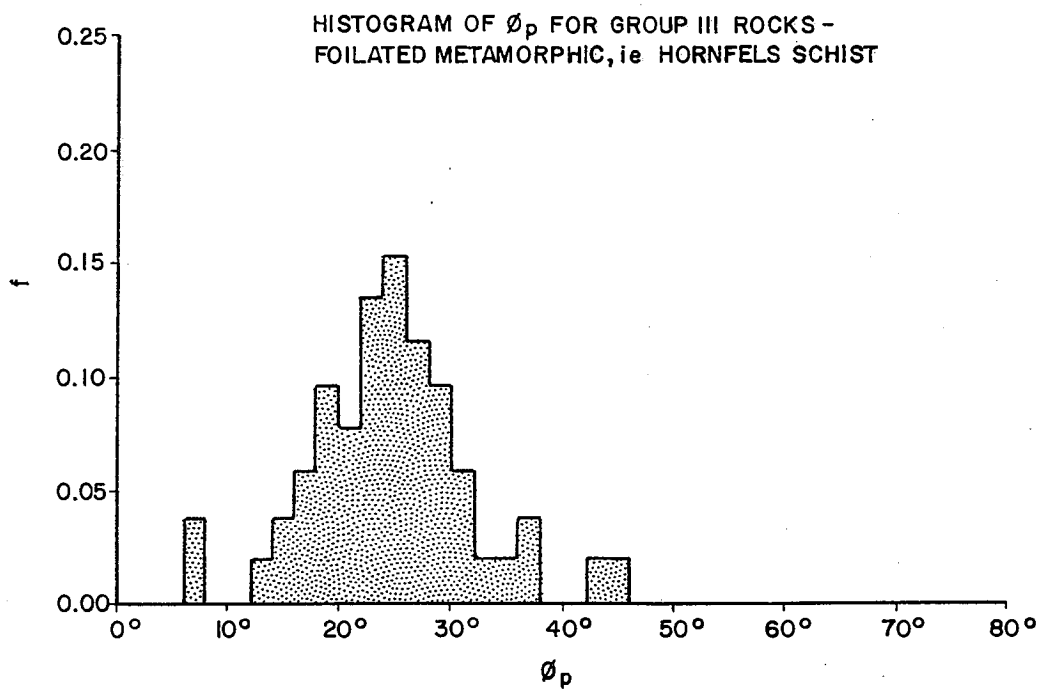


PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 13
DATE 3/85	Consulting Engineers	ESTIMATED SHEAR STRENGTH OF ROCK MASS
REVISION NO. 0		

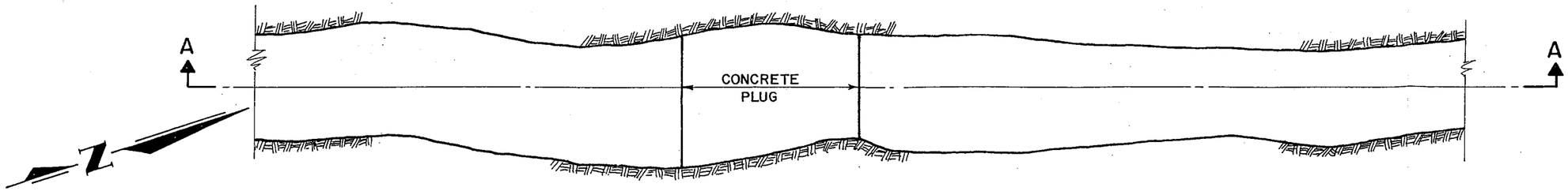


PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 14
DATE 3/85	Consulting Engineers	VERTICAL SECTION THROUGH MAIN ACCESS DRIFT SHOWING ASPERITIES
REVISION NO. 0		

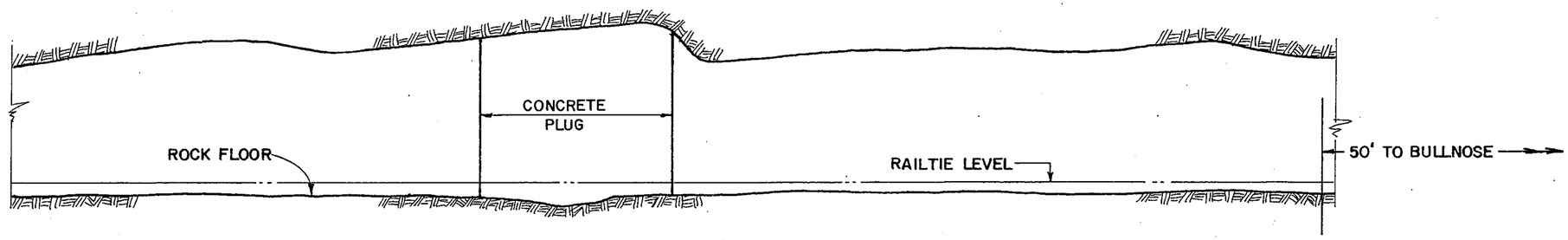




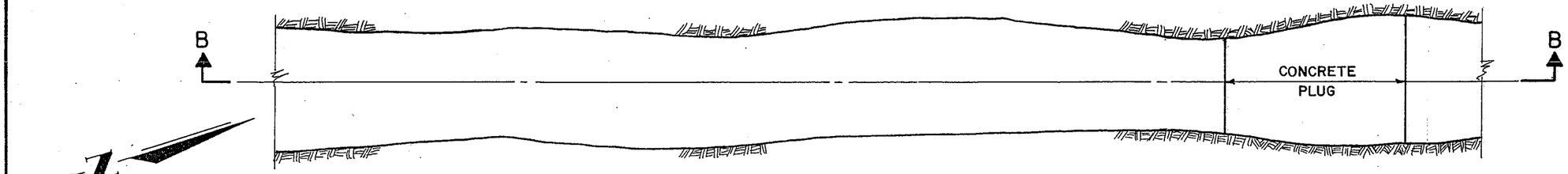
PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	FIGURE 15
DATE 3/85	Consulting Engineers	DISTRIBUTION OF PEAK FRICTIONAL STRENGTH
REVISION NO. 0		



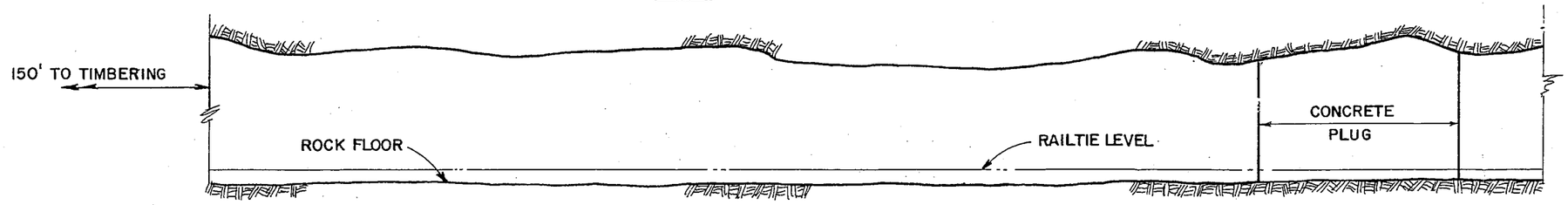
PLAN



SECTION A-A PREFERED PLUG LOCATION (NEAR WORKINGS)



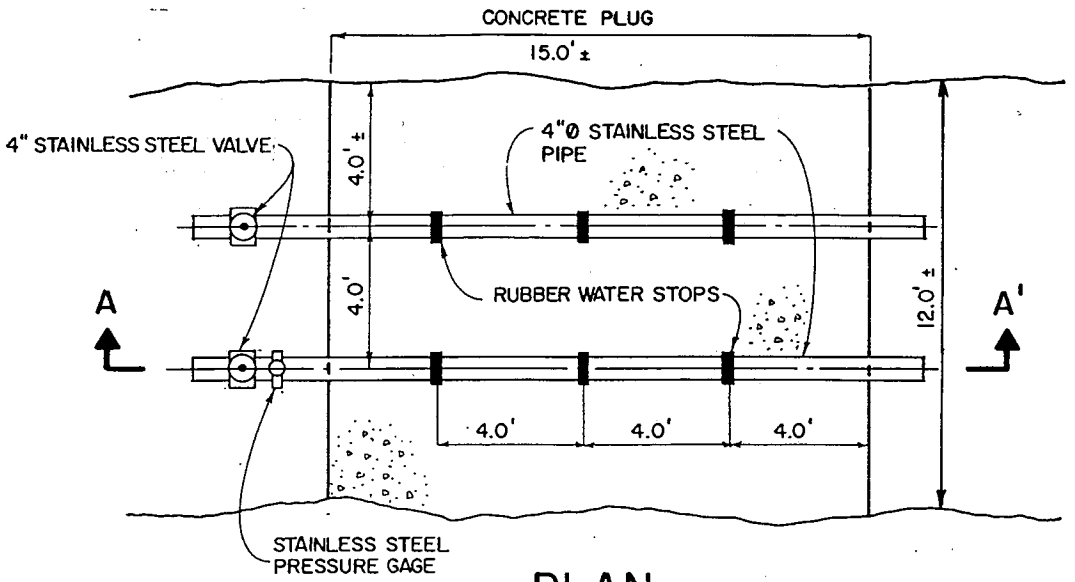
PLAN



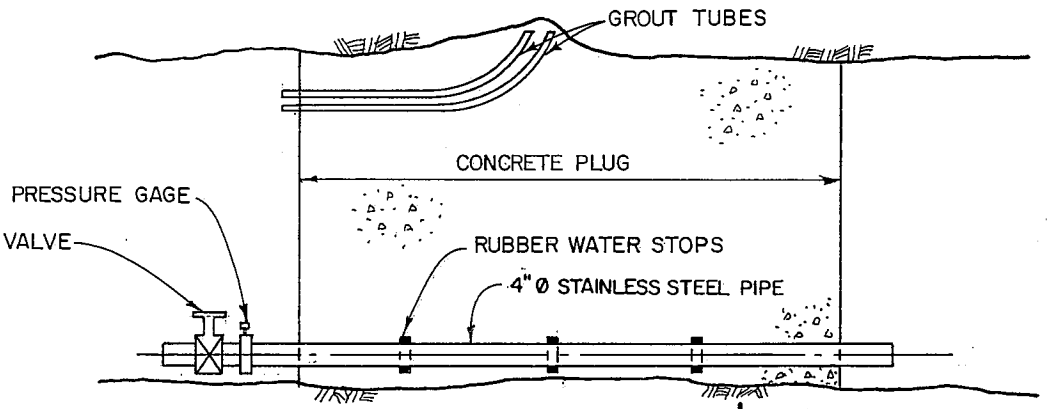
SECTION B-B ALTENATIVE PLUG LOCATION (NEAR TIMBERING)

ROCK FLOOR CONFIGURATION ESTIMATED

PROJECT NO. 06901	PREPARED BY STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 16
DATE 3/85		MAIN ADIT PLUG LOCATIONS PLAN AND SECTIONS
REVISION NO. 0		



PLAN



SECTION A-A'

PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	FIGURE 17
DATE 3/85		TYPICAL DRAIN PIPE DETAILS
REVISION NO. 0		

3.0 PLUG SPECIFICATION AND CONSTRUCTION CONSIDERATIONS

3.1 Plug Specifications

The sections below summarize materials to be used in the construction of the plug. Discussions on the proposed mix design are presented in Appendix I. Technical specifications for bid purposes are presented in the attached addendum to this report.

3.1.1 Location and Dimensions

Main Adit Plug at approximately 12,950 N, 11,420 E
Plug Length = 15 ft
Piute Plug at approximately 18,600 N, 10,000 E
Plug Length = 15 ft

3.1.2 Site Preparation

The plug site shall be cleaned and prepared to ensure an adequate bond between the rock and concrete surfaces. Methods of site preparation shall be proposed by the contractor and approved by the engineer prior to construction. The cleaned and prepared surface shall be approved by the engineer prior to placement of concrete.

Access to the sites may require additional site preparations for transporting construction materials. This shall be done on an as-needed basis. Such site work need not be to the extent of maintaining permanent access, but shall be such that safe working conditions are established.

3.1.3 Formwork

The formwork for the bulkheads shall be constructed of good quality material and in such a manner as to provide a good seal for containment of the concrete and

any grout that may be injected. The design of the formwork shall be sufficient to withstand the fluid pressure of the concrete and any increased pressures due to grouting or concrete placement. The formwork will be subject to the engineer's approval prior to placement of the concrete.

3.1.4 Concrete

The concrete used to form the plugs shall be a 3,000 psi, 28-day strength mix. The mix shall use fine aggregate of the gradation and durability as specified in ASTM C 33-82 and C 117-80. The cement shall be sulfate-resistant Portland cement. Slump shall be 4 to 7 inches (see Appendix 1). Water used in the mix shall be of good quality so as not to degrade the concrete. Mine and mine drainage waters are not acceptable for use in the concrete mix. The mix design and admixtures are presented in Section 4.4 of the Addendum.

Concrete delivery and placement shall be according to ASTM and ACI standards. Under no circumstances shall delivery scheduling or placement methods be such that a cold joint shall be formed in the plug. If necessary, curing retards may be included in the mix design.

3.1.5 Piping and Valves

Two drainage pipes through the main adit plug shall each be 4-inch diameter schedule 40 stainless steel pipe. The valve(s) shall be of a corrosion resistant metal as specified in Section 4.5 of the Addendum or equivalent. Placement of the pipe shall be of good standard practice. Minimum clearance around the pipe shall be 12 inches.

A stainless steel screen shall be placed around the upstream end of the pipes. The screen shall have 3/4-inch opening. Placement and anchoring shall be determined as part of construction.

Piping for grout tubes shall consist of flexible nylon, PVC, or HDPE tubing.

3.1.6 Grouting

Grouting shall be done in areas of overhangs or protrusions to provide a tight seal between the rock and concrete. Grout tubes shall be placed such that air entrapment does not occur in the voids. A return line shall be installed at each location to provide a means of determining total void filling with grout. Placement of the grout lines is subject to the approval of the engineer.

Grouting may not be done within the first seven days after concrete emplacement. Grout pressures shall not exceed 1,500 psi. The grout shall be a neat mix of sulfate-resistant Portland cement. Chemical grouts may be used upon approval by the engineer.

3.1.7 Monitoring

Monitoring pressure head behind the in place plug in the main adit shall be done by means of a direct-reading pressure gauge inserted in one of the drainage pipes. In the event that an internal plug is constructed, pressure head in the Piute Section will be measured by an open standpipe piezometer installed from the surface or by a piezometer or vibrating wire piezometer installed during construction. Provisions for installation shall be included at the time of construction.

3.1.8 Operation

The discharge valves shall be locked at all times, except during operation or testing by authorized personnel. Upon completion of operation or testing, the operator shall check to see that the valves are locked prior to leaving the site. Operation and testing shall be done only by authorized personnel of the California Regional Water Quality Control Board Central Valley Region.

Prior to opening a valve, all personnel and equipment shall be clear of the line of discharge. This a high pressure system and will discharge at a high velocity and pressure. The valves shall be opened and closed at a slow and constant rate.

A warning sign shall be posted at the valves listing the above procedures.

3.2 Discussion of Alternatives

Effective permanent abatement of the flow of AMD from the Walker Mine could require up to four stages of control measures, each stage increasing the degree of confidence in the effectiveness of the solutions to the problem. These stages and comments on the rationale behind their conception are:

1. Installation of a concrete bulkhead plug in the 700 Level Main Access Adit.

   This measure will effect an immediate halt to the contaminating emissions from the mine, but, in the absence of any additional precautions, the halt might be only temporary. If water in the workings was able and permitted to rise until it could overflow through the

Piute shaft, the problem might simply be transferred from Dolly Creek to the Middle Fork of Ward Creek after a hiatus of up to ten years. The means by which such a transfer can be avoided are detailed in Section 5.2.

The optimum site for this plug is in the Access Adit, as close to the mine workings as possible. This site is indicated in Figures 3 and 4, and detailed in Figure 16. An alternate, less favorable site has been identified closer to the portal, about 250 ft from the end of the timbered section of the adit. This site could be used to replace the original bulkhead should that ever become necessary.

2. Establishment of diversion ditches above subsidence slumps over the Central and Piute Orebodies.

Evidence derived from examination of seasonal flow records for the 700 Level Adit suggest that a large part of the outflow of AMD consists of surface runoff, principally spring snowmelt which enters the mine workings through subsidence slumps. Adequate control of this inflow, combined with stoppage of the outflow by means of a plug in the 700 Level Adit, could allow the inflow of groundwater to reach equilibrium at a level below the next point of egress above the 700 Level, i.e. the Piute Shaft Landing Tunnel.

Much of the excavation necessary to divert flows in the upper catchment of the South and Middle Forks of Ward Creek around subsidence slumps has been done. A conservative estimate of the cost of additional upgrading of the diversion system has been based on observations on site during June, 1985. Unlike the concrete bulkhead plug, the diversion ditch system will require periodic inspection and maintenance, which might be timed to

coincide with availability of personnel and equipment near the site.

3. Isolation of the Piute Section of the mine workings.

Isolation could be achieved by construction of a concrete bulkhead plug in the 700 Level Haulage between the Piute and 712 Sections. The site of this plug is indicated in Figures 3 and 4. Its effect would be to compartmentalize the mine workings and permit groundwater to reach equilibrium at different levels in two separate sections of the mine workings, probably below the level at which water would overflow to surface from the flooded workings.

Construction of an internal (Piute) plug would be undertaken through the 700 Level Adit and Haulage. This would require rehabilitation of the haulage for a distance of about 6,000 feet to the extent that the rail track was clear and sound enough to permit passage of a locomotive and flat cars or concrete mixer cars for about 20 trips during plug construction. The alternative of gaining access to the internal plug site through the Piute Shaft has been rejected on the basis of evident unsafe conditions close to the collar, and Mr. Donato's reported observation of the severe deterioration and collapse of timbering in the shaft. Rehabilitation would be both slower and more expensive than cleaning out the 700 Level Haulage. Remote placement of a grouted plug through surface boreholes has been rejected because an effective seal could not be assured without thorough preparation of the rock surface at the plug site, and this would require almost as much rehabilitation work in the 700 Level Haulage as would be needed for conventional construction.

There is an indication on one sketch, prepared to indicate ventilation flows during an underground fire in the Walker Mine in 1940, that there might be a second drift on the 700 Level, parallel to the Main Haulage connecting the 712 and Piute Sections. Underground inspection does not support this possibility.

The very high cost of isolating the Piute Section is considered excessive in view of the low risk that it might be required, and the availability of other, lower-cost alternatives (see Section 2.2).

4. Construction of a seal in the Old Sawmill Adit.

This adit is the highest artificial outlet for water from the mine workings below the large openings provided by subsidence slumps over the Central Orebody. As such, it is the highest point at which a seal could be attempted in the event that groundwater did not reach equilibrium level at a lower elevation following isolation of the Piute Section. It is considered very unlikely that groundwater inflow could cause an overflow from the flooded mine workings through the slumps. Only under exceptional circumstances would heavy surface inflows raise the water level in the flooded workings to overflow level, and then only brief flows of minimally contaminated water could be expected to enter Ward Creek.

The Old Sawmill Adit Portal appears to have collapsed naturally and would probably permit passage of water overflowing from the mine workings. Insufficient information is available to design or estimate accurately the cost of a seal in this adit should it be needed some twenty years or so after construction of the 700 Level plugs.

3.3 Construction Consideration and Cost Estimate

3.3.1 Construction Considerations

It is generally more difficult to stop leakage past a bulkhead than it is to make the bulkhead strong enough to resist the total thrust due to hydrostatic pressure. Even if an impermeable plug or seal is effectively placed within the tunnel opening, the permeability of the contact between the plug material and the surrounding rock can be a weak link in the total performance of the plug. It has been noted in South Africa that leakage is likely along the floor and the roof, even at low pressure, where mud and air pockets commonly weaken the concrete-rock contact. This type of behavior has likewise been observed in tunnel plug construction at the Nevada Test Site. Construction practices have been developed to circumvent such undesirable behavior.

Several things can be done to reduce the likelihood of leakage along the plug perimeter. The first step in obtaining a good contact between the plug material and the surrounding rock is to have the rock thoroughly cleaned after final excavation and before placement of the plug material. This involves not only cleaning of the rock surface, but also spraying the rock surface with a concrete adhesive or a sodium silicate grout material and then spraying a fine-grained angular sand upon this adhesive material. It has been found that such a pre-treatment of the rock surface enhances and promotes the final bond between the concrete plug and the surrounding rock.

During actual placement of the concrete, bulkheads must be constructed at the two ends of the plug. These bulkheads must be strong enough to withstand the pressure

of the fluid concrete. Provisions must be made prior to concrete placement to allow air escape at the upper portion of the zone to be filled with concrete. It has been found useful, when topping off the concrete plug, to drill two six-inch diameter holes from outside of the bulkhead to the uppermost point of the void to be filled with concrete. Small pipes are then grouted into these two holes. As a topoff mechanism, the uppermost portion of the concrete is grouted by injection of grout in one of the two topoff pipes until grout flows from the second topoff pipe. At this point, the ejection pipe is shut off with a valve, the pressure on the injection pipe is increased to some predetermined value and then it is shut off. It has been found in tunnel plug construction practice, that placement of concrete at a minimum slump of 7½ inches increases the workability and flow characteristics of the fluid concrete within the tunnel plug forms. Even so, additional provisions must be made to promote the complete flow of concrete against both the tunnel form and the rock surface, to eliminate the possibility of honeycombing and void development at the concrete-rock interface.

It has been found in both South Africa and Nevada Test Site practices that leakages around tunnel plugs can be sealed acceptably by at least one stage if not multiple stages of grouting. The critical points to grout are at the top of the structure where topoff procedures may possibly not have completely filled the void, and the lower portion of the structure where sediment may have been allowed to collect. In grouting these areas, grout holes approximately two feet apart and intersecting the rock-concrete interface are suggested. This pressure grouting has been accomplished at pressure levels of a few hundred psi in South Africa.

It is extremely important that horizontal cold joints in the concrete plug be avoided by all means. Such cold joints can be crucial to the permeability of the concrete plug, and can make the entire plug ineffective if permeability through the plug is allowed. It has also been suggested that standard commercial grade expansive agent additives be employed to promote expansion of the concrete during curing, and thus to help seal any voids that may have a tendency to develop. Placement of plugs up to 30 ft long at the Nevada Test Site has not experienced any problems in thermal cracking and associated crack permeability. It should be noted however, that in these plugs concrete is placed at temperatures no higher than 55°F. This procedure ensures that all hydration takes place within the forms, and that excessive temperatures do not develop.

Due to the chemistry of the mine waters that the bulkheads are intended to confine, sulfate resistant cement should be used in construction. In addition, it is recommended that a 3000 psi, 28-day strength concrete be used.

3.3.2 Cost Estimates

The level of accuracy of cost estimates is approximately -20%, +32%.

A. MAIN ACCESS ADIT PLUG

Activity Description	Labor	Equipment	Materials	Sub-Contract	Total
1. Mobilization	3,900	1,800	-	6,200	11,900
2. Site Service	5,300	8,700	-	-	14,000
3. Site Preparation	14,400	6,600	-	-	21,000
4. Plug Construction	15,700	7,300	36,600	-	59,600
5. Demobilization	6,600	3,000	-	6,100	15,700
6. Diversion Works	-	-	7,500	5,400	12,900
7. Management/Q-C	14,300	-	-	-	14,300
TOTAL	60,200	27,400	44,100	17,700	149,400
Plus 10% Contingency					14,900
Estimated Construction Cost					$164,300

For budgeting purposes:

- Total Estimated Construction Cost = $165,000
- Duration of Construction Activities = 35 days or 6 weeks

Activities itemized in the Cost Estimate include:

1. Transport of personnel and equipment from source to site, and set up.
2. Installation or extension of compressed air and water lines, ventilation fan and ducting, and rail track on surface, as well as generator, compressor and pumps.
3. Construction of cofferdam and bypass pipe, lifting track at plug site, excavation of invert, and barring/hammering/washing entire plug site to sound, clean rock. Best quote for concrete batched at portal is $180.00 per cu yd for 100 cu yd required.
4. Construction of bulkhead formwork, installation of reinforcing, pipes, valves and instrumentation, and grouting.
5. Stripping pipelines (fan and ducting left in place) and removal of equipment and personnel.
6. Five days of dozer work with supporting hand labor, and approximately 300 cu yd riprap.
7. Site supervision, inspection and certification by professional engineers.

B. PRELIMINARY AND ONGOING COSTS

1. Water Balance Survey:

Engineering time	$ 4,300
Equipment and materials	1,000
Travel and subsistence	1,200
Total estimated cost	$ 6,500

2. Discharge Treatment Plant Specifications:

Engineering time	$ 6,500

3. Routine Maintenance:

Inspection and gauge reading	-	(Board staff)
Equipment	$ 2,000	
Labor	500	
Materials (riprap, etc)	1,000	
Total estimated cost	$ 3,500/year	

C. ADDITIONAL COST FOR INTERNAL/PIUTE PLUG
(Assumed constructed immediately prior to Main Adit Plug)

Rehabilitation at 700' Level Haulage	$130,000
Concrete at Portal	17,000
Plug construction	60,000
Contingency @10%	20,000
Total estimated cost	$227,000

D. COST OF PLUGS IN MINOR ADITS
(Assumed constructed immediately after the Main Adit Plug)

1. Piute Landing Tunnel Plug:

Site Access and Cleanup	$ 12,000*
Plug construction	11,000
Estimated cost of plug	$ 23,000

2. Old Sawmill Adit Plug:

Site Access and Cleanup	$ 9,000*
Plug Construction	11,000
Estimated cost of plug	$ 20,000

*Tentative estimates as portals are caved.

E. POSSIBLE FUTURE TREATMENT PLANT.
(Subject to B.2)

1. Construction of a facility for short-term treatment (estimate) $250,000

2. Operation of AMD treatment facility, allowing for materials and minimal supervisions $ 5,000/year

4.0 MONITORING

Three factors relating to the effectiveness of abatement procedures at the Walker Mine will have to be monitored:

- The water level in the flooded mine workings and, hence, the rate at which the workings fill up following installation of a seal;

- The development of surface springs or seepage indicating escape of mine waters; and

- Precipitation, in order to determine a relationship between rainfall, snowmelt, rate of filling of mine workings, and possible surface seepage.

4.1 Water Level in Mine Workings

Continuous pressure head readings will be taken at the main adit plug to monitor water level. This will be accomplished by the remote continuous recording station specified in Section 4.7 of Addendum 1 to this report. Data should be collected from the recording as near to quarterly as possible. As the adit will be a dead-end after installation of the plug, the remote reading and recording instruments will be set inside the portal immediately inside the steel door so observers will not need to enter the adit. The instrument station will be set sufficiently far back from the door to avoid adverse effect on the power supply due to low temperatures during the winter months.

4.2 Surface Springs and Seepage

During the construction period, a survey of seeps, springs, and drainage channels (wet or dry) will be made around the area of the mine. Following completion of the main plug, these areas should be inspected visually on a quarterly basis to see that no new seeps are developed as the mine fills. If additional seepage is noted at

any time, water quality samples should be taken to assess the impact of the mine filling on that water source. In addition, quarterly observations of the mine adit to check leakage from around the plug should also be made.

4.3 Precipitation and Temperature

A rain gauge and temperature recorder should be installed between Middle and South Forks of Ward Creek. Data from these recorders should be collected during the scheduled site visits. This data would then be used to compare the mine filling with precipitation/snow to the extent to which mine filling can be related to direct infiltration. It can also be used to determine the effectiveness of the installed diversion system and whether or not modifications or remedial work are warranted.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Observations

5.1.1 Achievement of Primary Objective

The installation of a concrete bulkhead seal in the main 700 Level Access Adit to the Walker Mine at an elevation of approximately 6,200 ft is technically feasible, and would be effective in sealing off the main source of copper contamination to the Dolly and Little Grizzly Creeks, assuming there are no other hitherto unidentified outlets below the level of the Piute Shaft Landing Tunnel (approximately 6,585 ft elevation).

5.1.2 Potential Adverse Effects

Under present conditions of incomplete control of spring runoff entering subsidence sinkholes over the Central and Piute Orebody workings, there is a remote possibility that the back-up of water caused by a seal in the main Access Adit at the 700 Level could rise to the level of the Piute Shaft Landing Tunnel within 10 years. A reduced flow of AMD, of a quality similar to that presently flowing from the 700 Level Access Adit, would then discharge through the Piute Shaft into the Middle Fork of Ward Creek. It is very unlikely that the average volume discharged would be more than 10 gpm.

5.1.3 Mitigation of Adverse Effects

Rehabilitation and regular maintenance of a system of diversion ditches, designed to keep surface runoff in the catchments of the Middle and South Forks of Ward

Creek out of the subsidence slumps, and consequently out of the mine workings, would substantially increase the time it would take to flood the old workings up to the level at which discharge could occur. This remedial action could be expected also to reduce the probability of any flow out of the Piute Shaft to insignificant levels. See Section 5.2.(5) for further possible precautions.

5.1.4 Maximum Security Option

In addition to installation of a primary seal in the main 700 Level Access Adit and establishing effective diversion ditches around slumps, isolation of the Piute Section by installing a concrete bulkhead in the 700 Level haulage (the only connection between the Piute Section and the remainder of the mine to the south) could be expected to reduce the volume of any possible outflow of AMD through the Piute Shaft by about 90%.

The mine workings in the Piute Section would flood to the level of the natural water table. Only snowmelt or rain in the immediate catchment of the Piute subsidence slumps would enter the workings and, if the water table was close to overflow level, run out of the Piute Shaft Landing Tunnel at approximately 6,580 ft elevation. Minimal mixing with and contamination by the stagnant water in the flooded Piute workings would occur.

The South, Central, North and 712 sections of the mine would also flood to the level of the natural water table in each section. If this level should be above the Old Sawmill Adit (6,770 ft elevation at its intersection with the mine workings), it might be necessary to clean out this adit portal and install a bulkhead capable of withstanding the maximum head of 110 ft of water that would be developed if the workings were to fill with

water to the level of the subsidence slumps above the Central Section workings. As in the case of the Piute Section described above, only local snowmelt or rain runoff could be expected to enter the upper part of the workings and possibly overflow, without significant contamination by the stagnant water in the mine workings.

The time required for flooding in the mine workings to reach equilibrium in this worst-case scenario is estimated to be in excess of 15 to 20 years after two bulkhead seals had been installed.

5.1.5 Critical Appraisal of Maximum Security Option

Rehabilitation of the 700 Level haulage to gain access to the site of a possible internal plug would be more expensive and time-consuming than expected prior to visual inspection. Costs have been estimated on the basis of sluicing sludge with a jet of water pumped from flooded lower workings. Suspended solids would settle in the large sump of the Central and South Orebody workings below the 700 Level. Any residual turbidity emerging from the adit would be settled in the existing ponds below the portal.

Items leading to higher costs included:

a) Sludge cover on the floor of the haulage, which was generally deeper than expected, up to 18 inches in places.

b) The collapse of timber stope draw point chutes which has caused significant blockages with 30 to 50 tons of rock and timber lying in the haulage at four points, which would require tedious hand labor for clearing.

c) Deterioration of timber sets, which has exposed potentially dangerous bad ground at two locations and would require re-timbering to permit safe passage of personnel and equipment.

d) Clearing of timber and other materials buried in the sludge, which would require considerable manual labor.

e) Track in sections of the haulage that pass over shafts or rock-passes, which is supported on timber that might not now support the weight of a locomotive and concrete cars without reinforcement.

f) Rails that showed signs of corrosion and were absent over several hundred feet through the Central Section.

g) 5 x 10 ton Bilby-type mine cars parked in the haulage in the North Orebody Section, which would have to be removed. The condition of their wheel bearings could not be determined.

h) Collapse of the northern-most stope drawpoint chute in the 712 Orebody Section (Chute No. 208), which has almost blocked the haulage with 150 to 200 tons of broken rock and timber. Stulls and platforms loaded with broken rock could be seen in the open stope above the drawpoint, making conditions hazardous for removal of the blockage.

i) It was possible to crawl over the blockage at drawpoint No. 208 and continue northward on the 700 Level haulage. Up to 3'-6" of a thick, opaque, azure blue colloidal suspension was backed up behind the blockage. The volume held back was estimated at 90,000 to 100,000 gallons.

The investigating team did not proceed more than 300 ft beyond the No. 208 drawpoint, but selected and measured tunnel dimensions at a suitable site for a plug about 150-ft north of No. 208 drawpoint. The time required for taking measurements, the 39° F "water", and the need to return to the portal within the predicted 5½ to 6 hours precluded further progress into the Piute Section.

Accurate measurement of water flow in the 700 Level haulage was not possible. A portable direct-reading flowmeter was used to determine flow velocity at points where the cross-sectional area of the channel could be estimated reasonably. From these measurements it was inferred that, of about 560 gpm flowing into the workings above the 700 Level, less than 300 gpm were being discharged through the main 700 Level Adit. The balance is presumed to return as recharge to the groundwater system.

Observation of the rock mass quality between the 712 and Piute Orebodies and calculation of the permeability of the pillar between the stoped out areas in these orebodies indicate that, although a plug in the 700 Level haulage between the 712 and Piute Sections would initially halt a potential 10 gpm outflow through the Piute Shaft, a flow of up to 1 gpm could be established through the pillar after a few years.

5.2 Conclusions

1. Installation of a plug in the 700 Level Adit, some 2,700 ft from the portal, would stop the discharge of Acid Mine Drainage (AMD) from the Walker Mine.

2. Water backed up in the mine workings would probably reach equilibrium below the 6,500 ft elevation, as the increasing head could be expected to increase the rate of recharge of the groundwater system.

3. Recharge of the groundwater system would be dispersed over the full strike length of the workings, maximizing the attenuation effect on AMD re-entering the surrounding rock mass. No seepage has been located which can be identified as a point at which water recharged from the mine workings eventually reaches surface.

4. The cost of rehabilitation of the 700 Level haulage and installing an internal plug between the 712 and Piute Section is considered excessive for insurance against the low risk of AMD emission through the Piute Shaft (see Section 3.2 (3)).

5. A more cost-effective back-up to a single plug in the 700 Level Adit would be:

   a) Rehabilitation and maintenance of diversion channels around surface sinkholes, to minimize inflow of runoff from rain or snowmelt.

   b) Regular monitoring of water level in the mine workings, by means of pressure gauges at the plug with remote-reading facilities at the portal.

   c) The facility to open valves on the 4-inch diameter pipes through the plug, to relieve any excessive build up of water in the workings. Two 4-inch diameter pipes, 30 ft long, could pass over 2,400 gpm under 400 ft head, equivalent to the peak expected instantaneous rate of inflow.

d) Adequate notice of impending overflow of water accumulating in the mine, through the Piute Shaft, would be available to permit construction of a small treatment plant at the portal of the 700 Level Adit.

By these means, the small and short-duration release of any possible excess inflow into the mine could be neutralized without risk of contaminating an unaffected catchment (Ward Creek).

e) The cost of such a treatment facility (should it ever be needed) would be less than the total cost of the internal plug and would be deferred for probably not less than ten years (see Section 3.3).

f) This proposal provides for a means to direct any possible emission of AMD from the Walker Mine, under controllable conditions, through a neutralizing facility, provided the build up of water pressure behind a plug did not divert excessive quantities of AMD through natural outlet(s), which could deliver it to surface without adequate natural attenuation of its acid and metal content.

6. Installation of a plug in the main adit of the Walker Mine need not necessarily sterilize the mine for future exploitation. Should it become feasible at some future time to mine the known mineral resource, the valves on pipes through the plug could be opened and the mine water drained in less time than it took to enter the workings. The workings could be drained at a controlled rate during the period required to plan mining operations and secure the relevant permits. The AMD could be treated at a rate of, say, 500 to 800 gpm and discharged to surface waters. It is not possible to comment on or endorse the economic feasibility of such a course of action without knowledge of the potential ore reserves.

5.3 Recommendations

Immediately:

1. Undertake minor rehabilitation of diversion channels around Central Orebody sinkholes;

2. Undertake minor rehabilitation of diversion channels around the southern sinkholes above the Piute Orebody and establish a diversion channel around the northern end; and

3. Conduct a flow and water quality balance study on water movements from the mine workings above 700 Level, along 700 Level Haulage and Adit, entering and leaving the workings below 700 Level, and in the Dolly Creek from the mine portal to its confluence with Little Grizzly Creek.

Then, subject to the findings of 3:

4. Install a single plug in the 700 Level Adit approximately 2,700 ft from the portal;

5. Monitor water levels in the mine workings by means of gauges reading pressure behind the plug; and

6. Prepare a contingency plan for future construction and operation of a small treatment plant at the 700 Level Adit Portal, to neutralize AMD that might have to be discharged periodically (several years after installation of the plug) to relieve any excessive build up of water that might threaten to overflow out of the Piute Shaft.

Note: Implementation of Item 3 would require:

a. Channelization of drains and construction of simple flow measurement stations at up to six points in the 700 Level Haulage and Adit;

b. Establishment of up to five flow measurement stations between the 700 Level Adit portal and the Dolly Creek's confluence with Little Grizzly Creek; and

c. Careful measurement of water flow quantity and quality at each measuring station, to determine the entire flow pattern between Walker Mine workings above 700 Level and Little Grizzly Creek.

6.0 GLOSSARY

Where used in this report, the following terms will be defined as follows:

Adit: A horizontal or nearly horizontal passage driven from the surface for the working or drainage of a mine;

Aquaclude: A geologic formation that prevents the passage of gound water in significant amounts;

Asperities: Protrusions forming roughness or jaggedness on the surfaces of the walls, roof and floor of a tunnel/adit;

Bulkhead: (i) A wall or partition erected to resist ground or water pressure; (ii) A tight partition of wood, concrete or metal used for retainment of fluids in a tunnel or channel; also used for protection against gas or fires in mines;

Bullnose: The narrow-angled corner formed where the walls of two tunnels intersect at less than 90°;

Haulage: Underground level either along and inside an orebody or closely parallel to it, usually in the footwall. On this level, the mineral drawn from stopes is transported to a shaft for hoisting or to surface through an adit. Haulage ways include levels and connecting passage ways (crosscuts) and are also used to transport supplies, waste rock, and for movement of personnel;

Portal: Any entrance to a mine, more usually the surface entry to an adit; and

Stope: An excavation from which ore has been extracted in a series of steps usually applied to steeply inclined or vertical veins.

APPENDIX I
CONCRETE MIX DESIGN RECOMMENDATIONS

by
Mr. Robert F. Adams, P.E.
Consulting Concrete Engineer

ROBERT F. ADAMS, P.E.
CONSULTING CONCRETE ENGINEER
5971 ANNRUD WAY
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(916) 428-9121

NOV 1985

12 NOVEMBER 1985

Mr. Don Poulter
Steffen Robertson & Kirstan
7510 W. Mississippi Ave., Suite 210
Lakewood, CO 80226

Dear Mr. Poulter:

Subject: Concrete for Tunnel Plug, Walker Mine
Your Project No. 06901

I have reviewed your Draft Final Feasibility and Design Report for the Walker Mine pollution abatement project. You requested that I furnish my recommendations for concrete for the tunnel plug, the key feature of this project. This reports my recommendations for materials for concrete and concrete for the tunnel plug. A discussion gives the reasons for some of the recommendations and other matters pertaining to construction of the tunnel plug.

The low pH 4.1 of the acid mine water makes the concrete requirements of more concern than usual. Had the pH been above 5, there would have been less concern.

MATERIALS FOR CONCRETE

Aggregate shall meet the requirements of ASTM 633 for use in a severe weathering region. The sand shall be a natural sand. The coarse aggregate shall be a crushed limestone Size 57 (1 inch to No. 4) or Size 67 (3/4 inch to No. 4). The amount of flat and elongated particles in the coarse aggregate not exceed 15 percent. (Corps of Engineers Test CRD-C119). The sand and coarse aggregate may be rejected if the specific gravity, saturated surface dry basis, is less than 2.60.

Portland Cement shall be Type II, low alkali, meeting the requirements of ASTM C150.

Pozzolan shall be Class N,, natural or F, fly ash, meeting the requirements of ASTM C618. If a fly ash, Class F, pozzolan is used, the ignition loss shall be less than one percent.

Air Entraining Admixture shall meet the requirements of ASTM C260.

Water Reducing-Retarding Admixture shall be an unmodified lignosulfonate meeting the requirements of ASTM C494, Type D, supplied as a 40 percent solution.

Silica Fume shall be EMSAC F-100 as supplied by Elkem Chemicals, Inc., Pittsburgh, Pennsylvania.

Water- Use good quality water for mixing water. Do not use mine water. Sulfates should not exceed 1500 ppm and chlorides should not exceed 2000 ppm. The water should not contain oil or material that would affect the setting of portland cement.

CONCRETE PROPORTIONS AND PROPERTIES

Cement Content:

Portland cement - 450 pounds per cubic yard
Pozzolan - Class N - 150 pounds per cubic yard
or Class F - 200 " " " "

Air Content: 5+1 percent

Slump: 4 to 7 inches

Water-Reducing Admixture: Use 8 fluid ounces of water-reducing admixture per 100 pounds of cementing material.

Silica Fume: Use EMSAC F-100 at dosage of 2 gallons per 100 pounds of portland cement.

Design Strength of Concrete: 3000 psi at 28 days. (The strength of concrete as specified above should far exceed the design strength under normal conditions.)

DISCUSSION

The following gives some of the reasons for some of the above recommendations and other discussion and recommendations pertaining to the job.

Low permeability of the concrete is one big factor in reducing aggressive chemical attack on concrete such as that caused by sulfates and acids. Lower permeability is achieved by lower water-cement ratio (which means higher cement content, other things being equal), air entrainment, use of pozzolans and use of silica fume (a rather special pzzolan).

The rather low sulfate content of the mine water, 146 ppm (in your Table 2) does not justify the use of Type V portland cement, a premium price cement. The use of Type II portland cement with pozzolans provides protection from sulfates, if needed, equivalent to a Type V portland cement alone, except in the most severe sulfate conditions.

The use of a limestone coarse aggregate is recommended as a sacrificial aggregate for the acid water. Limestone coarse aggregate is frequently used in concrete pipe for sanitary sewers where acid conditions sometimes form. The closest commercial source of limestone coarse aggregate known to me is Sierra Rock Co., Placerville, a distance of about 150 miles from the jobsite.

Another advantage to limestone aggregate concrete is that it has a lower coefficient of thermal expansion, hence less thermal volume change.

The tunnel plug, being 12 by 12 by 15 feet in section is "mass concrete" for which there is sometimes concern about temperature rise in the concrete and temperature differences which sometimes cause cracking. It is believed that with the cement contents recommended there will be no problem because the concrete is placed against rock in a rather stable temperature environment and is not exposed. Another reason for using a pozzolan is to lower the temperature rise of the concrete substantially.

My recommendations have included the use of silica fume, a "super" pozzolan which reduces the permeability of concrete by up to two orders of magnitude. Silica fume is recommended because of this, and your report notes a 100 year expected life for the job. Unfortunately, the particular silica fume recommended is rather expensive and will increase the cost of the concrete some 30 to 50 dollars per cubic yard, a small amount considering the total cost of the job and believed to be justified for this job. (See attached sales literature for EMSAC silica fume.)

Your report mentions the use of an expansive agent in the concrete. This has not been recommended because the expansion comes at the wrong time in this kind of job. This in grout would be OK. The use of shrinkage-compensating cement has not been recommended either because of some problems with this cement.

The closest ready mix producer is in Portola, some 25 to 30 miles away - over a dirt road part of the way at least. If concrete is to come from this source, the cement, pozzolan and admixtures should not be added until the ready mix truck gets to the jobsite. It would seem very desirable to bring in a very small portable batch plant to batch at the jobsite. Such plants are available in the area.

Your report mentions rock cleanup prior to concreting. This is a must. The floor particularily should be cleaned of all loose rock, mud, debris, etc. etc.

It is suggested that vibration of the concrete in the lower portion of the plug be required, particularly on the floor and against rock and forms and around the pipe - and lower slump concrete, 4 to 5 inches, can and should be used here. In the crown, more slump is required - 5-1/2 to 7 inches slump.

The pump slickline should be kept buried in the crown, pumping to refusal to fill in the arch as well as possible, and backing out the slickline as the arch is filled.

Grouting the arch will be necessary. And from your experiences, grouting the sides appears to be necessary also. It is suggested grouting wait at least a month to allow the plug to cool and stabilize dimensionally. The peak temperature might occur at about 5 to 7 days.

Wood forms would be better than steel forms because they would provide more insulation.

Limited trial mixes should be made to establish a recommended starting mix. This should be done after the Contractor has selected his material sources.

Job inspection and quality control should be done to insure that the requirements of the specifications are followed and that good construction practices are followed. Most importantly, the air content of the concrete should be controlled by tests.

This report was reviewed by a colleague, Mr. Lewis H. Tuthill who concurred with my recommendations.

Please advise if you have any questions or I can furnish further information or help.

Sincerely,

Robert F. Adams

Robert F. Adams, P. E.

Some Addresses

Source of EMSAC F-100. Hill Brothers Chemical Co., 410 Charcot Avenue, San Jose, CA 95131. Phone 408-263-3131

Small jobsite concrete plant - Engineered Concrete Placement, Box 51333, Middletown, CA 95461, Phone 707-987-0151.

Source of Class N Pozzolan - Lassenite Industries, Inc., produced this at Hallelujah Junction about 35 miles East of Portola. Believe this still being produced. Office for this company now believed to be in Oroville, or Yuba City, California. Phone might be 800-221-3134.

Limestone Aggregate - Sierra Rock Co., 1845 Quarry Road, Placerville, CA 95667, Phone 916-622-8571.

White Cap Ready Mix, Portola, Bob Higgins, 916-832-4225

ADDENDUM 1

TO

WALKER MINE PROJECT

FINAL

FEASIBILITY AND DESIGN REPORT

CONTRACT NO. 4-051-150-0

WALKER MINE PROJECT
700 LEVEL ADIT PLUG
AND
SURFACE DIVERSION DITCHES
TECHNICAL SPECIFICATIONS

Prepared for:
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, California 95816

Prepared by:
Steffen Robertson and Kirsten (Colorado) Inc.
3232 South Vance Street, Suite 210
Lakewood, Colorado 80227

November, 1985

TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION

1.1 General
1.2 Definitions
1.3 Permits

2.0 CONTRACTOR'S RESPONSIBILITY

3.0 INSPECTION OF WORK

4.0 PLUG SPECIFICATIONS

4.1 Plug Location and Dimensions
4.2 Site Preparation

4.2.1 Access
4.2.2 Mine Water Diversion
4.2.3 Plug Site

4.3 Formwork
4.4 Concrete

4.4.1 General
4.4.2 Applicable Codes of Specifications
4.4.3 Cement
4.4.4 Water
4.4.5 Concrete Aggregates
4.4.6 Admixtures
4.4.7 Curing Aids and Coating
4.4.8 Handling and Storage of Materials

4.4.8.1 Aggregate
4.4.8.2 Cement

4.4.9 Proportioning
4.4.10 Batching of Concrete Mixture

4.4.10.1 Cement and Aggregate Measurements
4.4.10.2 Water Measurement
4.4.10.3 Moisture Content
4.4.10.4 Admixture Measurement
4.4.10.5 Batching Plant

4.4.11 Mixing and Transportation of Concrete

4.4.11.1 Mixing Equipment
4.4.11.2 Mixing and Delivery
4.4.11.3 Control

TABLE OF CONTENTS (con't)

Page No.

4.4.11.4 Retempering

4.4.12 Testing of Concrete

4.4.12.1 Strength Tests
4.4.12.2 Slump Tests
4.4.12.3 Tests for Entrained Air

4.4.13 Enforcement of Strength Requirements

4.4.13.1 Definition of Failure
4.4.13.2 Failure of Test Specimens

4.5 Piping
4.6 Grouting
4.7 Instrumentation
4.8 Cleanup

5.0 DIVERSION DITCHES

5.1 Scope
5.2 Definitions
5.3 Clearing and Grubbing

5.3.1 General
5.3.2 Protection
5.3.3 Extent of Removal
5.3.4 Disposal
5.3.5 Timing

5.4 Riprap Materials
5.5 Riprap Bedding Material
5.6 Existing Ditches
5.7 New Ditches

1.0 INTRODUCTION

1.1 General

In the following paragraphs, technical specifications are presented for the various work items noted. Specific items concerning contractual agreements, environmental controls, and health and safety requirements that must be complied with by the Subcontractor, have not been included as part of these specifications.

The work to be performed under these specifications is the construction of a concrete plug with drains in the 700 Level Adit of the Walker Mine, diversion of mine waters during plug construction, remedial work on the diversion ditches around the subsidence above the Piute and Central Orebodies and construction of a new ditch around the Piute Orebody. Also included in the work is the reclamation of the disturbed areas resulting from the construction of these facilities. This includes the replacement or repair of portal doors which are currently in place.

The structures specified herein are to be constructed to the lines and grades shown in the construction drawings to meet the technical requirements in these specifications.

While every effort has been made to have specifications and construction drawings free of error and ambiguity, the Subcontractor is responsible for bringing any such points to the attention of the Owner's representative before execution of the work to allow correction and/or interpretation.,

For any discrepancy or ambiguity in the specifications, construction drawings, codes, standards, or regulations, it is the intent of these specifications that the most restrictive interpretation shall apply unless intepreted otherwise by the Engineer.

1.2 Definitions

a) "Agency", when referred to, shall be understood to mean a duly authorized representative of the California Regional Water Quality Control Board - Central Valley Region.

b) "Engineer", when referred to, shall be understood to mean a duly authorized representative of Steffen Robertson and Kirsten (Colorado) Inc. (SRK); SRK is a subcontractor to the Agency.

c) "Contractor", when referred to, shall be understood to mean the party which has executed a contract agreement for the work with the Agency.

d) "Regulatory Agencies", when referred to, shall be understood to mean duly authorized representatives of such public agencies that have jurisdiction over this project in addition to the Agency.

e) "Drawings", when referred to, shall be the 06901 series drawings for Contract No. 4-051-150-0.

1.3 Permits

All permits required to execute and complete the work under these specifications shall be the responsibility of the Contractor. This includes, but is not limited to permits required for 1) mobilization and demobilization of equipment of the site, 2) execution of underground work, and 3) access and clearing for construction of the diversion ditches, and 4) any permits required by Regulatory Agencies.

The Agency will provide the permit for right of entry to the property on which the mine portal is located.

2.0 CONTRACTOR'S RESPONSIBILITY

The Contractor shall carefully examine all of the technical specifications and construction drawings, and the site of the work. He shall fully inform himself as to the character of all conditions at the site, local and otherwise, affecting the execution of the work, including those conditions to which Federal, State, and local safety and/or health laws and regulations may be applicable. Failure to comply with the requirements of this section shall not relieve the Contractor of responsibility for complete performance of the work.

It shall be the sole responsibility of the Contractor to determine and satisfy himself, by such means as he considers necessary or desirable, as to all matters pertaining to this work including, but not limited to:

- The location and nature of work;
- Climatic conditions;
- The nature and conditions of the terrain;
- Geologic conditions at the site;
- Transportation and communication facilities;
- Location and nature of construction materials available for use in the work;
- Other construction or operation in the project area that may be underway simultaneously with the construction work for the adit plug or diversion ditches; and
- All other factors that may affect the cost, duration, and execution of the work.

Before accepting the work, the Contractor shall acknowledge in writing that he has inspected the site and determined the characteristics of the work and the conditions indicated above.

Technical and other information relating to the site of the work is available in the following reports:

1) "Walker Mine Project, Feasibility and Design Report", Contract NO. 4-051-150-0 (SRK, 1985); and
2) Open file data through the Agency.

This report and data are provided for the Contractor's information and convenience. Neither Agency nor SRK will assume any responsibility for the Contractor's interpretation of, or conclusions reached from, examination of such data.

The performance of items specified to be submitted for review and comment by the Engineer remain the responsibility of the Contractor.

3.0 INSPECTION OF WORK

Full-time inspection of all construction activities under this work shall be as defined in the contract documents between the Agency and their subcontractors. Inspection of all work shall be carried out by the Engineer while such work is in progress. Notwithstanding such inspection, the Subcontractor shall be held responsible for the acceptability of the finished work.

The Engineer and/or his representatives shall at all times have access to the work whenever it is in preparation of progress. The Contractor shall fully cooperate with the Engineer to facilitate inspection. The Contractor shall give the Engineer ample notice of readiness of the work for inspection to see that the work is performed in accordance with the requirements set forth in the technical specifications and construction drawings. All work done by the Contractor shall meet the approval of the Engineer, but the detailed manner and methods of doing work shall be the responsibility of the Contractor.

If any work should be covered up without prior review or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination and be properly restored at the Contractor's expense.

It is the intent of these specifications that all materials will be inspected and tested by the Engineer before final acceptance of the work. Test data will be made available to the Contractor for inspection at his option. Any part of an item of work which is found not to comply with the specification requirements or which is improperly located or constructed shall be removed and replaced to the satisfaction of the Engineer, at the Contractor's expense.

4.0 PLUG SPECIFICATIONS

4.1 Plug Location and Dimensions

The plug shall be located as shown in the drawings. The approximate coordinates of the plug center are 12,950 N, 11,420 E. The actual location will be field sited by the Engineer. The plug site shall be surveyed and recorded by a Contractor for the Agency. The plug shall be 15 ft in length.

4.2 Site Preparation

4.2.1 Access

Access and remedial work required to maintain access to the plug site during construction shall be the responsibility of the Contractor. Ventilation in the adit and working area shall remain in-place and in working order upon completion of construction. All work shall be done in accordance with the required mine health and safety regulations.

4.2.2 Mine Water Diversion

Mine waters running through the plug site shall be diverted such that the plug (including form work) is constructed in the dry. The diversion system shall be maintained until such time that water against the plug will not adversely effect the completion of the concrete placement. The method of diversion and schedule shall be submitted to the Engineer for approval prior to construction. Such approval does not relieve the Contractor from the responsibilities for the performance or adequacy of the diversion system.

4.2.3 Plug Site

The plug site shall be cleared and prepared to ensure an adequate bond between the rock and concrete plug. All loose rock within the plug site shall be spawled off to sound, intact rock. The rock surface shall be cleaned of all loose and fine materials. Limits of the site preparation shall extend a minimum of 5 ft past either end of the plug limits.

Methods of site preparation shall be proposed by the Contractor and submitted for review and comment by the Engineer. This in no way relieves the Contractor from his responsibility to accomplish the required site preparation in an efficient and timely manner. The prepared site shall be approved by the Engineer prior to placement of concrete.

4.3 Formwork

The formwork for the bulkheads shall be the responsibility of the Contractor. It shall be constructed of good quality material and in such a manner as to provide an efficient seal for containment of the concrete and any grout that may be injected. The design of the formwork shall be in accordance with ACI 347, "Recommendated Practice for Concrete Formwork", and of sufficient strength to withstand the fluid pressure of the concrete and any increased pressures due to grouting or concrete placement. A reference design is provided in the drawings.

The Contractor shall be responsible for the design and safety of form work. Completed forms in place will be approved by the Engineer prior to concrete placement to check all lines, grades, and tolerances as shown in the drawings. A reference design showing drain pipe locations is provided in the drawings.

4.4 Concrete

4.4.1 General

Contained in the following sections are concrete materials specification, recommended mix specifications, and handling requirements for the concrete plug. Concrete mixing, delivery and placement shall be in accordance with ACI Standards and Specifications.

The selected method and procedures for mixing, transportation and placing the concrete shall be submitted to the Engineer for review and comment prior to construction mobilization.

All material testing shall be done to ASTM specifications where applicable or unless otherwise specified. Under no circumstances shall delivery scheduling or placement methods be such that a cold joint will be formed in the plug.

The Contractor shall locate and supply all materials and equipment necessary for this work, including water, concrete aggregate, additives, and vehicles for transport of concrete to the plug location. Once all materials have been located, the Contractor shall prepare a trial mix for testing to check the adequacy of the mix design. The mix design and test results shall then be submitted to the Engineer prior to construction.

Before any concrete is placed, the mix design shall have been approved by the Engineer, formwork and the prepared site shall have been inspected by the Engineer, and tests of all materials and mechanical operation of all equipment shall have been completed.

4.4.2 Applicable Codes of Specifications

The following publications of the latest edition are a part of this specification, except as noted within this specification.

American Society for Testing and Materials

ASTM C-31	Specification for Making and Curing Concrete Test Specimens in the Field
ASTM C-33	Specification for Concrete Aggregates
ASTM C-39	Test for Compressive Strength of Cylindrical Concrete Specimens
ASTM C-94	Specification for Ready-Mixed Concrete
ASTM C-143	Method of Test for Slump of Portland Cement Concrete
ASTM C-150	Specification for Portland Cement
ASTM C-171	Specification for Sheet Materials for Curing Concrete
ASTM C-172	Method of Sampling Fresh Concrete
ASTM C-231	Test for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C-260	Specification for Air Entraining Admixtures for Concrete
ASTM C-309	Specification for Liquid Membrane - Forming Compounds for Curing Concrete
ASTM C-494	Specification for Chemical Admixtures for Concrete

American Concrete Institute Publications

ACI 211.1	Recommended Practice for Selected Proportions for Normal and Heavy Weight Concrete
ACI 214	Evaluation of Strength Test Results of Concrete
ACI 304	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 306	Recommended Practice for Curing Concrete
ACI 309	Recommended Practice for Consolidation of Concrete
ACI 311	Recommended Practice for Concrete Inspection
ACI 347	Recommended Practice for Concrete Formwork

4.4.3 Cement

Cement shall be an approved brand of Portland Cement complying with all the requirements of ASTM C-150, Type II.

4.4.4 Water

The water used for mixing concrete will be clean and free from oils and other substances deleterious to concrete. Sulphates shall not exceed 1,500 ppm and chlorides shall not exceed 2,000 ppm. Mine water is not acceptable for use in the concrete mix.

4.4.5 Concrete Aggregates

Aggregate shall meet the requirements of ASTM 633

for use in a severe weathering region. The sand shall be a natural sand. The coarse aggregate shall be a crushed limestone Size 57 (1 inch to No. 4) or Size 67 (3/4 inch to No. 4). The amount of flat and elongated particles in the coarse aggregate not exceed 15 percent. (Corps of Engineers Test CRD-C119). The sand and coarse aggregate may be rejected if the specific gravity, saturated surface dry basis, is less than 2.60.

4.4.6 Admixtures

The following admixtures shall be used in the design mix:

1. Pozzolan shall be Class N, natural or F, fly ash, meeting the requirements of ASTM C618. If a fly ash, Class F, pozzolan is used, the ignition loss shall be less than one percent.
2. Air Entraining Admixture shall meet the requirements of ASTM C260.
3. Water Reducing-Retarding Admixture shall be an unmodified lignosulfonate meeting the requirements of ASTM C494, Type D, supplied as a 40 percent solution.
4. Silica Fume shall be EMSAC F-100 as supplied by Elkem Chemicals, Inc., Pittsburgh, Pennsylvania, or equivalent.

4.4.7 Curing Aids and Coating

All materials used for curing shall conform to ASTM C-309. All materials used for coating shall conform to ASTM D-977. These apply to the front face of the plug once the formwork is removed.

4.4.8 Handling and Storage of Materials

4.4.8.1 Aggregate

Stored aggregate shall be handled in such manner as to prevent segregation of sizes and to avoid the inclusion of dirt and/or foreign materials in the concrete. Material shall be removed from stockpiles in approximately horizontal layers.

4.4.8.2 Cement

Cement in sacks or barrels shall be stored under a weather-tight cover with the floor raised at least one-half foot above the ground. Cement that has hardened or partially set shall be removed from the site and not used.

Bulk cement shall be stored in airtight and weatherproof bins with access for inspection.

4.4.9 Proportioning

It is the intent of this specification to secure, for every part of the work, concrete of homogeneous structure which, when hardened, will have the required strength, impermeability and resistance to chemicals and weathering.

Proportions shall be selected to produce concrete with a minimum 28-day compressive strength of 3,000 psi. The recommended design mix is as follows:

1. Cement Content:
   Portland cement - 450 pounds per cubic yard
   Pozzolan - Class N - 150 pounds per cubic yard
   or Class F - 200 pounds per cubic yard
2. Air Content: 5 + 1 percent
3. Slump: 4 to 7 inches (see Appendix I of SRK Feasibility and Design Report for explanation).
4. Water-Reducing Admixture: Use 8 fluid ounces of water-reducing admixture per 100 pounds of cementing material.
5. Silica Fume: Use EMSAC F-100 at dosage of 2 gallons per 100 pounds of Portland cement.

4.4.10 Batching of Concrete Mixture

The measurement of materials for concrete batching shall be in accordance with ASTM Specification C-94, Sections 6 and 7. After the equipment is set in operating position, the batching plant shall be inspected by an authorized agency and scales checked for accuracy. An inspection seal or tag properly documented shall be attached to the equipment.

4.4.10.1 Cement and Aggregate Measurements

The Contractor shall measure cement and aggregate by weighing only. Weighing shall be accurate to within 1.0 percent of the required weight. Cement may be measured in standard bags, however, no fraction of a bag shall be used unless weighed.

4.4.10.2 Water Measurement

The Contractor shall measure the water by

volume or by weight. The device for the measurement of the water shall be readily adjustable and under all operating conditions shall have an accuracy within 1.0 percent of the quantity of water required for the batch.

4.4.10.3 Moisture Content

The Contractor shall provide a moisture meter to measure the amount of free water in fine aggregates within 0.3 of a percent. The Contractor shall compensate for varying moisture contents of fine aggregates and change batch weights of materials if necessary before batching.

4.4.10.4 Admixture Measurement

Admixtures shall be used strictly in accordance with manufacturer's recommendations. All admixtures shall be added to the concrete mixture with dispensing equipment furnished by the manufacturer.

4.4.10.5 Batching Plant

Bins

Bins with adequate separate compartments for fine aggregates and for each required size of coarse aggregate shall be provided in the batching plant. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper. Means of control will be provided so that, as the quantity desired in the weighing hopper is approached, the material

may be added slowly and shut off with precision. Weighing hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully.

Scales

The scales for weighing aggregates and cement shall be of either the beam type of the springless dial type. Scales shall be accurate within 1.0 percent under operating conditions.

4.4.11 Mixing and Transportation of Concrete

Concrete shall be mixed and transported in equipment approved by the Engineer in a manner which will deliver uniform and homogeneous concrete to the forms. Mixing and transporting shall be in accordance with the appropriate ACI and ASTM codes. Revisions to applicable codes to accomodate field conditions shall be approved by the Engineer prior to construction.

4.4.11.1 Mixing Equipment

Mixers may be stationary mixers or truck mixers. Agitators may be truck mixers or truck agitators. Truck mixers shall be equipped with revolution counters and water meters. Stationary mixers shall be equipped with a timing device that will not permit the batch to be discharged until the specified mixing time has elapsed.

Each unit shall have attached thereto, in a prominent place, a metal plate or plates on which are plainly marked, the various uses for

which the equipment is designed, the capacity of the drum or containers in terms of volume of mixed concrete and the speed of rotation of the mixing drum, blades, or paddles.

4.4.11.2 Mixing and Delivery

Concrete shall be mixed and delivered alongside the forms by one of the methods listed below. It should be noted that transport equipment from the portal to the plug site will be rail mounted.

Central Mixed

The materials completely mixed in a stationary mixer and transported to the delivery point in a truck agitator, a truck mixer operating as a truck agitator, a non-agitating truck approved by the Engineer or by pumping through a pipeline.

Shrink Mixed

The materials partially mixed or blended in a stationary mixer and the mixing completed in a truck mixer enroute to the job. This shall only be allowed provided the stationary mixer is located at the mine portal.

Transit Mixed

The materials placed into the truck mixer and all mixing done in the truck mixer.

4.4.11.3 Control

The Engineer will make slump tests from

samples taken at approximately the one-quarter and three-quarter points of the load. When the above pairs of slumps differ by more than two inches, the truck or agitator shall not be re-used until the condition causing the non-uniformity has been corrected.

The Engineer will make air content measurements at the beginning and approximately the one-half points of the load. When the air content is measured to be outside the limits of the specified content, the remainder of the load shall be refused. Subsequent loads will be tested prior to placement, and as above, to see that the problem has been corrected.

4.4.11.4 Retempering

Water shall not be added to mixed batches of concrete to increase the slump without specific written approval of the Engineer.

4.4.12 Testing of Concrete

The following tests will be performed by the Engineer on work performed under this Specification.

4.4.12.1 Strength Tests

During the course of construction, tests will be made to determine whether the concrete, as being produced, complies with the standards of quality specified in Section 4.4.9. The actual testing will be performed by an approved testing laboratory.

Preparation of Test Specimens

The concrete for test specimens will be sampled in accordance with ASTM C-172. The specimens will be cast and cured in accordance with ASTM C-31 and will be tested in accordance with ASTM C-39. Each test specimen will be tagged with the location of the sampled batch in the structure, the mix proportions or number, the slump and the type and brand of cement.

Number of Test Specimens

Not less than three (3) test specimens will be made for each 40 cubic yards, or portion thereof, of concrete placed in any one shift.

Age of Test Specimens

One or more test specimens will be broken at seven (7) days and the remaining specimens will be broken at twenty-eight (28) days.

4.4.12.2. Slump Tests

Slump tests will be made in accordance with ASTM C-143.

4.4.12.3 Tests for Entrained Air

The entrained air content of fresh concrete will be determined in accordance with ASTM C-231.

4.4.13 Enforcement of Strength Requirements

4.4.13.1 Definition of Failure

Cast Specimens

The test specimens cast in the field shall be considered to have failed the strength requirements when the average of all the strength tests or the average of any five consecutive strength tests is less than the specified strength or when more than one test in ten has an average value less than 90 percent of the specified strength. A strength test shall be the average strength of at least two companion cylinders.

Cored Specimens

The concrete represented by cored specimens shall be considered to have failed the strength requirements when the average strength of three specimens falls below 85 percent of the specified strength.

4.4.13.2 Failure of Test Specimens

When test specimens are made, cured, and tested in accordance with Section 4.4.12 of this specification, fail as defined above, the Engineer may require the following action be taken:

Testing of Cored Specimens

Specimens shall be secured, prepared and tested in accordance with ASTM C-42.

The Engineer will specify the location where each core specimen shall be secured. No more than three cores shall be taken from each portion of the structure for which cast test specimens have failed, as defined in Section 4.4.13.1 above.

Cored specimens shall be tested no later than sixty (60) days after the concrete was placed unless otherwise approved by the Engineer.

Where cored specimens fail as defined in Section 4.4.13.1 above, the Contractor shall strengthen or replace the structure in accordance with a plan approved by the Engineer.

4.5 Piping

Two drain pipes through the concrete plug shall be installed as shown in the drainings. The pipes shall be 4-inch diameter stainless steel pipes. The values shall be as specified in the drawings or equivalent. The valve types and materials are subject to approval by the Engineer prior to installation.

Rubber water stops shall be placed around the pipes as shown in the drawings. If pipe connections are required within the concrete plug, they shall be threaded joints unless otherwise approved by the Engineer. Pipe connections shall be sufficiently tight to withstand up to 600 psi pressure.

4.6 Grouting

Grouting shall be done in areas where ever needed to provide a tight seal between the rock and concrete. Grout tubes shall be placed such that air entrapment does not occur in voids. A return line shall be installed at each location to provide a means of determining total void filling with grout. Placement of the grout lines is subject to the approval of the engineer.

Grouting may not be done within the first seven days after concrete emplacement. Grout pressures shall not exceed 1,500 psi. The grout shall be of a neat mix using sulfate resistant Portland cement. Chemical grouts may be used upon approval of the Engineer.

4.7 Instrumentation

A pressure gage shall be installed on one drainpipe and connected to a data logger as shown in the drawings. The equipment required is specified below. Installation and connection of the equipment shall be done as specified by the supplier. Routing of the readout lines shall be such as to protect them from damage.

The instrumentation installed shall be as listed below or equivalent. The supplier of the equipment itemized below is available upon request.

- Wekslar Gage - No. AA4-4-2
- TERRATRAC Model T/1015 Data Logger with 2,000 reading capacity; int. clock; in portable heavy-duty, gasketed case; battery-pak; signal connectors.
- Extended Operation Battery Pack (6 mo. of daily readings)
- Battery Charger (120VAC)
- HP-41CX Advanced Calculator (with programming for Interrogation; Extended Memory Module; HP-IL Module)
- Precision Pressure Transducer (SENSOMETRIC Series 97, 250 psig)

- Instrument Signal Cable (non-direct burial, 3 conductor and 100% shield)

Unless otherwise arranged and agreed to by the Agency, the Contractor shall be responsible for the selection, procurement and installation, operation of the above or equivalent instrumentation system.

Also, the Contractor shall be responsible to see that the instrumentation system is maintained in good condition and is properly operating at the time of acceptance of the work by the Agency. The Contractor shall also provide an operating warranty of the equipment for one full year following acceptance of the work by the Agency.

4.8 Cleanup

All materials used during construction and not built into the plug shall be removed from the adit and portal area, including the formwork at the face of the mine plug. Any support placed in the adit by the Contractor will be left in place.

The portal, the portal doors, and immediately surrounding area shall be left in a safe and operable condition. Reclamation of disturbed areas outside the portal shall consist of removal of all equipment and unused or discarded materials. The site shall be graded to re-establish original drainage conditions.

5.0 DIVERSION DITCHES

5.1 Scope

The work under this specification includes clearing, grubbing, and excavation for a diversion ditch as shown in the drawings, and remedial work for existing ditches.

5.2 Definitions

1) Clearing is defined as the cutting near ground level of trees and brush, and the removal of such cut material along with downed timber, rotten wood, rubbish, any other vegetation, and objectionable material.

2) Grubbing is defined as the removal from below the surface of the natural ground of stumps, vegetation, and roots 1-inch diameter and larger.

3) Excavating is defined as the removal of soil, soil-rock or rock materials within the limits shown on the construction drawings or specified by the Engineer.

5.3 Clearing and Grubbing

5.3.1 General

Clearing and grubbing shall be done along the alignment of new diversion ditches. Only clearing shall be done along access routes to the work area. Clearing along access shall be kept to a minimum. Prior to clearing, access routes shall be approved by the Engineer and the Regulatory Agencies.

5.3.2 Protection

1) Trees and vegetation beyond the specified limits for the diversion ditch and access route shall not be removed or damaged without the approval of the Engineer.

2) Beyond the clearing and grubbing limits, the following activity is not permitted:

   a) Compaction of root area by moving trucks or heavy motor equipment, or by storage of heavy equipment, supplies, gravel, and earthfill.
   b) Damage by trucks and motor equipment bumping into trees, leaning equipment, lumber, pipes, and other supplies against trees.
   c) Nailing or bolting objects to trees, using trees as temporary support posts, power poles, or sign posts.
   d) Strangling trees by tying ropes, guy wires, power lines to trunks or large branches of trees.
   e) Poisoning trees by pouring paint thinner, paint, solvents, oil, gasoline, dirty water, and other expendable materials on or around trees and roots.
   f) Burning of foilage and branches by burning trash under trees or so near that wind-blown heat damages tree leaves.
   g) Cutting of roots by utility ditching, foundation digging, placement of curbs and benches, and other miscellaneour excavation.
   h) Damaging of branches and foliage by temporary overhead power and telephone lines, swinging of power crane booms, cherry pickers, or driving too-tall van trucks under trees.

i) Cutting off branches, to allow for construction, by improper pruning methods such as peeling bark down the truck.

5.3.3 Extent of Removal

Clearing and grubbing shall be done for a maximum distance of 5 ft beyond the limits of the ditch excavation and grading; and 3 ft beyond the limits required for equipment access.

Blasting of stump removal shall not be permitted.

5.3.4 Disposal

a) If applicable, branches and brush shall be put through a chipper and the residue spread in designated areas to retard erosion and provide for dust control.
b) Larger trees and limbs shall be disposed of as proposed by the Contractor and approved by the Engineer, or as specified in a separate contract with the Agency.

5.3.5 Timing

Clearing and grubbing shall not be permitted during the rainy season unless proper sediment control structures have been installed to limit erosion and to prevent an increase in sediment loads in the streams. All runoff and sediment control measures shall be submitted to the Engineer in detail for comment and review. All waters discharged from the sediment control area shall be in compliance with State of California water quality control standards and discharge permit requirements.

5.4 Riprap Materials

Riprap may be required to provide protection against excessive erosion of the diversion ditches. It is anticipated that this material will be available from a local supplier. Suitable material may exist outside the mine portal and could be used subject to the Engineer's approval.

Riprap shall be as specified below.

Riprap with $*d_{50}$ = 6 inches

Intermediate Rock Dimension	Percent smaller than given size by weight
24 inch	100
15 inch	70-100
12 inch	40-60
9 inch	20-40
6 inch	10-20
2 inch	2-10

$*d_{50}$ = median particle size

5.5 Riprap Bedding Material

Riprap bedding material is not anticipated to be available at the site and will be obtained from commercial sources. Samples of the materials proposed for bedding shall be provided for testing and approval by the Engineer prior to use. Specifications for bedding are listed below.

Riprap Bedding Material

U.S. Standard Sieve	Percent Finer by Weight
3 inch	90-100
3/4 inch	20-90
No. 4	0-20
No. 200	0-3

5.6 Existing Ditches

Existing ditches requiring remedial work shall be regraded to their original geometry. Areas showing excessive erosion shall be regraded and protected from addtional erosion. Details for such protection are shown in the drawing.

Areas requiring additional work shall be field located by the Engineer in conjunction with the Contractor.

Acceptance of the completed work shall be subject to the approval of the Engineer.

5.7 New Ditches

New ditches to be installed shall be excavated and graded to the lines and grades or shown in the drawings. Areas which may be susceptible to excessive erosion under normal flow conditions will be protected as shown in the drawings.

Final alignment of the diversion ditch(es) will be field located and approved by the Engineer.

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

January 23, 1986
Project No. 06901

JAN 29 2 36 PM '86

California Regional Water Quality Control Board
Central Valley Region
3201 "S" Street
Sacramento, California 95816

Attention: Mr. William Marshall, Contract Manager

RE: EVALUATION OF FLOW IN WALKER MINE - ADDENDUM TO FINAL REPORT FOR CONTRACT NO. 4-051-150-0

Dear Bill,

Enclosed is the report on the evaluation of flow in the Walker Mine. This report is an addendum to the final feasibility study and design report for plugging the Walker Mine which was prepared under Contract No. 4-051-150-0.

The report presents a summary of the field data collected and laboratory tests conducted for the flow evaluation study. The data was interpretated by Adrian Brown and the conclusions were presented to and discussed with the project team prior to finalizing this report. The conclusions are unchanged from those forwarded to you in our December 12, 1985 letter and preliminary report.

Sincerely,

STEFFEN ROBERTSON AND KIRSTEN
(COLORADO) INC.

Colin F. Smith

Colin Smith
Project Manager

CS/gg

Encl.

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FLOW EVALUATION WITHIN THE WALKER MINE
ADDENDUM REPORT TO WALKER MINE PROJECT
FINAL FEASIBILITY AND DESIGN REPORT
CONTRACT NO. 4-051-150-0

Prepared for:
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, California 95816

Prepared by:
Steffen Robertson and Kirsten (Colorado) Inc.
3232 S. Vance Street, Suite 210
Lakewood, Colorado 80227

January, 1986

1.0 INTRODUCTION

On December 6, 1985, an inspection of the Walker Mine was made by Steffen Robertson and Kirsten (SRK) staff for the purposes of evaluating the mine flow system and of resolving the question as to whether there is currently any water which flows into the mine that does not pass out through the portal adit. This information is critical to the prediction of the post-sealing performance of the mine, particularly with respect to the question as to the likelihood of copper-laden water from the mine ever entering the Ward Creek catchment via the Piute Shaft.

The personnel participating in this phase of the work and the preparation of this report were Adrian Brown and Mark Logsdon of Terra Therma, Inc. and Colin Smith, associate consultants to SRK. As geohydrologist on the team, Adrian Brown was the lead engineer responsible for the data interpretation and preparation of this report.

2.0 ACTIVITIES

The mine was visited on Friday, December 6, 1985. The SRK team entered the adit at about 1000 hours and progressed from the portal to the rockfall between the Piute and 712 sections, taking water quality samples and flow measurements at appropriate locations on the way. The party returned to the portal at about 1715 hours. The water samples were filtered that evening, and carried to Denver the following morning for analysis.

3.0 RESULTS

3.1 Field Measurements

The results of the field measurements of flow and water quality are summarized on Table 1.

TABLE 1
SUMMARY OF RESULTS OBTAINED FOR FLOW ON THE 700 LEVEL

LOCATION	FLOW (gpm)	TEMP (^{o}C)	pH (units)	COND (umho)
Flow in the adit	21	7.3	5.25	340
South end of South orebody	1	5.9	3.29	289
South end of Central orebody	41	4.0	6.23	221
South end of North orebody	55	3.7	8.40	208
South end of 712 orebody	46	3.4	8.28	231
South end of Piute orebody	40	3.4	8.58	198

The pH results are questionable due to a malfunction of the pH probe resulting from the difficult conditions encountered underground. It should be noted that other readings were taken during the trip; the values presented above are the key values with respect to the question which was of primary interest during this visit.

The water level in the lower workings was visible at a few locations, and the distance below track grade was measured using a tape at these points. The results are indicated in Table 2.

TABLE 2
ELEVATIONS OF WATER LEVELS IN WORKINGS BELOW THE 700 LEVEL

LOCATION	CHAINAGE (feet)	TRACK ELEVATION (feet)	DEPTH TO WATER (feet)	WATER ELEVATION (feet)
North end of adit	-1900	0.0	0.0	0.0
Center of Center Orebody	- 500	7.0	5.0	2.0
Center of North Orebody	800	13.5	14.5	-1.0

Note: Elevations are relative to the elevation of the north end of adit. Elevation of the track is computed on the assumption that the track gradient is 0.5 percent. This is the gradient computed from plans.

Given the relatively low precision of the measurements, it is considered that the water elevations are the same; that is, the water level in the South, Central, and North orebody workings below the 700 level is the same, and is about equal to the elevation of the adit discharge point.

3.2 Laboratory Results

Seven water quality samples were collected in conjunction with the flow measurements in the mine, and a water quality sample of the outflow from the adit was also collected. Table 3 presents the laboratory analytical data for the samples.

All eight samples were analyzed for pH, specific conductance, and TDS, as indicators of the overall chemistry, and for copper (Cu), the heavy metal of principal concern. The water exiting the adit was analyzed for a full suite of major and minor species, primarily to allow correlation of these data with other sampling sessions. Copies of the laboratory report are attached.

TABLE 3

WATER QUALITY DATA, WALKER MINE - DECEMBER, 1985

PARAMETER	UNITS	SAMPLE NUMBER AND LOCATION							
		1	2	3	4	5	6	7	8
		S. end South ext.	S. end Central	S. end North	Inflow from roof, S. end North	S. end of 712	N. end of 712	S. end of Piute	Outflow from adit
pH	umho/cc	4.05	7.41	7.46	3.44	7.21	7.58	5.43	5.31
Conductivity	mg/l	346	242	217	436	222	203	167	256
TDS	mg/l	235	88	153	244	155	149	117	195
Alkalinity	mg/l $CaCO_3$				<1		73	11	12
Ca	mg/l				17		25	13	23
Mg	mg/l				5.5		5.1	3.1	6.2
Na	mg/l				1.87		3.6	1.81	3.1
K	mg/l				2.21		1.11	1.51	1.39
HCO_3	mg/l				<5		72	<5	<5
CO_3	mg/l				<1		<1	<1	<1
OH	mg/l				<.5		<0.05	<0.05	<0.05
SO_4	mg/l				135		45	73	111
Cl	mg/l				.5		0.5	0.5	0.6
Al	mg/l								0.4
As	mg/l								<0.01
Ba	mg/l								<0.1
Cd	mg/l								<0.01
Cr	mg/l								<0.01
Cu	mg/l	11.5	.33	.54	12.1	.73	1.00	10.4	8.7
Fe	mg/l				12.1		<0.05	0.21	0.10
Pb	mg/l								<0.01
Mn	mg/l				5.3		0.90	1.59	2.52
Hg	ug/l								<0.3
Ni	mg/l								<0.05
Se	mg/l								<0.01
Ag	mg/l								<0.01
Zn	mg/l				.96		0.24	0.40	0.65

4.0 DISCUSSION

These results quite clearly indicate that water which enters the mine does not all leave by the adit. The main inflow at the time of the visit was from the Piute area. In the 712 mine section, and to a lesser extent in the North orebody, there was some evidence of inflow from above. However, the two largest of the observed flows were measured and found to be of the order of 2 gallons per minute. It is estimated that, at the time of the visit, less than 10 gallons per minute of flow was observed coming from the workings above 700 level adit. There may, however, have been inflow to this level in sections which were not visible to the party, due to being in other segments of the drive system.

The available maps of the mine indicate that there is no mined connection between the Piute and the 712 orebody below the 700 level. Similarly, there is no known connection between the 712 orebody and the North orebody below the 700 level. Thus, it is not surprising to find that the flow on the 700 level increases from the south end of the Piute orebody to the south end 712 orebody.

There is believed to be connection below the 700 level between the North, Central and South orebody workings. The flow values reflect this, as the flow in the drain on the 700 level reduces in this stretch, presumably because of leakage to the lower workings. During the recent inspection trip, the flow could be seen to be disappearing from the 700 level adit drain into the lower workings at a number of locations, particularly in the South orebody area. The drain was essentially dry at the point where the 700 drive intersects the exit adit. Flow in the exit adit comes from the south extension, and is presumably return flow from the deeper mined area, which collects water from the entire mine.

The water level information indicates that there is a connection between the North, Central and South orebody workings below the 700 level. Water is presumably flowing into the lower workings from the 700 level, and moving towards the adit exit through the conduits provided by

the workings. This effect did not appear to be significant in the North orebody at the time of the visit. However, on the previous visit where this location was inspected, a considerable flow was observed to be dropping into the deeper portion of the North orebody workings at the location where the water level was measured this time.

The chemical parameters indicate regular changes from the input areas to the outflow areas. As the field readings were taken in winter, the water was entering the mine colder than the mine rock temperature. As a result, the water was warmed by the rock, which clearly shows in the field results.

The laboratory values for conductivity (and related TDS) are consistent with the field measurements - both generally increased from inflow to outflow points within the mine. The laboratory pH values (which were not subject to the vicissitudes of measurement under highly adverse field conditions) have a very strong correlation with TDS ($r = -0.78$). The correlation is even higher for copper, the metal of greatest interest ($r = -0.96$) for zinc and sulfate, the correlation factors are -0.93. These correlations clearly indicate that the dissolved load of the waters, particularly the concentrations of heavy metals is dependent primarily on pH.

The correlation of copper concentration with pH offers a ready explanation for why flow from the mine to the natural groundwater system has not introduced significant quantities of copper into the surface water system. The acid drainage in the mine system is the result of oxygenated waters reacting with the sulfide ores. When the water in the mine system flows out of the mine workings and into the country rock, it flows away from the concentrated sulfide zone, and along many flow paths through the granodiorite (and potentially other units) before it discharges to surface waters. During this flow, the acid produced in the ore zone is neutralized by water-rock reactions (primarily with the feldspars), and the copper initially carried in solution is precipitated and/or scavenged by clays, oxyhydroxides, and other phases that are present in the country rock.

The importance of the observation that there is a loss of a considerable amount of water from the mine to the groundwater system under natural conditions is as follows:

1. The loss from the mine will presumably increase as the mine fills after flooding, due to the higher driving head;
2. The increased flow loss from the mine makes it highly unlikely that water will ever rise high enough in the workings to cause a discharge from the Piute area, and into the presently unaffected catchment of Ward Creek; and
3. The losses have presumably been going on since the closing of the mine, and to date there is no evidence of a stream of copper-laden water egressing from the groundwater system to the surface water system via the natural flow system. Based upon the data collected in the mine, it is expected that as the water enters the groundwater, it is neutralized and the copper is precipitated from solution. Therefore, no increases in copper-ladened waters are expected to occur in the surface water system as a result of plugging the mine.

5.0 CONCLUSIONS

The conclusions of the evaluation are as follows:

1. The flow in the mine is a clearly identifiable hydraulic and geochemical system; water moves from the 700 level drive to the lower workings where it can, and discharges from the deep workings to the deep groundwater system, to the adjacent downgradient mine workings (when they are connected), or to the main exit adit and thence to the portal;
2. There is clearly loss of water from the mine which is a result of discharge of water from the deep mined workings to the natural groundwater system. At the time of the visit, about 40 percent of the influent water was appearing at the proposed plug location as flow in the adit drain, and approximately 60 percent of the inflow to the mine was discharging into the bedrock from the deep mine workings;

3. Based on these results, it is considered highly unlikely that copper-rich water could flow from a plugged mine to the catchment of Ward Creek via the Piute Shaft; and
4. There is a low probability that copper from the mine will emerge from the groundwater system once a plug has been installed in the mine and the water pressure in the mine has increased. In fact, the production of acid drainage will gradually decrease in importance to the extent that inflow of oxygenated surface water can be reduced (by reducing the flow into the surface shafts, particularly the Piute) and as the water stored in the plugged mine consequently becomes less oxidizing over time.

CORE LABORATORIES, INC.
ANALYTICAL REPORT

ANALYTICAL REPORT

W85884

TERRA THERMA INC.

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

CLIENT IDENTIFICATION

JOB NO.:6307-W85884
COMPANY: TERRA THERMA, INC.
JOB/GROUP REMARKS:

IDENTIFICATION	IDENTIFICATION
1) 1285-04	2) 1285-06
3) 1285-07	4) 1285-08
5) 1285-01	6) 1285-02
7) 1285-03	8) 1285-05

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
DATE/TIME SAMPLED	12-06-85/1415	12-06-85/1515	12-06-85/1530	12-06-85/1730
DATE/TIME RECEIVED	12-09-85/	12-09-85/	12-09-85/	12-09-85/
DATE/TIME ANALYZED	12-10-85/	12-10-85/	12-10-85/	12-10-85/
CHEMIST: RIF/DRH				
LOCATION: AURORA, CO				

LAB pH (@ 25 deg. C)	3.44	7.58	5.43	5.31
LAB COND. (as umhos/cm @ 25C)	436	203	167	256

--ALL VALUES REPORTED ON A DISSOLVED BASIS (MG./L.) UNLESS INDICATED OTHERWISE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
MAJOR CATIONS				
CALCIUM (Ca)	17 (0.85)	25 (1.25)	13 (0.65)	23 (1.15)
MAGNESIUM (Mg)	5.5 (0.45)	5.1 (0.42)	3.1 (0.26)	6.2 (0.51)
SODIUM (Na)	1.87 (0.08)	3.6 (0.16)	1.81 (0.08)	3.1 (0.13)
POTASSIUM (K)	2.21 (0.06)	1.11 (0.03)	1.51 (0.04)	1.39 (0.04)
SUM OF MAJOR CATIONS (me/l)	(1.44)	(1.86)	(1.03)	(1.83)
SUM OF TOTAL CATIONS (me/l)	(2.69)	(1.93)	(1.44)	(2.27)
MAJOR ANIONS				
BICARBONATE (HCO3)	<5 (0.00)	72 (1.18)	<5 (0.00)	<5 (0.00)
CARBONATE (CO3)	<1 (0.00)	<1 (0.00)	<1 (0.00)	<1 (0.00)
HYDROXIDE (OH)	<0.5 (0.00)	<0.5 (0.00)	<0.5 (0.00)	<0.5 (0.00)
SULFATE (SO4)	135 (2.81)	45 (0.94)	73 (1.52)	111 (2.31)
CHLORIDE (Cl)	0.5 (0.01)	0.5 (0.01)	0.5 (0.01)	0.6 (0.02)
SUM OF MAJOR ANIONS (me/l)	(2.82)	(2.13)	(1.53)	(2.33)
SUM OF TOTAL ANIONS (me/l)	(2.82)	(2.13)	(1.53)	(2.33)

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
GENERAL PARAMETERS				
TOTAL DISSOLVED SOLIDS (CALC.)	244 (193)	149 (118)	117 (106)	195 (158)
*TOTAL ALK. (pH 3.7 as CaCO3)	<1	73	11	12

*--FILTERABLE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
DISSOLVED METALS				
ALUMINUM (Al)				0.4
ARSENIC (As)				<0.01
BARIUM (Ba)				<0.1
CADMIUM (Cd)				<0.01
CHROMIUM (Cr)				<0.01
COPPER (Cu)	12.1	1.00	10.4	8.7
IRON (Fe)	12.1	<0.05	0.21	0.10
LEAD (Pb)				<0.01
MANGANESE (Mn)	5.3	0.90	1.59	2.52
MERCURY (Hg)--ug./l.				<0.3
NICKEL (Ni)				<0.05
SELENIUM (Se)				<0.01
SILVER (Ag)				<0.01
ZINC (Zn)	0.96	0.24	0.40	0.65

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
DATE/TIME SAMPLED	12-06-85/1100	12-06-85/1210	12-06-85/	12-06-85/
DATE/TIME RECEIVED	12-09-85/	12-09-85/	12-09-85/	12-09-85/
DATE/TIME ANALYZED	12-10-85/	12-10-85/	12-10-85/	12-10-85/
CHEMIST: RIF/DRH				
LOCATION: AURORA, CO				

LAB pH (@ 25 deg. C)	4.05	7.41	7.46	7.21
LAB COND. (as umhos/cm @ 25C)	346	242	217	222

--ALL VALUES REPORTED ON A DISSOLVED BASIS (MG./L.) UNLESS INDICATED OTHERWISE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
GENERAL PARAMETERS				
TOTAL DISSOLVED SOLIDS	235	88	153	155

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
DISSOLVED METALS				
COPPER (Cu)	11.5	0.33	0.54	0.73

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BUFF SHEET

ITEM: 3

SUBJECT: Walker Mine, Robert R. Barry, Calicopia Corporation and The Standard Bullion Company, Plumas County.

a. Consideration of a Resolution to approve a Negative Declaration.

b. Consideration of a Resolution directing the Executive Officer to seal the mine.

REPORT: Walker Mine is a nonoperating copper mine in Central Plumas County. An acidic, heavy metal-laden discharge from the main portal has eliminated fish and aquatic life downstream in Dolly and Little Grizzly Creeks. Mining operations ceased in 1941.

A Board consultant has evaluated the feasibility of installing a mine seal to stop the discharge. The consultant recommends a concrete seal in the main adit of the mine and the rehabilitation of diversion channels around the sinkholes. The single mine seal will provide the most cost-effective method of pollution abatement and provide the best protection for the surrounding surface waters and watersheds.

An Initial Study was conducted to determine if the project may have any significant effect on the environment. Staff has completed an Initial Study and proposes that the Board approve the Negative Declaration pursuant to Title 14, California Administrative Code, Section 15074.

RECOMMENDATIONS: Adopt Resolutions:

(1) Approving the Negative Declaration.

(2) Directing the Executive Officer to seal the mine in accordance with the consultant's recommendations.

TABLE OF CONTENTS

		Page
1.	Staff Report	4-1
2.	CEQA Document a. Proposed Negative Declaration and Initial Study b. Comments received on proposed Initial Study and Negative Declaration c. Response to comments received on Initial Study and Negative Declaration	4-7
3.	Letters and names of persons who have responded to the Walker Mine Hearing Notice	4-42
4.	Proposed Resolution approving Negative Declaration	4-46
5.	Proposed Resolution directing the Executive Officer to take steps to seal the Walker Mine	4-47
6.	Public Notice	4-50

STAFF REPORT

WALKER MINE

Location

The Walker Mine, owned by Mr. Robert R. Barry, Calicopia Corporation, is an inactive copper mine approximately 20 miles east of Quincy in Plumas County.

History

Walker Mine was actively mined for copper from 1916 to 1932, and from 1935 to 1941. Since the mid-40s, the mine has discharged acid and heavy metals to Dolly Creek. Discharge from the mine has resulted in the elimination of aquatic life downstream in Dolly Creek and Little Grizzly Creek. These creeks have been affected by this discharge for approximately 12 miles. Above the mine, these creeks contain abundant levels of aquatic insects and fish. Only through dilution at the confluence of Grizzly Creek and Indian Creek is the quality of these waters improved sufficiently for aquatic habitat.

Waste discharge requirements were first adopted in 1958. The mine has continuously violated these and subsequent requirements, except for short periods in extremely dry years when the discharge ceased.

The following chronology provides a brief history of actions at the Walker Mine:

8 Apr 1959	Cleanup and Abatement Order adopted
23 Jun 1960	Referred 8 April 1959 C&A Order to Attorney General
18 Jul 1963	Cease and Desist Order adopted
26 Oct 1970	Abatement Order issued (Section 13305 of the CWC)
8 Sep 1971	C&A Order issued by Executive Officer
28 Jul 1972	Referred 8 September 1971 C&A Order to Attorney General
23 May 1975	NPDES Order No. 75-119 adopted
30 May 1980	NPDES Order No. 80-058 adopted; C&A Order No. 80-070 adopted; Referred to Attorney General; Order No. 80-071 adopted
21 Dec 1983	Abatement Order issued (Section 13305, CWC)
25 Jan 1985	NPDES Order No. 85-033 adopted

Prior Attempts to Abate Pollution

Proposals to abate the pollution and operate the Walker Mine are not new. In 1969, Norandex, Inc., a major mining company, proposed to open the mine and submitted a letter stating how pollution would be abated. In 1974, mining consultant William McClung proposed remedial measures on behalf of Mr. Barry. In 1975, a tin tank was able to cut effluent copper concentrations from 14 mg/l to 9.7 mg/l. This process is no longer in operation. Continental Oil Co. (CONOCO) did extensive exploration work at the mine in 1978 and 1979. During July of 1980, staff requested access to construct remedial diversion work in the glory hole areas with Clean Water Bond funds. Conoco, the lessee at that time, provided a bulldozer and operator for one day to complete the diversion work. However, no pollution abatement procedures were implemented. Mr. Barry, the mine owner, and the Standard Bullion Company, the current lessee, presented a new abatement proposal in January 1985. However, no pollution abatement was accomplished at the mine during the summer of 1985. Untreated acid mine waste continues to discharge from the mine. No detailed plans or time schedules have been submitted by Mr. Barry or his lessee.

Alternative Methods for Stopping Acid Mine Drainage

Several alternatives for abating the acid mine drainage problem have been studied. As part of a 208 Area-wide Planning Program, D'Appalonia Consulting Engineers completed a feasibility study on these alternatives The 208 Study recommended that a chemical treatment plant be built to remove heavy metals and neutralize the acid mine drainage. The Regional Board obtained a grant under the Clean Water and Water Conservation Bond Act of 1978 (SAP) for design and construction of facilities to stop the acid mine discharge. Pearson and Associates were hired to design and supervise construction of the chemical treatment plant recommended in the 208 report. The Pearson report, completed in April 1984, showed that the treatment plant was very expensive in terms of operations and maintenance. Pearson estimated that 2.6 staff-years per year would be required to staff the treatment plant. Construction costs were estimated at $336,000.

As previously stated, mine owner, Robert Barry, and lessee, Standard Bullion Company, proposed a chemical treatment process also. However, neither Mr. Barry nor Standard Bullion have shown that they have the resources to install or operate the treatment system which they proposed.

Before taking action on the Pearson report, staff decided to reexamine the option of sealing the mine. The sealing option had been dismissed in the 208 Study because sealing would preclude an active mining operation. The Board hired Steffen, Robertson and Kirsten Mining Engineers (SRK) to design and construct a seal, if feasible. SRK finished its report in January 1986. Construction of the mine seal was estimated at $165,000. Operation and maintenance of the seal was very low compared to the chemical treatment option. Seal maintenance consists of reading pressure gauges at the seal and surveying the mine area for springs which may result from increased water levels in the mine.

The "no-project" alternative was described by SRK in its design report. SRK states that, if nothing is done, Walker Mine will continue to produce acid mine drainage well into the future.

In a report, dated 18 November 1985, SRK has found that sealing the mine is a feasible and cost-effective method of pollution abatement. SRK recommends the following items:

1. Install a single plug in the adit approximately 2,700 ft. from the main portal - $165,000.

2. Rehabilitation of diversion channels around sinkholes - $14,000.

3. Prepare a contingency plan for construction and operation of a small treatment plant for a controlled discharge at the main portal should it be necessary to open the valves. - $6,500.

Because of concerns that sealing the mine could cause acid mine waters to spill from the Piute portal and enter Ward Creek, SRK entered the mine on 7 December 1985 and did a water balance and water quality survey. That survey concluded that chances of spill from the Piute portal were remote.

Mr. Barry has expressed concerns about his future ability to operate the Walker Mine after a seal is built. The mine has not been operated since 1941 and Mr. Barry has not demonstrated that the mine will be operated in the future. Installation of a seal in the main adit of the Walker Mine will not prevent future use of the mine. Should it become feasible to resume mining, valves in the seal could be opened to drain the mine. Mine fluids could be drained or pumped at a controlled rate, treated, and discharged. There is some concern from residents of the Ward Creek watershed about possible discharge from the Piute portal at the opposite end of the mine. This portal is 400 feet higher in elevation than the main portal. Staff plans to mitigate this threat by regular monitoring of the water level in the mine workings by means of pressure gauges at the plug with remote reading facilities at the portal. Should a discharge become imminent, one or both of the valves in the seal would be opened to release the excessive build up of water.

The controlled mine discharge could be treated in one or both of the following ways.

1. Through monitoring, adequate notice of a threatened discharge would provide time to construct a small treatment plant at the portal of the main adit. Specifications for this treatment facility could be provided by SRK in the recommended contingency plan.

2. Small and short-duration releases of possible excess inflow could be discharged at specific times of the year. This would be done during the peak spring runoff so that the advantages of dilution may be used.

In addition, Ward Creek will be monitored to ensure that the pollution problem is not transferred to this watershed by springs or other unknown outlets from the mine.

These measures will adequately protect the Ward Creek watershed from a discharge from Walker Mine.

Mine Access

During two previous attempts to provide underground mine access for SRK, the Board has been forced to go to Plumas County Superior Court and ask for an order allowing SRK access to the underground workings. In January 1986, Mr. Barry was found to be in contempt of court for not providing timely access in accordance with the Court's Order. In order to insure continued access to perform abatement work, the Board will need to request the Superior Court of Plumas County to (1) grant access to construct the seal in the main adit, (2) to rehabilitate the diversion structures as needed, and (3) to monitor and maintain the system.

Cost of Recommended Alternative:

Mine seal construction	$165,000
Discharge Treatment Plant Specifications	6,500
Rehabilitate Diversion Ditches	14,000
	185,500*

The exact costs will not be known until construction bids are solicited and a contract awarded.

Funds Available from State Assistance Program (SAP) Grant:

	SAP Grant	259,050
Less	Pearson & Associates	83,786
Less	Regional Board Staff Charges	24,230
Less	SRK	100,000
	Remaining SAP Grant	51,034

Additional funds needed: 185,500 - 51,034 = $134,466

In a separate SAP grant for work in the West Stanislaus Resource Conservation District, there is a savings well in excess of the required $134,466. These SAP funds may be transferred to the Walker Mine project with approval of the State Water Resources Control Board.

Walker Mine owner, Robert Barry, may have sufficient assets to pay for the pollution abatement work. Water Code Section 13305 enables the Board to abate a condition of pollution or nuisance by correction of the condition at the property owner's expense. The Board adopted Order No. 83-148, Request to Abate Pollution, under Section 13305 on 9 December 1983. If the mine seal is installed, Board staff will seek reimbursement of Board costs from Mr. Barry and Calicopia Corporation.

CEQA Compliance

An Initial Study has been completed for the proposed pollution abatement project pursuant to Title 14, California Administrative Code, Section 15063. A Negative Declaration was prepared pursuant to California Adminstrative Code, Sections 15070 through 15073. The public review period began 2 January 1986 and ended 31 January 1986. All comments received during this period were considered and are attached to the Negative Declaration. The following agencies have made minor comments on the Initial Study. These comments and their respective responses are attached:

1. Native American Heritage Commission

2. California Department of Conservation, Division of Mines and Geology

Mr. Peter Dohms, of Condor Mineral Management Inc., submitted major comments on the Initial Study. Mr. Dohms is addressing the Initial Study as the consultant for Mr. Robert Barry, the mine owner. The following is a summary of his comments:

1. The proposed seal has little chance of ending the acid and metal discharge to Dolly and Little Grizzly Creek because of the contribution from the USFS tailings.

2. (a) The seal has the potential to cause a discharge into an uncontaminated watershed.

   (b) Water buildup in the mine will be degraded to the point that, if it is released, it will cause more damage than the current discharge.

   (c) Increased hydraulic head behind the seal will accelerate the discharge of mine water to ground water.

3. The seal will adversely affect the nonrenewable resource (mine ores).

4. The project may achieve short-term benefits to the disadvantage of long-term environmental goals.

In response to Mr. Dohms' summary comments, Regional Board staff contends the following:

1. The seal will prevent almost all of the heavy metal-acid mine discharge to Dolly and Little Grizzly Creek. In the past, the Department of Fish and Game have been able to show that fish can live in Little Grizzly Creek when the mine is not discharging. This would suggest that the USFS tailings do not contribute enough heavy metals to be toxic to fish.

2. (a) Discharge to Ward Creek is rated highly unlikely by SRK. In the case of a threatened discharge, pipes in the seal could be opened to drain the mine through a treatment plant into Dolly and Little Grizzly Creeks instead of Ward Creek.

   (b) Water released to Dolly and Little Grizzly Creeks can do no more damage than the current discharge. However, a regulated discharge through the seal and/or treatment plant could be an improvement over the current unregulated discharge.

   (c) Discharge to ground water may be accelerated, but the metals in this discharge will be neutralized by water-rock reactions (primarily with feldspars). Metals will be precipitated and/or scavenged by clays, oxyhydroxides, and other phases present in the country rock which is mostly granadiorite.

3. The mine may be reopened after the seal is built. Mine waters may be treated and discharged from the mine under the existing NPDES permit.

4. Mr. Dohms does not show how long-term environmental effects will occur.

It has been determined that, although the proposed project could have a significant effect on the environment, mitigation measures have been included in the project that will avoid the effects or mitigate the effects to a point where there will be no signifcant adverse effects. The Board must consider the proposed Negative Declaration, together with any comments received, during the public review period. After approval of the proposed Negative Declaration, the Board may consider approval of the pollution abatement project.

Community Concern

Staff have received twenty-eight letters expressing concern over the ongoing pollution problem at Walker Mine and their support of a Resolution directing staff to seal the adit of Walker Mine to abate the polluting discharge. One letter was received from a Ward Creek property owner expressing his concern over the protection of the Ward Creek Watershed.

Recommendation

Staff recommends adoption of the Final Negative Declaration and a Resolution ordering staff to take steps necessary to install the seal in the main Walker Mine adit in accordance with the SRK report.

CEQA DOCUMENT

1. Proposed Negative Declaration and Initial Study

2. Comments received during the review period on the Initial Study and proposed Negative Declaration

3. Responses to comments received during the review period on the Initial Study and proposed Negative Declaration

NEGATIVE DECLARATION
Pursuant to Section 21108
Public Resources Code

To: Office of Planning and Research
State Clearinghouse
1400 Tenth Street
Sacramento, CA 95814

From: Regional Water Quality
Control Board
Central Valley Region
3201 S Street
Sacramento, CA 95816

PROJECT TITLE: Water Pollution Abatement at Walker Mine

APPLICANT: Regional Water Quality Control Board, Central Valley Region

PROJECT DESCRIPTION:

The proposed project will be: construction of a mine seal, rehabilitation of surface diversion structures and the implementation of a surface water survey for the purpose of abating acid mine drainage discharging from Walker Mine.

LOCATION: 20 miles east of Quincy, Plumas County, Section 7, T24N, R12E, MDB&M. See attached map.

The Central Valley Regional Water Quality Control Board has determined that, although the proposed project could have a significant effect on the environment, there will not be significant adverse effect in this case because the mitigation measures described in the attached Initial Study have been added to the project. A NEGATIVE DECLARATION WILL BE PREPARED.

Mitigation measures outlined in the Initial Study include the implementation of the "Surface Water Survey" and the rehabilitation of the diversion structures.

Contact Person: William A. Croyle Telephone: 445-0270

APPROVAL OF THE ABOVE IS RECOMMENDED BY:

William A. Croyle 12/27/85 William J. Merkell 12/27/85

Signature Date
Water Resoucres Control Engineer
North Mountain Unit

Signature Date
Senior Water Resource Control
Engineer, North Mountain Unit

APPROVED

Signature Date
Executive Officer

INITIAL STUDY

FOR

WALKER MINE, PLUMAS COUNTY

The California Regional Water Quality Control Board, Central Valley Region (Board) is proposing a pollution abatement project at Walker Mine. This project entails the placement of a seal in the main adit of the mine, the rehabilitation of diversion structures above the mine, the implementation of a water quality monitoring program in the Little Grizzly Creek and Ward Creek watersheds and the formulation of a contingency plan for any threatened discharge. The Board has received the final Feasibility and Design report from Steffen, Robertson and Kirsten (hereafter SRK). The objective of this report was to evaluate the feasibility of sealing the Walker Mine main adit to prevent a direct discharge of acid and heavy metal laden water from the underground workings. The Board has assumed the lead agency role for this project under the California Environmental Quality Act and has completed this Initial Study in accordance with Section 15063, Title 14, of the California Administrative Code, "CEQA: The California Environmental Quality Act, Law and Guidelines, January 1984".

STATEMENT OF PROBLEM

The Walker Mine discharges acid and heavy metal laden water from an adit into Dolly Creek, which is a tributary to Little Grizzly Creek. The discharge from the mine has totally eliminated aquatic life in Dolly Creek, and in Little Grizzly Creek for a distance of approximately ten miles downstream from the mine.

The primary goal of the Board is to restore Little Grizzly Creek and Dolly Creek to a condition capable of supporting a diversity of aquatic life and protect all other water courses in the Walker Mine area.

PROPERTY HISTORY

Copper ore was first discovered at the Walker Mine site in 1904. Production commenced in 1916, continuing until 1932 and again from 1935 to 1941, when it was closed down by the operator, Walker Mining Company, a subsidiary of Anaconda Copper Company. Mining started on the 200 Level (approximately 6,670 feet elevation) near the outcrop of the Central Orebody. The Main Access Adit on the 700 Level (approximately 6,200 feet elevation) was driven in the early 1920's. This adit went from the millsite at Dolly Creek, northerly for some 3,000 feet where it intersected the South Orebody. From there, the adit was driven north by northwest, following the vein through the Central, North, 712 and Piute Orebodies. Approximately 10,000 feet from the portal, the Piute Shaft was raised in the vein from the 700 Level to surface in 1927/28. The portal of the 700 Level Main Access Adit remains the lowest point at which the underground workings reach the surface.

No stoping was done below the 700 Level until the 1930's. The deepest level from which ore was mined was the 1000 Level (approximately 5,720 feet elevation) and the deepest exploration winze was sunk to below the 1200 Level (approximately 5,400 feet elevation) on the Central Orebody.

A total of 5,319,000 tons of ore was mined between 1916 and 1941, from which 83,890 tons of copper were recovered (an average recoverable grade of 1.58% Cu with 0.03 oz/ton gold and 0.68 oz/ton silver recovered as by-products).

Soon after cessation of mining in November, 1941, all the mining equipment was removed and the surface plant was dismantled. When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage water flowing from the main Access Adit Portal on the 700 Level began to affect Dolly Creek and Little Grizzly Creek. Increasing concern over the detrimental effects of the acid mine drainage prompted the Board to commission several investigations.

DESCRIPTION OF THE PROJECT

A recent feasibility study has shown that using a mine seal is the most cost-effective way of preventing acid mine drainage from discharging to surface water-courses.

To abate the ongoing pollution discharge from Walker Mine, the Board will place an engineered concrete seal in the Main Access Adit approximately 2,700 feet from the 700 Level portal. This seal will effectively remove the main source of heavy metal and acid contamination in Dolly Creek and Little Grizzly Creek.

The project will largely consist of underground construction. A small concrete batch plant will be set-up on the surface at the 700 Level portal. Construction materials will be stockpiled at the 700 Level portal and used as required to complete the project.

The function of the seal will be to prevent a direct discharge of acid and heavy metal laden water from the underground workings and provide an immediate relief from the contaminated discharge.

The project will also consist of rehabilitating the diversion structures around the glory holes and implementing the "Surface Water Survey" in Ward Creek and Little Grizzly Creek Watersheds. Rehabilitation of the diversion structures will be performed as recommended by the Board's consultants; Steffen, Robertson and Kirsten, and Pearson and Potter Associates. This work will reduce the amount of surface water seeping into the underground workings. The "Surface Water Survey" will provide water quality baseline data and will monitor surface waters before and after seal construction. The survey will be designed to provide an early warning of any threatened discharge to Ward Creek.

ENVIRONMENTAL SETTING

Walker Mine is located approximately 20 miles by road from Portola, in Plumas County. The mine is situated in hilly country at an altitude of between elevation 6,000 and 7,000 feet. Access is by well-graded gravel road through the Plumas National Forest from California Highway 70 at Portola. The elevation of the main portal is approximately 5,720 feet. The mine site is subject to heavy snowfall in the winter and is generally inaccessible between November and April. The site is typical of mid to high elevation Northern Sierra Nevada climate. Wintertime low temperatures are well below freezing and summertime high temperatures are in the 90's. Average annual precipitation is about 40-50 inches. Average annual evaporation is 45 inches.

OTHER ENVIRONMENTAL FEATURES

The Walker Mine area includes portions of two watersheds; Little Grizzly Creek and Ward Creek. The Ward Creek Watershed experiences excellent water quality and contains an abundance of aquatic biota. Portions of Little Grizzly Creek Watershed have experienced the total elimination of aquatic life. This is largely due to the discharge from the Walker Mine main portal. Both watersheds have areas that are frequented by those who enjoy fishing, swimming, hunting, sightseeing, and picnicking, especially during the summer months. Logging activities are performed throughout the area. The U.S. Forest Service has informed the Board that there will be a contract logging operation directly adjacent to the Walker Mine site and proposed seal construction staging area during the target construction period.

ENVIRONMENTAL EFFECTS

Attached is a completed "Environmental Checklist Form" for the proposed project.

DISCUSSION OF ENVIRONMENTAL EVALUATION

WATER

Water quality is the major environmental concern with regard to the proposed project. The purpose of this project is to abate a polluting discharge which has eliminated aquatic organisms in portions of two watercourses.

The proposed project will result in a change in the direction of water movement; drainage patterns, and/or rate and amount of surface runoff; and the amount of surface water in local creeks. It is the Regional Boards' intent to prevent a discharge from the main adit of Walker Mine and to prevent surface water (i.e., snow and/or surface runoff) from seeping into underground workings. In doing so, the direction of water movement in the mine will be directed to deep ground water recharge and the surface waters normally seeping in the sinkholes will be diverted to surface waters (i.e., Ward Creek). The amount of surface runoff due to the

diversion structures is small and will not cause significant erosion. The amount of surface water in Dolly Creek and Little Grizzly Creek will decrease due to the seal placement. No significant adverse impacts are expected, due to the reduction. The changes in these creeks are viewed as beneficial impacts.

The proposal will result in a change in the discharge into surface waters and in surface water quality due to the placement of the mine seal. By eliminating the mine's discharge, Dolly Creek will contain only natural spring water, snowmelt and/or precipitation. This condition will improve water quality.

The proposed project will result in a change in the rate of flow of ground water, but not result in a change in usable ground water quality. Steffen, Robertson and Kirsten, the Board's consultants, have investigated the hydraulic characteristic of the underground workings on two occasions. They suggest that there is conservatively twice as much ground water recharge deep within the mine as flow from the mine. By raising the water head behind the seal, ground water recharge will increase. Ground water recharge will prevent a surface discharge from the other adits. Flooding the mine will also have the following water quality benefits:

1. Reduce oxidation of the ore body.

2. Allow the natural attenuation process to treat the low pH and heavy metal water in the earth-ground water system.

To assure protection of surface water from a polluted ground water discharge, the Regional Board will conduct a "Surface Water Survey" throughout the Ward Creek and Little Grizzly Creek Watersheds. This survey will assess water quality before and after seal construction. It will be designed to provide an early warning should a threatened ground water discharge exist. Survey data will be used to insure that water quality in both Ward Creek and Little Grizzly Creek Watersheds is being maintained or improved.

PLANT AND ANIMAL LIFE:

The proposed project will not adversely affect the diversity or species, or number of species of plant and/or animal life.

The purpose of the mine seal is to stop the discharge of acid and heavy metal-laden water to Dolly Creek and Little Grizzly Creek. By eliminating the toxic barrier caused by the discharge, plant and animal populations would be able to reestablish themselves in the affected area. Thus, the seal will beneficially impact these organisms. The rehabilitation of the diversion structures and implementation of the "Surface Water Survey" will result in a beneficial impact. These phases of the project will prevent erosion and provide background water quality data, respectively.

The plants and animals of the Ward Creek Watershed will be protected against a toxic discharge by implementing the "Surface Water Survey" and assessing the water quality before and after mine seal construction. This survey will be designed to provide an early warning of any threatened discharge to Ward Creek. The Survey will also be used to check water quality in the Ward Creek Watershed, as well as Little Grizzly Creek and Dolly Creek.

Should there be a threatened discharge in any watershed, the contingency plan will provide the mine owner and/or Regional Board staff with the available options. One option would be to open valves in the seal and return the hydrologic system to its pre-seal condition.

It is the intention of the Regional Board to first protect the Ward Creek Watershed and, second to protect the Dolly Creek and Little Grizzly Creek Watersheds.

PUBLIC SERVICES

The proposed project will not have a significant effect upon, or result in a need for new or altered governmental services in the areas of fire protection; police protection; schools; parks or other recreational facilities; maintenance of public facilities, including roads.

There will be a temporary impact on the Central Valley Regional Water Quality Control Board due to the implementation of surface water and mine seal monitoring program. Temporary staff requirements will be met by existing Regional Board staff.

RECREATION:

The proposed project will not adversely affect the quality or quantity of existing recreational opportunities. Recreation will be enhanced by the removal of acid mine drainage from Little Grizzly Creek and the reestablishment of a fishery.

ARCHEOLOGICAL/HISTORICAL RESOURCES:

After consultation with Mr. Joe Pope of the State Water Resources Control Board and through him, the Office of Historic Prservation, it was determined that, due to previous destruction and removal of mill buildings, other town site buildings and other alterations at the site, an archeologica/historical resources survey will not be required. As a result of these alterations to the mine and mine site since closure in the 1940s, there is no resource value.

COMPATIBILITY WITH ZONING AND POLICY

The proposed project will be consistent with existing zoning, plans and other applicable land use controls and policies since there has been no change in land use. (General forest and 10 acre rural).

RECOMMENDATION

Based on the preceding study, I recommend that a Negative Declaration be prepared for this application.

William A. Croyle

WILLIAM A. CROYLE
Water Resources Control Engineer
North Mountain Regulatory Unit

12/24/85:WAC:gs

PERSON/AGENCIES PROVIDING ASSISTANCE OR INVOLVED IN THE PREPARATION OF THE INITIAL STUDY:

William A. Croyle, Area Engineer, California Regional Water Quality Control Board, Sacramento.

Edwin Z. Crawford, Area Engineer, California Regional Water Quality Control Board, Sacramento.

William J. Marshall, Senior Engineer, California Regional Water Quality Control Board, Sacramento.

Jack E. DelConte, Supervising Engineer, California Regional Water Quality Control Board, Sacramento.

Colin Smith, Project Manager, Steffen, Robertson and Kirsten, Lakewood, Colorado

Don Poulter, Project Engineer, Steffen, Robertson and Kirsten, Lakewood, Colorado

Joe Pope, Archeologist, State Water Resources Control Board, Sacramento

Plumas County Planning Department, Quincy

Office of Historic Preservation, via Joe Pope, Sacramento

WAC:gs

ENVIRONMENTAL CHECKLIST FORM

(To Be Completed By Lead Agency)

I. Background

1. Name of Proponent Regional Water Quality Control Board, Central Valley
2. Address and Phone Number of Proponent (916) 445-0270
   3201 S Street, Sacramento,CA 95816-7090
3. Date of Checklist Submitted _____
4. Agency Requiring Checklist Self
5. Name of Proposal, if applicable Water Pollution Abatement at Walker Mine

II. Environmental Impacts

(Explanations of all "yes" and "maybe" answers are required on attached sheets.)

	Yes	Maybe	No
1. Earth. Will the proposal result in:			
a. Unstable earth conditions or in changes in geologic substructures?			X
b. Disruptions, displacements, compaction or overcovering of the soil?			X
c. Change in topography or ground surface relief features?			X
d. The destruction, covering or modification of any unique geologic or physical features?			X
e. Any increase in wind or water erosion of soils, either on or off the site?			X
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?			X

	Yes	Maybe	No
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?			X
2. Air. Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?			X
b. The creation of objectionable odors?			X
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?			X
3. Water. Will the proposal result in:			
a. Changes in currents, or the course of direction of water movements, in either marine or fresh waters?	X		
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	X		
c. Alterations to the course or flow of flood waters?			X
d. Change in the amount of surface water in any water body?	X		
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?	X		
f. Alteration of the direction or rate of flow of ground waters?	X		
g. Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?		X	
h. Substantial reduction in the amount of water otherwise available for public water supplies?			X
i. Exposure of people or property to water related hazards such as flooding or tidal waves?			X

	Yes	Maybe	No
4. **Plant Life.** Will the proposal result in:			
a. Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?	X		
b. Reduction of the numbers of any unique, rare or endangered species of plants?			X
c. Introduction of new species of plants into an area, or in a barrier to the normal replenishment of existing species?			X
d. Reduction in acreage of any agricultural crop?			X
5. **Animal Life.** Will the proposal result in:			
a. Change in the diversity of species, or numbers of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects)?	X		
b. Reduction of the numbers of any unique, rare or endangered species of animals?			X
c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?			X
d. Deterioration to existing fish or wildlife habitat?			X
6. **Noise.** Will the proposal result in:			
a. Increases in existing noise levels?			X
b. Exposure of people to severe noise levels?			X
7. **Light and Glare.** Will the proposal produce new light or glare?			X
8. **Land Use.** Will the proposal result in a substantial alteration of the present or planned land use of an area?			X
9. **Natural Resources.** Will the proposal result in:			
a. Increase in the rate of use of any natural resources?			X

	Yes	Maybe	No
b. Substantial depletion of any nonrenewable natural resource?	___	___	X
10. Risk of Upset. Will the proposal involve:			
a. A risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	___	___	X
b. Possible interference with an emergency response plan or an emergency evacuation plan?	___	___	X
11. Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	___	___	X
12. Housing. Will the proposal affect existing housing, or create a demand for additional housing?	___	___	X
13. Transportation/Circulation. Will the proposal result in:			
a. Generation of substantial additional vehicular movement?	___	___	X
b. Effects on existing parking facilities, or demand for new parking?	___	___	X
c. Substantial impact upon existing transportation systems?	___	___	X
d. Alterations to present patterns of circulation or movement of people and/or goods?	___	___	X
e. Alterations to waterborne, rail or air traffic?	___	___	X
f. Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?	___	___	X
14. Public Services. Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:	___	___	X
a. Fire protection?	___	___	X
b. Police protection?	___	___	X
c. Schools?	___	___	X

	Yes	Maybe	No
d. Parks or other recreational facilities?			X
e. Maintenance of public facilities, including roads?		X	X
f. Other governmental services?		X	
15. Energy. Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?			X
b. Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?			X
16. Utilities. Will the proposal result in a need for new systems, or substantial alterations to the following utilities:			
a. Power or natural gas?			X
b. Communications systems?			X
c. Water?			X
d. Sewer or septic tanks?			X
e. Storm water drainage?			X
f. Solid waste and disposal?			X
17. Human Health. Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?			X
b. Exposure of people to potential health hazards?			X
18. Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?			X
19. Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	X		
20. Cultural Resources.			
a. Will the proposal result in the alteration of or the destruction of a prehistoric or historic archaeological site?		X	

	Yes	Maybe	No
b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?		X	
c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?			X
d. Will the proposal restrict existing religious or sacred uses within the potential impact area?			X
21. Mandatory Findings of Significance.			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?			X
b. Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals? (A short-term impact on the environment is one which occurs in a relatively brief, definitive period of time while long-term impacts will endure well into the future.)			X
c. Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.)			X
d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?			X

III. Discussion of Environmental Evaluation

See INITIAL STUDY

IV. Determination
(To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared. [ ]

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because the mitigation measures described on an attached sheet have been added to the project. A NEGATIVE DECLARATION WILL BE PREPARED. [X]

I find the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required. [ ]

12/27/85
Date

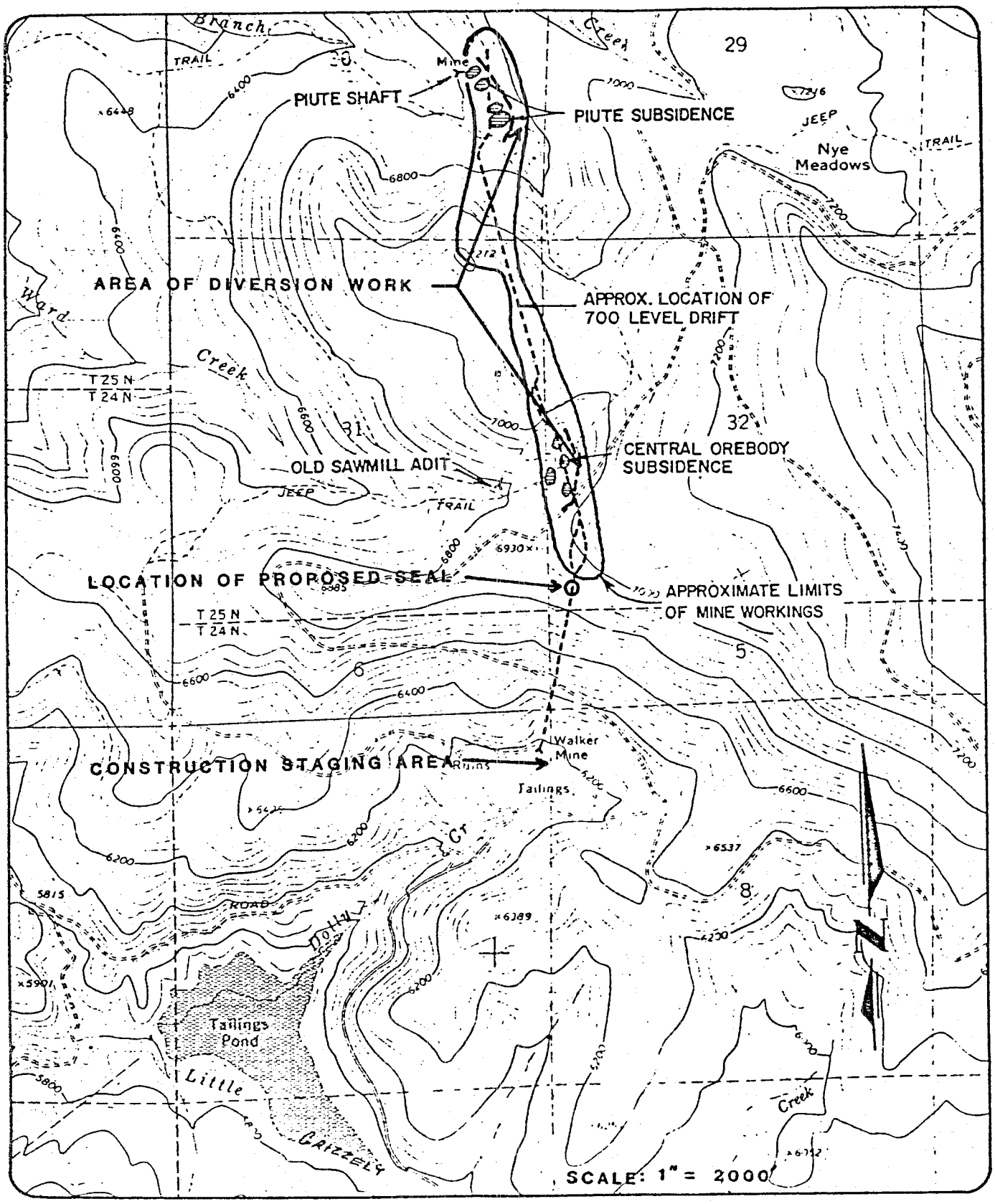
William C. Cox
Signature

For _____

LOCATION OF MAP ABOVE

PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN	General location map
DATE 3/85	Consulting Engineers	Northern California
REVISION NO. 0		FIGURE 1

4-23



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	WALKER MINE, PLUMAS COUNTY Section 7, T24N, R12E MDB&M Mt. Ingalls, CA USGS 7.5 Quad.
DATE 3/85		
REVISION NO. 0	4-24	FIGURE 2

COMMENTS AND RESPONSES TO COMMENTS

REGARDING THE NEGATIVE DECLARATION

Comments Were Received During The

January 2 through January 31 1986 Review Period

4-25

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, *Governor*

NATIVE AMERICAN HERITAGE COMMISSION
915 Capitol Mall, Room 288
Sacramento, California 95814

(916) 322-7791

January 21, 1986

William A. Croyle
Regional Water Quality Control Board
3201 S. Street
Sacramento, CA 95816

Re: Water Pollution Abatement at Walker Mine
SCH# 85123111

The Native American Heritage Commission appreciates the opportunity to express its concerns and comments in the environmental review process. As you may know, the Commission is mandated to preserve and protect places of special religious or cultural significance to Native Americans pursuant to Section 5097 et seq of the Public Resources Code.

The Commission has the further responsibility of assisting Native Americans in cemetery and burial protection pursuant to Section 5097.94(k) of the Public Resources Code. Should human remains of Native American origin be encountered during the project, we request that the County Coroner's Office be contacted pursuant to the procedures set forth in Section 7050.5 of the Health and Safety Code.

In order to mitigate potential impacts to California Indian ancestral burials and other cultural resources during the course of this project, we request that you consult with Indian individuals and/or groups in the project area.

Please do not hesitate to contact the Commission for any assistance relative to the above.

Very truly yours,

John Darwin Smith
Executive Assistant

JAN 23 10 14 AM '86
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SACRAMENTO
CVRWQCB

4-26

State of California

THE RESOURCES AGENCY OF CALIFORNIA

Memorandum

To : Dr. Gordon F. Snow
Assistant Secretary for Resources

Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, CA 95816

Date : January 27, 1986

Subject: Acid Mine Drainage Abatement - Walker Mine - Plumas County (#85123111) (Negative Declaration)

From : Department of Conservation—Division of Administration

In response to your request, the California Department of Conservation's Division of Mines and Geology has reviewed the documents submitted for the Acid Mine Drainage Abatement - Walker Mine - Plumas County (#85123111) (Negative Declaration). A site visit was not conducted.

The following advisory comments were completed on January 17, 1986 and are offered to the Water Quality Control Board in its role as a lead agency:

1) The proposed project is well designed and should improve water quality in Dolly Creek and Grizzly Creek.

2) We recommend that further mine reclamation be accomplished as a result of this project: revegetation associated with the "rehabilitation of surface diversion structures" could greatly enhance the total project.

We would very much appreciate it if you could send a copy of the "Feasibility and Design Report" from "Steffen, Robertson and Kirsten" (SRK) for the Division of Mines and Geology reclamation program files; it would serve as a reference report for other acid mine drainage problems. These files are open to the public and maintained as required by the Surface Mining and Reclamation Act. Please send the report to Paul Marshall (Senior Mining Engineer - Mine Reclamation Program Manager).

If you have any questions, please phone Paul Marshall, Division of Mines and Geology, Reclamation Program Manager, at (916) 323-8565.

Dennis J. O'Bryant
Environmental Program Coordinator

cc: Rudy Strand
Paul Marshall

RECEIVED
JAN 29 1986
State Clearinghouse

4-27

Responses to Comments by the Native American Heritage Commission

Paragraph No. 1 and 2

These comments are informational and are acknowledged.

Paragraph No. 3

Staff has contacted the Commission for assistance in consulting with Indian individuals and/or groups in the project area. Most of the project work will be underground in the mine adit, where no impacts to California Indian ancestral burials could occur.

Responses to comments by the California Department of Conservation's Division of Mines and Geology

Comment No. 1

Comment is acknowledged.

Comment No. 2

Revegetation of surface diversion structions will be considered during preparation of the construction contract.

CMM

CONDOR MINERALS MANAGEMENT INC.

2141 Mono Way
P.O. Box 3905
Sonora,
California, 95370
(209) 532-0361

January 30, 1986

Mr. William Marshall
Senior Water Resource Control Engineer
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, CA 95816

Dear Mr. Marshall,

Attached you will find comments drafted in response to the Initial Environmental Assessment on the Board's Walker Mine Project, Plumas County, California. Please add them to the record.

If you have any questions or need any clarification, please feel free to call me at the number captioned above.

Very Truly Yours,

Peter H. Dohms

Peter H. Dohms
Registered Geologist
California No. 3829

PHD:sp

cc:State Clearinghouse
R. Barry
file
XX:Initial.Wal

JAN 31 9 23 AM '86

4-29

(Comments by Mr. Peter Dohms; Regional Board responses indicated by **)

COMMENTARY
on the
INITIAL STUDY
for
WALKER MINE, PLUMAS COUNTY

INTRODUCTION

This document is a commentary on the Initial Study prepared by the California Regional Water Quality Control Board, Central Valley Region (the Board) concerning their proposal to install a permanent seal in the main access tunnel of the Walker Mine to block discharge of water from the mine. The first section of this commentary is an item by item response to the Environmental Checklist Form. The next section comments on the Initial Study and the final section summarizes the first two and recommends additional environmental review.

COMMENTS ON ENVIRONMENTAL CHECKLIST

The following comments are keyed to the Environmental Checklist Form prepared by the Lead Agency (the Board). They are in order.

Section II. Environmental Impacts

Item 1.a. - We suggest that the question be answered "maybe" instead of "no" for the following reasons: 1) Filling the mine with water will saturate a significant volume of earth that is not now saturated. Saturated earth in mountainous terrain is inherently less stable than is unsaturated earth. 2) Filling the mine with water will relieve some of the lithostatic load through hydrostatic buoyancy.

** Response - After the seal is put in place, the ground water system will be returned to its pre-mine condition. Since the Walker Mine area does not show evidence of landslides or unstable geologic formations prior to mining, we cannot see how a return to the pre-mine condition can cause unstable earth conditions.

Item 1.c. - The answer should be "yes"; cutting new trenches and rehabilitating existing trenches will both change the topography and ground surface relief features.

** Response - A large portion of the proposed diversion work will be the rehabilitation of existing trenches. Topography and ground surface relief features have been significantly altered by past mining and timber operations The surface diversion work does not represent a significant change in the area topography.

Item 1.e. - The answer should be changed to "maybe" from "no". It was noted in the March, 1983 report by Pearson and Associates (Regional Board Project 1-043-150-0) that rehabilitation of diversion trenches was reponsible for significant amounts of accelerated erosion (Page 1 & Figure 3)."

** Response - Diversion trenches (swales) were constructed on the Middle and South branches of Ward Creek. Erosion occurred only in one section of one of these ditches. It is this erosion which the proposed project will correct.

Item 1.g. - The answer should be changed from "no" to "maybe" for the reasons cited in Item 1.a. above.

** Response - Refer to responses to Item 1.a.

Item 3.c. - We believe that the answer should be changed from "no" to "yes". Construction and rehabilitation of the diversion works, particularly those in the South Branch of Ward Creek, will alter the course of flood waters.

** Response - The diversion ditches intercept sheet flow runoff and channel it away from the subsidence areas. No flood water "type" flows are associated with this area. Ward Creek will be unaffected by the proposed diversion work.

Item 3.e. - It is our understanding that the Board's answer of "yes" is based on their assumption that discharge from the mine would cease with construction of the plug. Unfortunately, discharge of acidic, metal laden water from the tailings pond located at the confluence of Dolly and Little Grizzly Creeks would continue. Thus, we suggest that the answer be changed to "maybe".

** Response - Any reduction in heavy metal discharge from Walker Mine will improve the existing polluted condition of downstream waters. Any discharge of metal from the USFS tailings area is a separate project. During a previous period when the Walker Mine adit was blocked, the Department of Fish and Game planted fish in Little Grizzly Creek. These fish survived until a discharge from the Walker Mine was reestablished by the mine owner. This would suggest that the USFS tailings do not contribute enough heavy metal-laden water to Dolly and Little Grizzly Creek to kill fish.

Item 3.g. - This item touches on a point which we consider to be a significant adverse impact which will result from implementation of the project, as proposed. On page 4 of the Initial Study, it is stated, "The proposed project will result in a change in the rate of flow of groundwater, but not result in a change in useable ground water quality." The answer to the question should, therefore, be "yes". In addition, we believe that implementation of the project will cause significant degradation of ground water quality. Further discussion of this point is made later in this commentary.

** Response - See later discussion under Response to Comment 3.

Item 5.a. - We suggest that the answer should be changed from "yes" to "maybe". It is our understanding that the Board's answer of "yes" is based on the belief that stopping discharge of water from the mine will allow restoration of aquatic life in Little Grizzly Creek. Until and unless discharge of acid and metal laden water from the old tailings pond at the confluence of Dolly and Little Grizzly Creek stops, that restoration will be impossible.

** Response - Refer to response for Item 3.e.

Item 8. - The answer should be changed from "no" to "yes". A planned land use, mining, will be foreclosed by implementation of the project, as proposed.

** Response - Mining will not be foreclosed by this project. The mine owner has indicated that plans are in the works for an open pit operation. The mine owner's consultant has stated that further exploration must be done and the price of copper and gold must increase before a mining operation can be planned. The proposed project has incorporated a means by which the mine can be dewatered. Should mining become feasible, valves that will be installed in the seal could be opened, allowing mine water to drain. The water draining from the mine would require treatment before being discharged to surface waters. Mine dewatering is frequently required before opening old mines in this mining region.

Item 9.b. - The answer should be changed from "no" to "yes". Implementation of the project, as proposed, will result in the direct loss of 3.5 million tons of measured mineral reserves which contain some 105 million pounds of copper, 2.5 million ounces of silver and 0.1 million ounces of gold. Loss of other reserves, which are less well defined at this time, could also be significant.

** Response - The mineral reserves will remain in the ground and will not be lost as a result of the mine seal. Once dewatering operations have been completed, the mine adit may be opened. The pollution of Little Grizzly Creek and Dolly Creek for over 40 years is not justified by the mine owner's desire to have easy access to a mineral resource which cannot currently be economically removed from the mine.

Item 10.a. - We believe the answer should be changed from "no" to "maybe". As discussed in detail in a later section of this document, if the Board is wrong in its belief that all discharge from the Walker Mine would permanently cease with implementation of the project as proposed, then there will be discharge of mine water to the Ward Creek watershed. That water will carry higher contents of acid and heavy metals than is now discharging into Dolly Creek.

** Response - SRK'S addendum report, dated January, 1986, specifically addresses the possibility of discharge to Ward Creek. The report concludes that it is highly unlikely that copper rich water could flow from a plugged mine to Ward Creek from the Piute shaft.

Item 19. - We believe that the Board's response of "yes" is based on the belief that implementation of the project as proposed will allow restoration of the sport fishery in Little Grizzly Creek below Dolly Creek. Until discharge of acid and metal laden water from the tailings impoundment located at the confluence of those two creeks ceases, restoration of the sport fishery will be impossible. The answer should be changed to "maybe" or "no".

** Response - Refer to response for Item 3.e.

Item 21.a. - In evaluating the Board's response to this question, the key word is "potential". Based on the reasons itemized above in Item 10.a. and later in this commentary, there is a potential for significant spilling of acid and metal laden water to the Ward Creek watershed if the project is implemented. The answer should be changed from "no" to "yes".

** Response - See response below.

Item 21.b. - As above, the key word is potential". As previously discussed and expanded later in this commentary, we believe that emplacement of a seal in the mine is a temporary expediency which will result in a significant long term threat to surface water quality in the Ward Creek watershed as well as long term degradation of groundwater quality. The answer should be changed from "no" to "yes".

** Response - see response below.

Item 21.d. - Due to the uncertainties identified above, the answer should be changed from "no" to "maybe".

** Response - Based on the SRK reports, we believe that there is not a potential to substantially reduce the habitat of fish species in Ward Creek. Any threat of discharge to Ward Creek from the Piute shaft may be eliminated by opening the valves in the seal and returning the mine to its pre-seal condition.

Mr. Dohms fails to show how any seal effects could be long term. He also fails to consider the possibility that the valves in the mine seal could be opened to prevent a discharge to Ward Creek.

Section IV. Determination

On the last page of the checklist, we believe that the wrong finding was checked. Based on the discussion above, we believe the third finding should be marked and that preparation of an Environmental Impact Report is necessary.

** Response - We believe the comments made by Mr. Dohms on the environmental checklist have been considered in the Initial Study and project evaluation. Because of these considerations and findings, we believe the finding is appropriate.

COMMENTARY ON INITIAL STUDY

Much of the basis of the Initial Study is included in the Final Feasibility and Design Report which was prepared by Steffen, Robertson and Kirsten (SRK). A detailed response to both that report and a supplemental report prepared by SRK is in preparation and will be submitted to the Board at an appropriate time. This commentary will be limited to points raised in the Initial Study.

Comment 1 - On page 2 of the Initial Study, it is stated, "When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage water flowing from the main Access Adit Portal on the 700 level began to affect Dolly Creek and Little Grizzly Creek". It is the historic record of this and other copper mines in California that acid mine drainage is not a problem while a mine is in operation. The owner of the Walker Mine has made repeated attempts to have the mine activated in recent years. Those attempts are continuing and, with the cooperation of the Board, the mine drainage problem can be alleviated without resorting to the drastic measure of permanently sealing the mine.

** Response - The Walker Mine owner has not made any serious attempts to reopen the mine. No serious proposals to stop the acid mine discharge have been made. Previous attempts by the owner to lessen the metal discharge are not now in operation. The mine owner has presented many ideas, but has not shown the financial capability to implement these proposals. Mr. Dohms infers that the Board needs to cooperate with Mr. Barry. The Board has been cooperative. For many years, the Board has encouraged Mr. Barry to install his own pollution abatement program so that Board involvement would be unnecessary. The Board's consultants have designed the seal in such a manner that the mine can be dewatered and the seal removed.

Comment 2 - Under the heading "Description of the Project" on page 2, the first sentence reads, "A recent feasibility study has shown that using a mine seal is the most cost-effective way of preventing acid mine drainage from discharging to surface...watercourses". The feasibility study in question is not identified. If the author of the Initial Study is referring to the SRK report, it should be noted that a comparative cost analysis of both the proposed mine seal and alternative methods of handling mine drainage was NOT a part of that study. The only comparative cost analysis of which we are aware is that performed in 1979 by D'Appalonia. That analysis was based on conceptual designs of both a mine seal and a treatment plant. The cost numbers therein are long since outdated.

** Response - While the cost numbers of the D'Appalonia report are outdated, they do show relative costs of different projects. The D'Appalonia report did not eliminate the mine seal on the basis of cost, but on the basis of the mine owner's desire to reopen the mine. However, the mine owner is no closer to reopening the mine today then when the D'Appalonia report was written.

Comment 3 - On page 3, under the heading "Water", it is stated, "In doing so, the direction of water movement in the mine will be directed to deep ground water recharge...". On page 4, it is further stated, "The proposed project will result in a change in the rate of flow of ground water, but not result in a change in useable ground water quality." This comment is directed at both of those statements.

A number of thoughts come to mind. The Board seems to be proposing to accelerate the amount of acid, metal laden water that will discharge to ground water. It may be assumed that a greater flow of this water will degrade the ground water to a certain extent. That ground water is presumably protected by the Porter-Cologne Act.

Secondly, it is entirely possible that ground water discharged in this fashion will carry higher levels of acid and metal than at present. It is apparent from study of in-mine flows that water quality degrades with time. The SRK flow model, upon which the above cited Board beliefs are based, requires that discharge to ground water would only occur after the water had the maximum amount of time to collect acid and metal. Other flaws in that flow model are discussed later in this section.

** Response - Based on both Board staff and SRK's independent works, it can be shown that the faster water moves through the mine, the greater the amount of heavy metals which will enter those waters. It is not apparent that water quality degrades with time. During the flow periods when water moves more slowly through the mine, the heavy metal concentrations are lower than in the spring when high flows move rapidly through the mine. An inundation of the mine will deprive the ore deposits of the current readily available air supply which aids in oxidation of the ores.

Sealing the mine will return the hydrologic system closer to a pre-mine state. Porter-Cologne provides for protection of beneficial uses. However, it is unlikely that anyone would want to drill through the mine's ore body in an attempt to find a fresh water supply. However, the cleanup of Little Grizzly Creek would supply immeidate recreational, aesthetic and water supply benefits to downstream residents. The Regional Board has received many letters from members of the Genessee Woods Recreation Association and others, indicating their desire to see Little Grizzly Creek cleaned up. However, we know of no one who would desire to use ground water from beneath the Walker Mine ore deposits.

Comment 4 - On page 4 of the Initial Study, it is stated, "By eliminating the mine's discharge, Dolly Creek will contain only natural spring water, snowmelt and/or precipitation". That is incorrect; over the years, Dolly Creek has collected a heavy load of metal, much of which will remain in the bed of the stream. Copper staining is visible on the rocks; particulate copper-bearing minerals are undoubtedly present in the streambed and banks. Release of that metal will continue for years.

** Response - Release of heavy metals from Dolly Creek's streambed depends on pH. These metals were deposited when the pH of discharging acid mine waters was low. Elimination of acid mine discharge will increase the pH. A lower pH would be required to dissolve these precipitated metals.

Comment 5 - On page 4 of the Initial Study, it is stated, "They (SRK) suggest that there is conservatively twice as much ground water recharge deep within the mine as flow from the mine. By raising the water head behind the seal, ground water recharge will increase. Ground water recharge will prevent a surface discharge from other adits." Our model of the hydrogeology of the Walker Mine, which will be presented to the Board when they consider implementing the project, does not agree with these statements. The remainder of this comment will summarize our findings as they relate to the above cited statements quoted from the Initial Study.

First off, SRK is apparently misquoted. On page 60 of the SRK report, it is stated, "...of about 560 gpm flowing into workings above the 700 Level (during the visit of June 19, 1985), less than 300 gpm were being discharged through the main 700 Level Adit. The balance is presumed to return as recharge to the ground water system." In other words, ground water recharge on that day was about equal to mine discharge, not twice as much. Spring time flows cause substantially more discharge from the mine than any possible ground water recharge.

Raising the water head behind the seal would cause some minor increase in ground water recharge, but that recharge would not be as dramatically increased as SRK and the Board believe. To summarize the hydrogeologic model we have developed, the following points are noted:

- Existing head at the bottom of the mine is on the order of 500 feet, the vertical difference between the top of standing water in workings below the 700 Level and the bottom of the mine.

- Vertical distance from standing water to the nearest known outlet above the 700 Level (which is the Piute Shaft Landing Tunnel, at 6585 feet elevation) is less than 400 feet. A degree of uncertainty exists whether or not there are other mine outlets at lower elevations than this elevation.

- Discharge is specified by SRK to be preferentially directed downward into the mineralized zone. Permeability in that direction is estimated at between $1 \times 10E^{-4}$ cm/sec and $1 \times 10E^{-5}$ cm/sec. We agree with SRK's estimates.

- Area of discharge is specified by SRK to be 6000 ft. x 40 ft., or 240,000 square feet.

Performing the necessary calculations, based on Darcy's Law, yields the result that the 400 foot increase in head to the elevation of the Piute Shaft Landing Adit (if that is, indeed, the next lowest outlet of the mine) is inadequate to increase the ground water recharge sufficiently to prevent the rising level of water from spilling out that adit. Our calculations indicate that, given normal precipitation patterns, mineralized water could begin spilling in as little as four years. Once spilling from upper workings begins, flow out the upper adit will instantly equal surface flow into the mine. Since most of the surface flow enters the glory holes above the Central Ore Body, it is certain that spill from the Piute Shaft Landing Adit will be highly mineralized, due to flow path length. It should be mentioned that such a spill would direct mineralized water into the Ward Creek watershed. Ward Creek is, to date, unaffected by mine discharge. Due to its smaller watershed, it can also be presumed to be more sensitive to adverse impact from such drainage.

** Response - Mr. Dohms' flow model, which is discussed above, has not been submitted for review and comment. This should have been submitted during the comment period. If Mr. Dohms is correct, this would reduce the threat to any underlying ground water. Also, in the event Mr. Dohms is correct and a spill is imminent, valves in the seal could be opened to prevent a spill from the Piute shaft. Mr. Dohms indicates that it would be at least four years before a spill could occur. This would give ample warning and enable the valves to be opened.

The "Surface Water Survey" is a major part of the proposed project. This survey is designed to provide baseline data before and after the seal is constructed and to provide a monitoring program for the seal. It is this program which will provide the early warning needed to protect uncontaminated surface waters.

Comment 6 - On page 4 of the Initial Study, it is stated, "Flooding the mine will also have the following water quality benefits:

1. Reduce oxidation of the ore body.

2. Allow the natural attenuation process to treat the low pH and heavy metal in the earth-ground water system."

We disagree with both of these statements. With respect to oxidation of the ore body, it is apparent that oxidation continues while the water moves through the lower workings from the Central Ore Body to its discharge back onto the 700 Level at the south end of the South Ore Body. This is easy to understand since the water entering the mine becomes saturated with oxygen as it cascades downward into the workings.

With respect to "natural attenuation", the Board has resisted such a mechanism when proposed by the industrial dischargers in California for their waste discharge requirements.

** Response

Water moving through the lower ore body can carry oxygen with it. Water entering the ore body may continuously carry new oxygen to the ore body. After the seal is in place, flows in the mine will slow to almost static conditions. This will greatly reduce the amount of new waterborne oxygen reaching the ore body.

The Regional Board has allowed Mr. Barry to use the natural attenuation process. The Walker Mine's NPDES permit contains receiving water limits for heavy metals. By allowing the use of receiving water limits instead of effluent limits, the Regional Board has showed its acceptance of natural attenuation processes.

Comment 7 - On page 4 of the Initial Study, it is stated,"The purpose of the mine seal is to stop the discharge of acid and heavy metal-laden water to Dolly Creek and Little Grizzly Creek. By eliminating the toxic barrier caused by the discharge, plant and animal populations would be able to reestablish themselves in the affected area. Thus, the seal will beneficially impact these organisms." In addition, on page 5, it is stated, "Recreation will be enhanced by the removal of acid mine drainage from Little Grizzly Creek and the reestablishment of a fishery".

These statements are, at best, only partially true. For instance, in the Pearson and Associates' report on Pilot Plant Treatment of Mine Drainage from the Walker Mine, it is noted on page 117 that a signifcant load of metal is added to the creeks from the mine tailings, which are located downstream of the 700 Level portal. In addition, recent work by Board staff suggests that

Dolly Creek, as it crosses the mill tailings at the confluence of Grizzly and Dolly Creeks, picks up additional metal and acid. It is apparent that, until the discharge from the tailings are remedied, beneficial impacts to plant and animal populations and recreational uses will not occur.

** Response - On a mass loading basis, the main Walker Mine adit contributes at least 85% of the heavy metal discharged to Dolly Creek and Little Grizzly Creek. The remaining 15%, or less, coming from the tailings may, in fact, be due to the subsurface flow from the upper portions of Dolly Creek. The heavy metal concentration in upper Dolly Creek is a direct result of the discharge from the main Walker Mine adit. The tailings on USFS property are currently being studied by Regional Board staff. Preliminary results suggest that a very small amount of heavy metal in Little Grizzly Creek originates in the USFS tailings.

In 1961, the Department of Fish and Game (DFG) planted 1,000 catchable trout in Little Grizzly Creek. This was during a time when the main adit was blocked due to a collapse near the entrance. During this period of Walker Mine's history, water would back up in the mine until water levels rose to the elevation of a ventilator shaft not far from the adit opening. Mine waters would overflow from the ventilator shaft late in the spring as a result of snowmelt and high inflow to the mine. During the summer of 1961, the mine did not spill and DFG decided to plant trout. Fishermen reported good success through the end of the fishing season. On 29 May 1962, five healthy trout were observed in Little Grizzly Creek, indicating an overwinter survival of catchable trout. This indicates the USFS tailings may not contribute enough heavy metals to be toxic to fish. There is also no evidence the USFS tailings lower the pH of Little Grizzly Creek. The tailings are covered by separate waste discharge requirements. Staff is currently proposing limits on the heavy metal discharge from the tailings.

Comment 8 - On page 5 of the Initial Study, it is stated, "Should there be a threatened discharge in any watershed, the contingency plan will provide the mine owner and/or Regional Board staff with the available options. One option would be to open valves in the seal and to return the hydrologic system to its pre-seal condition.

Examination of the contingency plan, as outlined in the SRK report, reveals one serious deficiency. No provision is made for maintenance of the 700 Level Portal and the first 1,300 feet of the tunnel. Examination of this portion of the 700 Level indicates that it is driven in "heavy" ground and the supporting timbers require constant care and maintenance. With the seal in place, there will be no incentive for the mine owner to perform this maintenance (what would be the point?). It is likely that the tunnel would collapse in a few years and access to the seal would be lost.

In addition, even if the seal were accessible and the valves could be opened, it is likely that the water that would be discharged after several years residence in the mine would carry considerably more mineralization than present. Simply opening the valves would not "return the hydrologic system to its pre-seal condition", it would create a condition worse than exists today.

This completes the comments regarding the Initial Study.

** Response - It is the Board's understanding that Mr. Barry remains committed to reopening the mine. If this is true, Mr. Barry should continue to maintain the main access tunnel. If Mr. Barry decides to abandon his efforts to reopen the mine, then the Board must make provision to maintain the access. Responsibility for maintenance of the entry tunnel would also be a subject of that litigation unless Mr. Barry abandons the mine property.

Mr. Dohms' comment in regard to possible degradation of Dolly and Little Grizzly Creeks, through release of more highly mineralized water, does not recognized the ability of the mine seal to release water during the springtime when large dilution flows exist nor does it recognize the possibility of treating this regulated discharge. Part of the proposed project includes the development of plans and specifications for treating the mine discharge.

SUMMARY AND RECOMMENDATIONS - The following points summarize our commentary:

1. Placement of a seal in the 700 Level access Tunnel of the Walker Mine has little chance of ending the discharge of acid and metal-laden water to Dolly and Little Grizzly Creek. The benefits of the proposed project are, thus, overstated.

2. Placement of the seal will have the following effects on the hydrogeologic system within the mine:

   - Water will rise behind the seal; it clearly has the potential to rise high enough to spill out of higher mine workings into a heretofore uncontaminated watershed.

   - The increase in hydraulic head as water builds up behind the seal will accelerate the discharge of mineralized mine water to the ground water system

3. Adverse impacts will occur to nonrenewable resouces if the project is implemented as proposed.

4. The project has the potential to achieve short-term, to the disadvantage of long-term, environmental goals. Based on the points cited above, the project could best be categorized as a temporary expediency which will result in an eventual worsening of the Walker Mine situation.

Each of these is judged to be a significant, adverse impact. The mitigations proposed in the Project Description are believed to be inadequate to prevent these impacts or to mitigate them to nonsignificant levels.

It is apparent that the Initial Study falls short of the CEQA goal of "Full Disclosure" of anticipated and potential environmental impacts. In addition to the points cited above, the Initial Study fails to address any alternatives to the proposed action. More investigation is clearly necessary. An Environmental Impact Report is recommended to fully explore the proposed project.

In addition, the Board should order staff to consider alternative remedies to the Walker Mine problem. The environmental consequences of these alterntives should similarly be studied and the superior remedy then can be identified.

** Response

The response to Mr. Dohms' summary and recommendations are contained in the CEQA section of the staff report.

LETTERS AND NAMES OF PERSONS WHO HAVE

RESPONDED TO THE WALKER MINE

HEARING NOTICE

United States Department of Agriculture
Forest Service
Plumas National Forest
159 Lawrence Street
P.O. Box 1500
Quincy, CA 95971

Reply to: 2540

Date: November 22, 1985

California Regional Water Quality Control Board
Central Valley Region
ATTN: Bill Croyle
3201 S. Street
Sacramento, CA 95816-7090

Dear Mr. Croyle:

This letter is a position statement by the USDA, Forest Service, Plumas National Forest, in the matter of the "Staff Report" and proposed Central Valley Region's "Resolution" for cleanup and abatement of pollution from Walker Mine, Plumas County. We request this position statement be entered into the record for the public hearing to be held December 6, 1985, in Fresno, California.

The public lands administered by the Plumas National Forest include the lower reach of Dolly Creek and Little Grizzly Creek, to near its confluence with Indian Creek. The management of the natural resources provided by Little Grizzly Creek, primarily good water quality, the fishery habitat, and the beneficial uses of those resources, requires water free of toxic substances. The Forest Service feels strongly that the degradation of these public waters and associated resources cannot be allowed to continue. We have reviewed the Water Quality Control Board's staff report and proposed resolution to abate this pollution source. We strongly urge the Board to accept the staff report and adopt the proposed resolution to seal the mine, rehabilitate the diversion channels, and prepare the contingency plan as stated on page 2 of the resolution.

The Forest Service commends your staff for the efforts expended to date to resolve this problem. We look forward to continued cooperation in solving this pollution problem.

Sincerely,

Rodney K Sellee
for LLOYD R. BRITTON
Forest Supervisor

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4-43

RESOLUTION NO. 85-3950-A

WHEREAS, Walker Mine is an inoperative copper mine located in Plumas County; and

WHEREAS, drainage from Walker Mine properties has damaged, and continues to periodically damage, aquatic life in Little Grizzly Creek; and

WHEREAS, outdoor recreation is of major economic importance to Plumas County, and Little Grizzly Creek recreational values are necessary and essential to the full development of Plumas County; and

WHEREAS, the waters of Little Grizzly Creek enter Indian Creek and eventually the East Branch North Fork Feather River; and

WHEREAS, these waters are used for domestic supply, irrigation, stock watering, light industry, power generation, and mining; and

WHEREAS, pollution from the Walker Mine properties is a potential threat to public health and to recreational and economic uses of certain waters; and

WHEREAS, the State Department of Health Services, Toxic Substances Control Division, has ranked Walker Mine among the most hazardous waste sites in California; and

WHEREAS, the California Regional Water Quality Control Board, Central Valley Region, has issued waste discharge requirements on several occasions, the most recent being NPDES Order No. 85-033; and

WHEREAS, the owner of Walker Mine, Robert L. Barry, has not complied with Board Orders and has continued to permit the conditions to exist,

NOW, THEREFORE, BE IT RESOLVED by the Board of Supervisors of the County of Plumas that this Board supports the efforts of the California Regional Water Quality Control Board, Central Valley Region, in seeking a solution to the pollution problems at Walker Mine; and

BE IT FURTHER RESOLVED that the Plumas County Board of Supervisors urges the Executive Officer, California Regional Water Quality Control Board, Central Valley Region, to take whatever steps necessary to seal the mine and cause the polluting conditions to be corrected.

The foregoing resolution was duly passed and adopted by the Board of Supervisors of the County of Plumas, State of California, at a regular meeting of said Board held on the 17th day of December, 1985, by the following vote:

AYES: Supervisors: Schramel, Glines, Gossett and Ross

NOES: Supervisors: None

ABSENT: Supervisors: Coates

ATTEST:

County Clerk and ex-officio Clerk
of said Board of Supervisors

4-44

Albert O. Glines
Vice-Chairman, Board of Supervisors

COMMUNITY CONCERN

The following persons have submitted letters of support for the issuance of a Resolution directing the Executive Officer to seal the adit of Walker Mine and cleanup Dolly and Little Grizzly Creek.

Plumas County Board of Supervisors	-	Quincy
Lloyd R. Britton, Forest Supervisor	-	Quincy
Kenneth L. Dotson	-	Sacramento
Jeff Stone	-	Twain
David Schaffer, President of Red Clover Creek Recreation Assn.	-	Quincy
Michaek and Sally Yost	-	Taylorsville
John T. Getz	-	Los angeles
Jerome M. Page	-	Taylorsville
Mr. Jean C. Musick	-	Taylorsville
Paul and Wagda Welber	-	Taylorsville
Jeff Ellermeyer	-	Quincy
Robert and Lou Boschee	-	Taylorsville
Linda Koehne	-	Quincy
Helmut H. Riemer	-	Stockton
Richard L. and Nancy L. Matthie	-	Taylorsville
Ford and Barbara Lewis	-	Sacramento
Salvatore and Nancy H. Catalano	-	Woodland Hills
Elisa Adler, for Friends of Plumas Wildneress	-	Quincy
Diane McCombs	-	Taylorsville
Patricia F. Coyler	-	Sacramento
Ralph W. Koehne, CA. Registered Civil Engineer	-	Quincy
Barbara Bosworth	-	Taylorsville
Dana Fenimore	-	Taylorsville
Robert M. Boardman	-	Salem, Oregon
Christopher D. Stanton, M.D.	-	Portola
Philip Hyde	-	Taylorsville
Bruce Livingston	-	Crescent Hills

The following person has submitted a letter of concern regarding the proposed pollution abatement project and the Ward Creek watershed.

Edwin L. McDowell	-	Taylorsville

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

RESOLUTION NO.

NEGATIVE DECLARATION FOR
WATER POLLUTION ABATEMENT AT
WALKER MINE, PLUMAS COUNTY

WHEREAS, the California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that a condition of pollution exists which has resulted from a nonoperating copper mine owned by Robert R. Barry, Calicopia Corporation and leased by Standard Bullion Corporation, Inc. (hereafter Discharger). The mine is in central Plumas County, about twenty miles east of Quincy, in Sections 19, 29, 30, 31, and 32, T25N, R12E, and Sections 5, 6, 7, and 8, T24N, R12E, MDB&M, and situated within the jurisdiction of this Board; and

WHEREAS, an Initial Study has been completed for the pollution abatement project. The Board has determined that, although the proposed pollution abatement project could have a significant effect on the environment, mitigation measures have been included in the project that will avoid the effects or mitigate the effects to a point where there will be no significant effects; and

WHEREAS, there is no substantial evidence before this Board that the project as mitigated may have substantial adverse effect on the environment; and

WHEREAS, said Negative Declaration has been prepared and is attached hereto as Exhibit A; and

WHEREAS, the Board, on 28 February 1986, in Sacramento, held a public hearing and considered all evidence concerning the Negative Declaration; and

WHEREAS, the Board has considered the proposed Negative Declaration together with all comments received during the review period: Therefore, be it

RESOLVED, that said Negative Declaration be, and it is hereby approved.

I, WILLIAM H. CROOKS, Executive officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 28 February 1986.

WILLIAM H. CROOKS, Executive Officer

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

RESOLUTION NO.

CLEANUP OF WALKER MINE
PLUMAS COUNTY

WHEREAS, the California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that a condition of pollution exists which has resulted from a nonoperating copper mine owned by Robert R. Barry, Calicopia Corporation and leased by Standard Bullion Corporation, Inc. (hereafter Discharger). The mine is in central Plumas County, about twenty miles east of Quincy, in Sections 19, 29, 30, 31, and 32, T25N, R12E, and Sections 5, 6, 7, and 8, T24N, R12E, MDB&M, and situated within the jurisdiction of this Board; and

WHEREAS, the Board, on 25 January 1985, adopted Waste Discharge Requirements Order No. 85-033 (NPDES No. CA0080110); on 21 December 1983, adopted Order No. 83-148, Request to Abate Pollution; on 30 May 1980, adopted Order No. 80-071, Referral to the Attorney General; and Order No. 80-070, Cleanup and Abatement Order against the Discharger; and

WHEREAS, the Discharger has violated, and continues to violate, waste discharge requirements established in Order No. 85-033 and Cleanup and Abatement Order No. 80-070. No significant progress has been made by the Discharger towards reduction of the toxic acid mine drainage. The discharge flows to Dolly Creek, tributary to Little Grizzly Creek, which is tributary to Indian Creek, thence the East Branch North Fork Feather River, waters of the United States; and

WHEREAS, unless certain measures are initiated, the mine will continue to discharge acid water containing metals toxic to fish and other aquatic life; and

WHEREAS, Steffen, Robertson and Kirsten (SRK) is currently under contract to determine the feasibility of sealing the mine. The Feasibility and Design Report for the proposed mine seal has been completed; and

WHEREAS, SRK's report has shown that sealing the mine's main portal will provide the most cost-effective method of pollution abatement and provide the best protection for the surrounding surface waters and watershed; and

WHEREAS, $259,050 have been allocated from the Clean Water and Water Conservation Bond Act of 1978 for the purpose of implementing a solution to Walker Mine water quality pollution problem; and

WHEREAS, the projected total cost of the Walker Mine pollution abatement program will be $393,576; and

WHEREAS, due to savings in the West Stanislaus Resource Conservation District State Assistance Program Grant Project, funds are available to cover the increased cost of the Walker Mine pollution abatement program; and

WHEREAS, pursuant to Section 13305 of the California Water Code, the Board may "... request the city, county, or other public agency in which the conditions of pollution...exists to abate it." The Regional Board may give notice that a condition of pollution or nuisance "will be corrected by the...Regional Board at the property owner's expense". "The owner of the property on which the conditions exist...is liable for all reasonable costs incurred...in abating the condition." And, "...the cost for abating the condition...shall constitute a lien upon the property...upon recordation...."; and

WHEREAS, the Board made the Notice called for in the California Water Code Section 13305, on 21 December 1983; and

WHEREAS, the Board has requested Plumas County and the U. S. Forest Service abate the existing pollution. These agencies have notified the Board that they cannot abate the condition of pollution resulting from Walker Mine within a reasonable time. No other local public agency has jurisdiction in the Walker Mine area; and

WHEREAS, on 21 December 1983, the Regional Board filed a complaint in the Plumas County Superior Court for preliminary and permanent injunction and civil penalties against Robert R. Barry and Calicopia Corporation and Does I through XXX, inclusive. This matter has not been brought to trial; and

WHEREAS, an Initial Study has been completed for the pollution abatement project. It has been determined that, although the proposed project could have a significant effect on the environment, there will not be significant adverse effect in this case because the mitigation measures described in the Initial Study has been added to the project. A Negative Declaration has been prepared; and

WHEREAS, the Central Valley Regional Water Quality Control Board has approved the Negative Declaration in Resolution Number _____; and

WHEREAS the Central Valley Regional Water Quality Control Board considers the water pollution abatement proposal at Walker Mine a project; and

WHEREAS, issuance of this Resolution is in compliance with the California Environmental Quality Act and Title 14, Chapter 3, of the California Administrative Code; and

WHEREAS, on 28 February 1986, in Sacramento, after due notice of Finding No. 1 to the Discharger and all affected persons, in accordance with Section 13305, California Water Code, the Board conducted a public hearing and considered all objections and protests to the proposed correction of the condition: Therefore, be it

DRAFT

RESOLVED, that the Executive Officer shall take steps necessary to seal the mine in accordance with the SRK Report; and be it further

RESOLVED, that the Executive Officer is directed to request that the State Water Resources Control Board reallocate $134,466 from the West Stanislaus Resource Conservation District State Assistance Program Grant Project to cover the increased cost of the Walker Mine seal project.

I, WILLIAM H. CROOKS, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on _____.

_____
WILLIAM H. CROOKS, Executive Officer

DRAFT

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
3201 S STREET
SACRAMENTO, CALIFORNIA 95816

NOTICE OF PUBLIC HEARING

in the matter of
ROBERT R. BARRY, CALICOPIA CORPORATION
AND STANDARD BULLION COMPANY, INC.
WALKER MINE
PLUMAS COUNTY

The California Regional Water Quality Control Board, Central Valley Region, will hold a public hearing:

DATE: 28 February 1986

TIME: 9:00 a.m.

PLACE: Department of Food and Agriculture
1220 N Street, Room 127
Sacramento, California

to consider adoption of a Negative Declaration and a Resolution directing Board staff to proceed with plans to seal the main adit of the Walker Mine.

The Walker Mine, owned by Robert R. Barry and Calicopia Corporation, is a non-operating copper mine in Section 18, T24N, R12E, MDB&M. Existing waste discharge requirements are contained in Board Order No. 85-033 (NPDES No. CA0080110). Walker Mine has been discharging acid and heavy metals to Dolly Creek for over forty years. Steffen, Robertson and Kirsten (SKR), the Board's mining consultant, have designed a seal to stop the Walker Mine discharge. SRK has also made hydrologic surveys to estimate the effect of sealing the mine. Board staff have prepared a draft Negative Declaration and Initial Study for the mine seal project.

Persons wishing to comment on the mine seal proposal may submit comments in writing no later than 18 February 1986. Interested persons are invited to attend to express their views on the issues relating to the above pollution abatement method. Oral statements will be heard, but for the accuracy of the record, all important testimony should be submitted in writing.

The Regional Board file on the discharge from the Walker Mine may be inspected and copied at the Regional Board office, 3201 "S" Street, Sacramento, California (916) 445-0270, at any time between 8:00 a.m. and 5:00 p.m., Monday through Friday.

Jack E. Del Conte
JACK E. DEL CONTE, Supervising Engineer

1/28/86:WAC:gs

4-50

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

ORDER NO. 86-073

WASTE DISCHARGE REQUIREMENTS
FOR
U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE, PLUMAS NATIONAL FOREST
WALKER MINE TAILINGS
PLUMAS COUNTY

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that:

1. The Board, on 24 April 1958, adopted Resolution No. 58-181, which prescribed requirements for a discharge by the United States Department of Agriculture, Forest Service, and Messrs. Robert R. Barry and Robert E. Wilson from the Walker Mine Tailings to Little Grizzly Creek.

2. The Walker Mine Tailings are on public land administered by the U. S. Department of Agriculture, Forest Service, Plumas National Forest (hereafter Discharger).

3. Neither Mr. Robert R. Barry nor Mr. Robert E. Wilson are known to presently have a claim on the tailings.

4. The Walker Mine Tailings are a hazard to water quality because of the potential for release of tailings, heavy metals, and turbid water to Little Grizzly Creek and downstream waters.

5. Dolly Creek and acid mine drainage from the Walker Mine traverse the tailings along the north end in a northeast-southwest direction.

6. Flows in Dolly Creek across the tailings range from about 250 gallons per minute to 2,500 gallons per minute.

7. An undetermined amount of storm water drainage enters a drop inlet at about the mid-point of the tailings on the southwest side and flows into Little Grizzly Creek.

8. Present waste discharge requirements, established by Resolution No. 58-181, are neither adequate nor consistent with plans and policies of the Board.

9. The Walker Mine Tailings are in Section 12, T24N, R11E, and Sections 7 and 18, T24N, R12E, MDB&M, with surface water drainage to Dolly Creek and Little Grizzly Creek, thence Indian Creek, thence the East Branch North Fork Feather River.

10. The beneficial uses of the Feather River and its tributaries are municipal, industrial, and agricultural supply; recreation; esthetic enjoyment; ground water recharge; hydroelectric power generation; and preservation and enhancement of fish, wildlife and other aquatic resources.

11. The Board, on 25 July 1975, adopted a Water Quality Control Plan for the Sacramento River Basin (5A) which contains water quality objectives. These requirements are consistent with that Plan.

12. The action to revise waste discharge requirements for this facility is exempt from the provisions of the California Environmental Quality Act, in accordance with Section 15301, Title 14, California Administrative Code.

13. The Board has notified the Discharger and interested agencies and persons of its intent to prescribe waste discharge requirements for this discharge.

14. The Board, in a public meeting, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED that Resolution No. 58-181 be rescinded and the U. S. Department of Agriculture, Forest Service, Plumas National Forest, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, shall comply with the following:

A. Discharge Prohibitions:

1. The direct discharge of wastes to surface waters or surface water drainage courses is prohibited.

B. Discharge Specifications:

1. Neither the treatment nor the discharge shall cause a pollution or nuisance as defined by the California Water Code, Section 13050.

2. The discharge shall not cause degradation of any water supply.

C. Receiving Water Limitations:

1. The discharge shall not cause concentrations in Dolly Creek or Little Grizzly Creek to exceed the following limits:

Constituents	Units	30-Day Average	Daily Maximum
Copper	mg/l	0.02	0.05
Zinc	mg/l	0.10	0.20
Suspended Solids	mg/l	30	45
Settleable Matter	ml/l	0.1	0.2

2. The discharge shall not cause concentrations of any materials in the receiving waters which are deleterious to human, animal, aquatic, or plant life.

3. The discharge shall not cause esthetically undesirable discoloration of the receiving waters.

4. The discharge shall not cause bottom deposits in the receiving waters.

5. The discharge shall not increase the turbidity of the receiving waters by more than 20% over background levels.

D. Provisions:

1. The Discharger shall comply with the attached Monitoring and Reporting Program No. 86-073.

2. The Discharger shall comply with the Standard Provisions and Reporting Requirements, dated 1 September 1985, which are a part of this Order.

3. The Discharger shall report promptly to the Board any material change or proposed change in the character, location, or volume of the discharge.

4. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the Discharger, the Discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be forwarded to this office.

5. The Board will review this Order periodically and may revise requirements when necessary.

I, WILLIAM H. CROOKS, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 28 March 1986.

William H. Crooks

WILLIAM H. CROOKS, Executive Officer

Revised:1/10/86:EZC:gs

Attachments

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

January 23, 1986
Project No. 06901

JAN 29 2 36 PM '86

California Regional Water Quality Control Board
Central Valley Region
3201 "S" Street
Sacramento, California 95816

Attention: Mr. William Marshall, Contract Manager

RE: EVALUATION OF FLOW IN WALKER MINE - ADDENDUM TO FINAL REPORT FOR CONTRACT NO. 4-051-150-0

Dear Bill,

Enclosed is the report on the evaluation of flow in the Walker Mine. This report is an addendum to the final feasibility study and design report for plugging the Walker Mine which was prepared under Contract No. 4-051-150-0.

The report presents a summary of the field data collected and laboratory tests conducted for the flow evaluation study. The data was interpretated by Adrian Brown and the conclusions were presented to and discussed with the project team prior to finalizing this report. The conclusions are unchanged from those forwarded to you in our December 12, 1985 letter and preliminary report.

Sincerely,

STEFFEN ROBERTSON AND KIRSTEN
(COLORADO) INC.

Colin F. Smith

Colin Smith
Project Manager

CS/gg

Encl.

3232 South Vance Street, Suite 210, Lakewood, Colorado 80227, U.S.A.
Tel. (303) 985-1333 Telex 383599 SRK USA Facsimile (303) 985-9947
Other offices in: U.S.A., Canada, United Kingdom and Africa

FLOW EVALUATION WITHIN THE WALKER MINE
ADDENDUM REPORT TO WALKER MINE PROJECT
FINAL FEASIBILITY AND DESIGN REPORT
CONTRACT NO. 4-051-150-0

Prepared for:
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, California 95816

Prepared by:
Steffen Robertson and Kirsten (Colorado) Inc.
3232 S. Vance Street, Suite 210
Lakewood, Colorado 80227

January, 1986

1.0 INTRODUCTION

On December 6, 1985, an inspection of the Walker Mine was made by Steffen Robertson and Kirsten (SRK) staff for the purposes of evaluating the mine flow system and of resolving the question as to whether there is currently any water which flows into the mine that does not pass out through the portal adit. This information is critical to the prediction of the post-sealing performance of the mine, particularly with respect to the question as to the likelihood of copper-laden water from the mine ever entering the Ward Creek catchment via the Piute Shaft.

The personnel participating in this phase of the work and the preparation of this report were Adrian Brown and Mark Logsdon of Terra Therma, Inc. and Colin Smith, associate consultants to SRK. As geohydrologist on the team, Adrian Brown was the lead engineer responsible for the data interpretation and preparation of this report.

2.0 ACTIVITIES

The mine was visited on Friday, December 6, 1985. The SRK team entered the adit at about 1000 hours and progressed from the portal to the rockfall between the Piute and 712 sections, taking water quality samples and flow measurements at appropriate locations on the way. The party returned to the portal at about 1715 hours. The water samples were filtered that evening, and carried to Denver the following morning for analysis.

3.0 RESULTS

3.1 Field Measurements

The results of the field measurements of flow and water quality are summarized on Table 1.

TABLE 1
SUMMARY OF RESULTS OBTAINED FOR FLOW ON THE 700 LEVEL

LOCATION	FLOW (gpm)	TEMP (^{o}C)	pH (units)	COND (umho)
Flow in the adit	21	7.3	5.25	340
South end of South orebody	1	5.9	3.29	289
South end of Central orebody	41	4.0	6.23	221
South end of North orebody	55	3.7	8.40	208
South end of 712 orebody	46	3.4	8.28	231
South end of Piute orebody	40	3.4	8.58	198

The pH results are questionable due to a malfunction of the pH probe resulting from the difficult conditions encountered underground. It should be noted that other readings were taken during the trip; the values presented above are the key values with respect to the question which was of primary interest during this visit.

The water level in the lower workings was visible at a few locations, and the distance below track grade was measured using a tape at these points. The results are indicated in Table 2.

TABLE 2
ELEVATIONS OF WATER LEVELS IN WORKINGS BELOW THE 700 LEVEL

LOCATION	CHAINAGE (feet)	TRACK ELEVATION (feet)	DEPTH TO WATER (feet)	WATER ELEVATION (feet)
North end of adit	-1900	0.0	0.0	0.0
Center of Center Orebody	- 500	7.0	5.0	2.0
Center of North Orebody	800	13.5	14.5	-1.0

Note: Elevations are relative to the elevation of the north end of adit. Elevation of the track is computed on the assumption that the track gradient is 0.5 percent. This is the gradient computed from plans.

Given the relatively low precision of the measurements, it is considered that the water elevations are the same; that is, the water level in the South, Central, and North orebody workings below the 700 level is the same, and is about equal to the elevation of the adit discharge point.

3.2 Laboratory Results

Seven water quality samples were collected in conjunction with the flow measurements in the mine, and a water quality sample of the outflow from the adit was also collected. Table 3 presents the laboratory analytical data for the samples.

All eight samples were analyzed for pH, specific conductance, and TDS, as indicators of the overall chemistry, and for copper (Cu), the heavy metal of principal concern. The water exiting the adit was analyzed for a full suite of major and minor species, primarily to allow correlation of these data with other sampling sessions. Copies of the laboratory report are attached.

TABLE 3

WATER QUALITY DATA, WALKER MINE - DECEMBER, 1985

PARAMETER	UNITS	SAMPLE NUMBER AND LOCATION							
		1	2	3	4	5	6	7	8
		S. end South ext.	S. end Central	S. end North	Inflow from roof, S. end North	S. end of 712	N. end of 712	S. end of Piute	Outflow from adit
pH	umho/cc	4.05	7.41	7.46	3.44	7.21	7.58	5.43	5.31
Conductivity	mg/l	346	242	217	436	222	203	167	256
TDS	mg/l	235	88	153	244	155	149	117	195
Alkalinity	mg/l $CaCO_3$				<1		73	11	12
Ca	mg/l				17		25	13	23
Mg	mg/l				5.5		5.1	3.1	6.2
Na	mg/l				1.87		3.6	1.81	3.1
K	mg/l				2.21		1.11	1.51	1.39
HCO_3	mg/l				<5		72	<5	<5
CO_3	mg/l				<1		<1	<1	<1
OH	mg/l				<.5		<0.05	<0.05	<0.05
SO_4	mg/l				135		45	73	111
Cl	mg/l				.5		0.5	0.5	0.6
Al	mg/l								0.4
As	mg/l								<0.01
Ba	mg/l								<0.1
Cd	mg/l								<0.01
Cr	mg/l								<0.01
Cu	mg/l	11.5	.33	.54	12.1	.73	1.00	10.4	8.7
Fe	mg/l				12.1		<0.05	0.21	0.10
Pb	mg/l								<0.01
Mn	mg/l				5.3		0.90	1.59	2.52
Hg	ug/l								<0.3
Ni	mg/l								<0.05
Se	mg/l								<0.01
Ag	mg/l								<0.01
Zn	mg/l				.96		0.24	0.40	0.65

4.0 DISCUSSION

These results quite clearly indicate that water which enters the mine does not all leave by the adit. The main inflow at the time of the visit was from the Piute area. In the 712 mine section, and to a lesser extent in the North orebody, there was some evidence of inflow from above. However, the two largest of the observed flows were measured and found to be of the order of 2 gallons per minute. It is estimated that, at the time of the visit, less than 10 gallons per minute of flow was observed coming from the workings above 700 level adit. There may, however, have been inflow to this level in sections which were not visible to the party, due to being in other segments of the drive system.

The available maps of the mine indicate that there is no mined connection between the Piute and the 712 orebody below the 700 level. Similarly, there is no known connection between the 712 orebody and the North orebody below the 700 level. Thus, it is not surprising to find that the flow on the 700 level increases from the south end of the Piute orebody to the south end 712 orebody.

There is believed to be connection below the 700 level between the North, Central and South orebody workings. The flow values reflect this, as the flow in the drain on the 700 level reduces in this stretch, presumably because of leakage to the lower workings. During the recent inspection trip, the flow could be seen to be disappearing from the 700 level adit drain into the lower workings at a number of locations, particularly in the South orebody area. The drain was essentially dry at the point where the 700 drive intersects the exit adit. Flow in the exit adit comes from the south extension, and is presumably return flow from the deeper mined area, which collects water from the entire mine.

The water level information indicates that there is a connection between the North, Central and South orebody workings below the 700 level. Water is presumably flowing into the lower workings from the 700 level, and moving towards the adit exit through the conduits provided by

the workings. This effect did not appear to be significant in the North orebody at the time of the visit. However, on the previous visit where this location was inspected, a considerable flow was observed to be dropping into the deeper portion of the North orebody workings at the location where the water level was measured this time.

The chemical parameters indicate regular changes from the input areas to the outflow areas. As the field readings were taken in winter, the water was entering the mine colder than the mine rock temperature. As a result, the water was warmed by the rock, which clearly shows in the field results.

The laboratory values for conductivity (and related TDS) are consistent with the field measurements - both generally increased from inflow to outflow points within the mine. The laboratory pH values (which were not subject to the vicissitudes of measurement under highly adverse field conditions) have a very strong correlation with TDS ($r = -0.78$). The correlation is even higher for copper, the metal of greatest interest ($r = -0.96$) for zinc and sulfate, the correlation factors are -0.93. These correlations clearly indicate that the dissolved load of the waters, particularly the concentrations of heavy metals is dependent primarily on pH.

The correlation of copper concentration with pH offers a ready explanation for why flow from the mine to the natural groundwater system has not introduced significant quantities of copper into the surface water system. The acid drainage in the mine system is the result of oxygenated waters reacting with the sulfide ores. When the water in the mine system flows out of the mine workings and into the country rock, it flows away from the concentrated sulfide zone, and along many flow paths through the granodiorite (and potentially other units) before it discharges to surface waters. During this flow, the acid produced in the ore zone is neutralized by water-rock reactions (primarily with the feldspars), and the copper initially carried in solution is precipitated and/or scavenged by clays, oxyhydroxides, and other phases that are present in the country rock.

The importance of the observation that there is a loss of a considerable amount of water from the mine to the groundwater system under natural conditions is as follows:

1. The loss from the mine will presumably increase as the mine fills after flooding, due to the higher driving head;
2. The increased flow loss from the mine makes it highly unlikely that water will ever rise high enough in the workings to cause a discharge from the Piute area, and into the presently unaffected catchment of Ward Creek; and
3. The losses have presumably been going on since the closing of the mine, and to date there is no evidence of a stream of copper-laden water egressing from the groundwater system to the surface water system via the natural flow system. Based upon the data collected in the mine, it is expected that as the water enters the groundwater, it is neutralized and the copper is precipitated from solution. Therefore, no increases in copper-ladened waters are expected to occur in the surface water system as a result of plugging the mine.

5.0 CONCLUSIONS

The conclusions of the evaluation are as follows:

1. The flow in the mine is a clearly identifiable hydraulic and geochemical system; water moves from the 700 level drive to the lower workings where it can, and discharges from the deep workings to the deep groundwater system, to the adjacent downgradient mine workings (when they are connected), or to the main exit adit and thence to the portal;
2. There is clearly loss of water from the mine which is a result of discharge of water from the deep mined workings to the natural groundwater system. At the time of the visit, about 40 percent of the influent water was appearing at the proposed plug location as flow in the adit drain, and approximately 60 percent of the inflow to the mine was discharging into the bedrock from the deep mine workings;

3. Based on these results, it is considered highly unlikely that copper-rich water could flow from a plugged mine to the catchment of Ward Creek via the Piute Shaft; and
4. There is a low probability that copper from the mine will emerge from the groundwater system once a plug has been installed in the mine and the water pressure in the mine has increased. In fact, the production of acid drainage will gradually decrease in importance to the extent that inflow of oxygenated surface water can be reduced (by reducing the flow into the surface shafts, particularly the Piute) and as the water stored in the plugged mine consequently becomes less oxidizing over time.

CORE LABORATORIES, INC.
ANALYTICAL REPORT

ANALYTICAL REPORT

W85884

TERRA THERMA INC.

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations, as to the productivity, proper operations, or profitableness of any oil, gas, coal or other mineral, property, well or sand in connection with which such report is used or relied upon.

CORE LABORATORIES, INC.
ANALYTICAL REPORT

CLIENT IDENTIFICATION

JOB NO.:6307-W85884
COMPANY: TERRA THERMA, INC.
JOB/GROUP REMARKS:

IDENTIFICATION	IDENTIFICATION
1) 1285-04	2) 1285-06
3) 1285-07	4) 1285-08
5) 1285-01	6) 1285-02
7) 1285-03	8) 1285-05

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
DATE/TIME SAMPLED	12-06-85/1415	12-06-85/1515	12-06-85/1530	12-06-85/1730
DATE/TIME RECEIVED	12-09-85/	12-09-85/	12-09-85/	12-09-85/
DATE/TIME ANALYZED	12-10-85/	12-10-85/	12-10-85/	12-10-85/
CHEMIST: RIF/DRH				
LOCATION: AURORA, CO				

LAB pH (@ 25 deg. C)	3.44	7.58	5.43	5.31
LAB COND. (as umhos/cm @ 25C)	436	203	167	256

--ALL VALUES REPORTED ON A DISSOLVED BASIS (MG./L.) UNLESS INDICATED OTHERWISE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
MAJOR CATIONS				
CALCIUM (Ca)	17 (0.85)	25 (1.25)	13 (0.65)	23 (1.15)
MAGNESIUM (Mg)	5.5 (0.45)	5.1 (0.42)	3.1 (0.26)	6.2 (0.51)
SODIUM (Na)	1.87 (0.08)	3.6 (0.16)	1.81 (0.08)	3.1 (0.13)
POTASSIUM (K)	2.21 (0.06)	1.11 (0.03)	1.51 (0.04)	1.39 (0.04)
SUM OF MAJOR CATIONS (me/l)	(1.44)	(1.86)	(1.03)	(1.83)
SUM OF TOTAL CATIONS (me/l)	(2.69)	(1.93)	(1.44)	(2.27)
MAJOR ANIONS				
BICARBONATE (HCO3)	<5 (0.00)	72 (1.18)	<5 (0.00)	<5 (0.00)
CARBONATE (CO3)	<1 (0.00)	<1 (0.00)	<1 (0.00)	<1 (0.00)
HYDROXIDE (OH)	<0.5 (0.00)	<0.5 (0.00)	<0.5 (0.00)	<0.5 (0.00)
SULFATE (SO4)	135 (2.81)	45 (0.94)	73 (1.52)	111 (2.31)
CHLORIDE (Cl)	0.5 (0.01)	0.5 (0.01)	0.5 (0.01)	0.6 (0.02)
SUM OF MAJOR ANIONS (me/l)	(2.82)	(2.13)	(1.53)	(2.33)
SUM OF TOTAL ANIONS (me/l)	(2.82)	(2.13)	(1.53)	(2.33)

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				

GENERAL PARAMETERS

TOTAL DISSOLVED SOLIDS (CALC.)	244 (193)	149 (118)	117 (106)	195 (158)
*TOTAL ALK. (pH 3.7 as CaCO3)	<1	73	11	12

*--FILTERABLE

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 1	W85884 - 2	W85884 - 3	W85884 - 4
SAMPLE ID:	1285-04	1285-06	1285-07	1285-08
SAMPLE REMARKS:				
DISSOLVED METALS				
ALUMINUM (Al)				0.4
ARSENIC (As)				<0.01
BARIUM (Ba)				<0.1
CADMIUM (Cd)				<0.01
CHROMIUM (Cr)				<0.01
COPPER (Cu)	12.1	1.00	10.4	8.7
IRON (Fe)	12.1	<0.05	0.21	0.10
LEAD (Pb)				<0.01
MANGANESE (Mn)	5.3	0.90	1.59	2.52
MERCURY (Hg)--ug./l.				<0.3
NICKEL (Ni)				<0.05
SELENIUM (Se)				<0.01
SILVER (Ag)				<0.01
ZINC (Zn)	0.96	0.24	0.40	0.65

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
DATE/TIME SAMPLED	12-06-85/1100	12-06-85/1210	12-06-85/	12-06-85/
DATE/TIME RECEIVED	12-09-85/	12-09-85/	12-09-85/	12-09-85/
DATE/TIME ANALYZED	12-10-85/	12-10-85/	12-10-85/	12-10-85/
CHEMIST: RIF/DRH				
LOCATION: AURORA, CO				

LAB pH (@ 25 deg. C)	4.05	7.41	7.46	7.21
LAB COND. (as umhos/cm @ 25C)	346	242	217	222

--ALL VALUES REPORTED ON A DISSOLVED BASIS (MG./L.) UNLESS INDICATED OTHERWISE

These analyses, opinions or interpretations are based on observations and material supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or representations, as to the productivity, proper operations, or profitableness of any oil, gas, coal or other mineral, property, well or sand in connection with which such report is used or relied upon.

CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
GENERAL PARAMETERS				
TOTAL DISSOLVED SOLIDS	235	88	153	155

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CORE LABORATORIES, INC.
ANALYTICAL REPORT

7-JAN-86

TERRA THERMA, INC.

RESULTS OF WATER QUALITY ANALYSIS
ON SAMPLES COLLECTED AT LOCATION:

JOB NO. 6307-	W85884 - 5	W85884 - 6	W85884 - 7	W85884 - 8
SAMPLE ID:	1285-01	1285-02	1285-03	1285-05
SAMPLE REMARKS:				
DISSOLVED METALS				
COPPER (Cu)	11.5	0.33	0.54	0.73

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COMMENTARY

on the

FINAL FEASIBILITY REPORT
for the
WALKER MINE CLOSURE PROJECT
PLUMAS COUNTY, CALIFORNIA

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

INTRODUCTION

The California Regional Water Quality Control Board, Central Valley Region (the Board) has proposed to seal the Main Access Tunnel of the Walker Mine in Plumas County, California in an attempt to halt the discharge of acid mine drainage (AMD) into Dolly and Little Grizzly Creeks. The Board has contracted with the consulting firm of Steffen, Robertson & Kirsten (SRK) of Denver, Colorado to "study the effectiveness and feasibility of sealing the Walker Mine adit in such a manner as to prevent a direct discharge of acid- and heavy metal-laden water from the underground workings". SRK was also contracted to design and estimate construction costs for such a seal.

This report is a commentary on the work done by SRK. Their work is summarized in two reports, each of which is considered herein. The first is the report titled, "Walker Mine Project, Final Feasibility and Design Report, Contract No. 4-051-150-0" and dated November, 1985. The second is titled, "Flow Evaluation Within the Walker Mine, Addendum Report to Walker Mine Final Feasibility and Design Report, Contract No. 4-051-150-0" and dated January, 1986.

In addition to the SRK reports, this commentary is also based on the following:

- A visit to the Walker Mine, including examination of underground workings, flow measurements and water quality sampling, January 22, 1986,
- Review of a number of reports and studies, including,
  - Pearson and Associates, "Pilot Plant Treatment of Mine Drainage, Walker Mine, Plumas County, CA", March, 1983
  - D'Appolonia, "Report, Evaluation of Water Pollution Sources & Development of Conceptual Pollution Abatement Plans, Walker Mine", December, 1979
  - California Division of Mines and Geology, Interagency Report on Walker Mine Discharge, August, 1972
- Review of file material, including water quality data, of record

at the Board offices in Sacramento.
- Interviews with the owner of the Walker Mine, with prospective operators, with the US Bureau of Mines and with other interested parties (including members of Board Staff)
- Previous experience with mining hydrogeology in general and AMD situations in particular.

The remainder of this commentary is divided into following sections:

- Perspective on the problem,
- Comments on the S.R.K. report,
- Comments on recent Board activities,

A discussion regarding alternatives to emplacement of the plug is being submitted as a separate document. Commentary on the Initial Environmental Study prepared by Board Staff has been previously submitted.

PERSPECTIVE ON THE PROBLEM

In any discussion of a question such as the Walker Mine, it is useful to get a grip on the various perspectives being brought to bear. In this case, those include the historic record, the owners perspective, the Boards view, other expert opinions, and, finally, our perspective. Each is discussed together with a recapitulation of the goal that should be kept in mind throughout this process.

Beginning with a review of the historic record, it has been stated, "When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage water flowing from the main Access Adit portal on the 700 Level began to affect Dolly Creek and Little Grizzly Creek" (Regional Board Initial Environmental Study, 1986). In other words, while the mine was operating, there was no AMD. This is consistent with the record of mines of this type throughout California, that operational periods are free of acid discharge.

The other important aspect of the historical record is that of placing the Walker Mine in its proper context with respect to other AMD sources in California. The following tabulation should assist in that regard:

MINE NAME	LOCATION	pH OF DISCHARGE
Iron Mountain	Central Valley Region	1 - 3
Penn Mine	Central Valley Region	3+ (in evap. ponds)
Leviathan Mine	Lahontan Region	3.2 +/-
Walker Mine	Central Valley Region	4.2 - 5.1

It can be seen that the Walker Mine discharge is one to three orders of magnitude less acidic than the other mines listed; metal contents of discharge waters show a similar relationship. This is not an attempt to minimize the problem, only to properly categorize it.

From the perspective of the mine owner, the solution proposed by the Board is excessivly drastic and will result in permanent closure of the mine, Staff and SRK statements to the contrary notwithstanding. He additionally perceives that past Board activities have discouraged prospective mine operators from pursuing investigations that might result in the reopening of the mine and abatement of the AMD problem. This in spite of the historic record of no AMD during mine operation.

The Board, of course, sees a problem and a discharge that is detrimental to the quality of the waters of the State of California. There is considerable pressure to do something, anything, to "solve the problem".

From our perspective, both the owner and the Board seem to have a point. Unfortunately, the two parties have allowed themselves to fall into an adversarial situation. At present, it appears that the current situation, if allowed to continue, will result in no resolution of the problem for some years to come while expensive, lengthy and needless litigation is pursued.

The goal of the current Walker Mine process needs to be carefully defined to allow all parties to focus on the solution. Is the goal to seal the mine portal or is the goal to restore the aquatic habitat in Dolly and Little Grizzly Creeks? This is not meant as a retorical question. The remainder of this commentary will demonstrate that simply placing a seal in the mine, 1) Will not allow restoration of Dolly and Little Grizzly creeks, and, 2) Offers the clear potential of introducing AMD to heretofore unimpacted watersheds.

COMMENTS ON THE STEFFEN, ROBERTSON & KIRSTEN REPORTS

This section is divided into the following subsections:

- Historic Mine Hydrogeology,
- Recent Observations,
- Comments on Respective Flow Models.

Each is discussed below.

- Historic Mine Hydrogeology -

In order to properly comment on the SRK report, an understanding of the historic record of Walker Mine hydrogeology is necessary. This section briefly outlines that history.

The Walker Mine was worked as an active producer of copper, gold and silver from 1923 to 1932 and 1936 through 1941. When closed in November, 1941, reserves "in sight" totaled nearly 4 million tons grading about 1.5% Cu, 0.75 oz.Ag/ton and 0.034 oz.Au/ton. (In recent years, minerals explorationists have identified the potential for economically significant precious metal deposits within and adjacent to the old mine workings.) Clear evidence exists for the presence of a mineral resource of regional or statewide significance at the Walker Mine.

The last work done in the mine prior to closure was the completion of the connection between the North Orebody and the Piute Orebody on the 1000 Level. Records are fragmentary due to the imminent mine closure, but it appears that the connection was made and that, as one of the last acts of the former mine owners, a bulkhead was installed on the 1000 Level between the 712 and North Orebodies. This is of note only as historic interest; SRK noted that the water level in the 712 and Piute Orebody stopes below the 700 Level is higher in elevation than is the water in the North, Central and South Orebody stopes below the 700 Level and that the former is not in hydraulic continuity with the latter.

The historic record also notes that the Main Access Tunnel portal caved some years after the mine was closed. In the 1950's it was noticed that water was being discharged from the Main Access Tunnel through a ventilator shaft collared east of the portal (and penetrating the tunnel). Deleterious effects on aquatic life in Dolly and Little Grizzly Creeks were noted due to the acid- and heavy metal-laden nature of this discharge.

The Board and the Division of Mines and Geology carried out a cooperative study in 1972. No underground access was possible at that time. The Division noted that there were two principal sources to acid and metal discharge and one minor source. The two principal sources identified were, 1) The mine discharge, and, 2) The contribution from the abandoned tailings pond which is located at the confluence of Dolly and Little Grizzly Creeks. The minor source is the natural contribution from the

native rock and metal deposits which occur in the vicinity.

In the mid-1970's, the mine owner succeeded in reopening and rehabilitating much of the Main Access Tunnel. To date, that rehabilitation has progressed to a point past the intersection of the Main Access Tunnel with the 700 Haulage Level (refered to herein as the 700 Level). At the same time, the first efforts were made to divert surface flows from entering various mine subsidences at surface. These subsidences were thought to be the principal points for entry of surface water into the mine. Although significant reductions in mine flow were acheived through these two actions, the AMD problem persisted.

In the late 1970's, D'Appolonia made a major study of the mine area and the AMD and reviewed a number of conceptual remediation plans. They did not have the benefit of access to as much of the mine as is available today, but many of their observations remain valuable.

A pilot plant for direct treatment of the AMD was constructed and run in 1982 - '83; results are summarized in the Pearson and Associates Report of March, 1983. Two observations on that report are salient. First, they established that elevated metal content in the AMD could be reduced to about 0.2 mg.Cu/l using conventional technology adapted to the remote locale. We will make further comments on the subject of treatment technology in a later section of this report. Secondly, they confirmed that a significant portion of the acid and metal load of Little Grizzly has its source in the abandoned tailings pond located at and in the mouth of Dolly Creek.

- Recent Observations -

This subsection of the report will focus on recent observations of in-mine flow paths and water quality. These observations were made by SRK and ourselves in 1985 and earliest 1986. They were possible due to the efforts of the mine owner to rehabilitate the mine and to regain access to the entire length of the workings. This subsection will be confined to observations of fact. Conclusions drawn from these observations by SRK and ourselves will be discussed in later parts of this report.

1. More water was observed to be entering the Walker Mine than flows out the portal of the Main Access Tunnel. Based on three sets of measurements (springtime high flow, late fall minimum flow and winter medium flow), it appears that between 35% and 50% of the flows measured within the mine discharge through the portal. Discharge of the remainder was not directly observed but is assumed to be to groundwater.

2. Flows from deep within the mine seem to collect on the 700 Level at a point north of the Central Orebody; the flow runs south on the 700 Level and discharges to mine openings below that level at a number of points. There is essentially no flow in the 700 Level from about the south end of the Central Orebody to the "Y" in the Main Access Tunnel where flow returns

from overflow discharging from stopes at the south end of the South Orebody. It is assumed that the water seen discharging into the lower stopes in the Central Orebody siphons through known connections with the lower levels of the South Orebody and thus returns to the 700 Level at the south end of the South Orebody.

3. The flow on the 700 Level through the Central Orebody area was observed to carry considerably less acid and metal content than the flow returning to the Main Access Tunnel from the south end of the South Orebody. This is very significant. It establishes that much of the acid and metal content of the water discharging from the portal is collected while the mine water is in residence within and siphoning through the lower stopes between the Central and South Orebodies.

These observations have established that flows within the mine are significantly (one to two orders of magnitude) higher in quality than current mine discharge. The SRK report of January, 1986, in Table 3, demonstrates this point quite well. Flow points 2 and 3 (essentially the same flow-stream) had the following characteristics when measured on December 5, 1985:

Flow Point	Flow(gpm)	pH	EC	TDS	Cu(mg/l)
2	41	7.41	242	88	0.33
3	55	7.46	217	153	0.54
Portal (for comparison)	21	5.31	256	195	8.7

The entire "Drinking Water Suite" was not run on these waters at the lab, but the constituents determined on the in-mine flow show that the water there meets Federal Drinking Water Standards (for those constituents tested).

The field data we collected on January 21, 1986 confirmed these values during a period when flows were approximately three times those measured by SRK, as follows:

Flow Point	Flow(gpm)	pH	EC	TDS	Cu(mg/l)
(same as) 2	175	6.53*	240*	n.m.	n.m.
(same as) 3	130	6.38*	200*	n.m.	n.m.
Portal (for comparison)	60	4.7	249	160	7.91**

Locations are estimated to be the "same as" SRK points 2 & 3; "n.m." - not measured; measurements marked with * indicate field readings; ** denotes laboratory analysis, sample was fixed, but not filtered.

4. A number of low-volume, poor quality inflows were noted to be entering

the main 700 Level flow stream from stopes above the 700 Level. They are tabulated below.

DATE	LOCATION	FLOW(gpm)	pH	EC	Cu(mg/l)
12-06-85	S. end North orebody	2	3.44	436	12.1
01-22-86	300' N. jct. Main Access & 700	1	3.88*	330*	n.m.
01-22-86	250' N. Central Orebody Hoist Sta.	5-7	3.30*	250*	n.m.

Values noted by * from field measurement; "n.m." - not measured.

These low quality inflows were noted during our January, 1986 visit to be issuing from drawpoints below old stopes.

In spite of these observations, a number of unresolved questions regarding flows in the Walker Mine remain. They include:

1. The source of most of the good quality flow on the 700 Level.

2. The mechanism of discharge to groundwater from the Walker Mine. This point is addressed further below.

- Comments on Respective Flow Models -

The observations listed above were made both by SRK and ourselves. Despite that agreement, substantial differences in the respective flow models were developed. The following points in the SRK flow model will be discussed in this section:

1. Their contention that the water discharged has had a short residence time in the mine (page 14, November 1985 report),
2. Their contention that an equilibrium water level would be acheived in a sealed mine at an elevation below the Piute Shaft Landing Adit (page 23, November, 1985 report)
3. That flow out the Piute Shaft Landing adit, if it were to occur, would be "no higher than 10 gpm" (page 24, November 1985 report)

Each of these points will be addressed in the following discussion.

1. Length of residency of water in the Walker Mine prior to discharge.

It has been noted that discharge water carries a higher metal content during spring flows than at other times of the year. This indicates to us that water has had a long residency in the mine. The low TDS values suggest that the orebody is not all that soluble. This is confirmed by in-mine flow streams and water qualities. The flow path of 700 Level to lower level stopes returning to the 700 Level from the South Orebody insures that the water spends months in the mine. In addition, water entering the lower stopes is better in quality than water discharging from those lower stopes.

Our conceptual model involves fresh water cascading through the upper stopes, being aerated to saturation, flowing downward into stopes below the 700 Level, picking up the acid and metal load while siphoning through the lower workings and eventually being disgorged back onto the 700 Level at the south end of the South Orebody.

In order to further check this hypothesis, it is suggested that the historic record of discharge water copper content be examined. If our model is correct, then the drought years should illustrate the following pattern: Discharge during the drought years should have substantially lower copper contents than discharge in the year following the drought. During those years, inflow into the mine would have been minimal. The chance for AMD formation and metal dissolution in the upper stopes would likewise have been minimal. The year the drought broke would have resulted in unusually heavy flows into, through and from the mine portal. If we are correct in asserting that the water so discharged was flushed from the lower stopes, then the copper content of those elevated flows should be higher than normal for springtime flows.

CONCCO compiled very complete discharge records for 1978, the year the drought broke. May, 1977 data are from CVRWQCB sampling. Spring, 1976 numbers are from AMAX summations. The following tabulation summarizes the data:

DATE	FLOW(gpm)	Cu(mg/l)
May, 1978	3000	51.0
May, 1977	(not measured)	7.2
Spring, 1976	(not measured)	10 - 12 (est)

The 3000 gpm flow in May, 1978 is the highest of record. These data support our hypothesis.

2. Will equilibrium be reached before a sealed Walker Mine spills?

We believe that discharge to the so-called "deep" groundwater system will not result in a steady state system, or stated otherwise, sealing the mine will not solve the problem. The relevant hydrologic calculations have been performed and are summarized as follows:

- Discharge through the bottom of the mine is of a saturated flow nature,

- Existing head at the bottom of the mine is about 500 feet,

- Increased head to the next KNOWN outlet is about 400 feet,

(At this point, a parenthetical comment is appropriate. When we examined the mine on January 22, 1986, there was a strong air flow from the portal inward toward the workings. That airflow entered the partially blocked workings south of the Main Access Tunnel, presumably passing into the South Orebody upper stopes and thence out of the mine at a higher elevation. Air, like any fluid, seeks to flow on the path of least resistance. The shortest path for the air to exit the mine was through the south workings, which have not been entered by any recent investigators. In addition, there are as yet unsubstantiated verbal reports that some of the upper levels in the South Orebody approach or cross above the location SRK picked for the mine seal. The implications of both the former observation and the latter possibility are obvious.)

- Permeability downward into the mineralized zone is 1 x 10E-4 cm/sec, or less,

- Area of discharge is about 240,000 square feet,

Calculations based on Darcys Law were performed on in-mine flows which were measured on three different occasions, as listed below:

DATE	SUM FLOWS INTO MINE	PORTAL DISCHARGE
19 June, '85	560 gpm	275 gpm (49%)
6 Dec., '85	55 gpm (?)	21 gpm (40%)
21 Jan., '86	175 gpm	60 gpm (34%)

The differences are presumably discharging into the deep groundwater system.

- Based on these figures and the discharge area noted above, the Darcy velocities for deep discharge on the three dates measured are 1.71, 0.20 and 0.69 gpd/sq.ft. respectively. With the assumed permeability of 1 x 10E-4 cm/sec, it is possible to solve for "i" (in the Darcy equation V=Pi); for each date listed the calculation results in the values of 0.8, 0.1, and 0.3 (unitless) respectively. These values have some fascinating implications:

  - It appears that discharge to groundwater is a function of inflow rather than head; plotting i vs. Inflow on both normal and log-log graph paper (Figures 1 & 2 attached) reveals that the boundary of i=1.0 (for vertical flow in

saturated media) is reached when mine inflow is 700 gpm (loss to groundwater at this point is revealed to be about 370 gpm) and that for any increase in inflow above 700 gpm, the marginal amount above 700 gpm would either discharge through the portal or, if the mine is sealed, would fill the mine. This type of inflow can be expected each spring.

We realize that these observations contradict accepted groundwater theory. It is apparent, however, that discharge to groundwater within the Walker Mine is not by a straightforward mechanism. If it were, then the percentage discharged would decrease with falling inflow instead of remaining fairly constant.

3. What would be the rate of flow from the Piute Shaft Landing Adit?

SRK asserts that, even if water were to rise to the level of the Piute Shaft Landing Adit, the flow from that adit would be unlikely to exceed 10 gpm. That is incorrect. Once spill begins, the amount discharged will instantly equal the amount entering the mine, less minor discharges to groundwater within the mine. In other words, any marginal inflow above the capacity of the groundwater system will be discharged whether that amount be 10 gpm or 10,000 gpm.

In addition, the quality of water discharged from the Piute Shaft Landing adit will surely be lower quality than current discharge due to two factors. The first is the long flow-path that water will take through the mine. The second is the time of in-mine residency the water will have while the mine is filling to that elevation.

4. Summary and Final Comment

More work is needed to properly understand the flow mechanisms operative in the Walker Mine. Until this understanding is acheived, the risk of damage is too great to allow the mine plug to be emplaced, especially in light of the historic record of the level of water in the mine rising to seek the next available outlet.

One final comment on the SRK work is offered. SRK apparently overlooked one significant cost in their estimates, the cost required to keep the mine portal open so that the plug may be accessed for inspection, or for working the valves if upper level overflow is threatened. That cost is significant; the portal and first 1300 ft of the Main Access Tunnel are driven in heavy ground. A possible scenario is offered:

- The plug is constructed,
- The Board places a lien on the property,
- The owner abandons all interest in the mine,
- The Board moves on to other, more pressing matters,
- Time passes, the diversion works deteriorate, the untended mine portal caves in,

- Water, mineralized with acid and metal, rises to the Piute Shaft Landing Adit and threatens to spill into Ward Creek.

What then?

RECENT BOARD ACTIVITIES

From our perspective, there appears to be a tendency for Staff to minimize data that fails to lend support to placing a seal in the Walker Mine. For instance, it is clear from several references that significant amounts of the metal and acid loading in Little Grizzly Creek have their source in the tailings on Forest Service land at the confluence of Dolly and Little Grizzly Creeks. There is also the historic record that, when the Walker Mine is sealed (as it was from the 1940's through the mid-1970's) water rises in the mine and spills from the next highest outlet.

A number of other conclusions can be drawn from recent observations in the mine and the arguments advanced above.

- As water pools in the mine, the quality will deteriorate below anything discharged to date,

- Once it rises and finds a new outlet, flow out that outlet will <u>instantly</u> equal flow into the mine,

- That outlet, based on best available information, is most likely the Middle Branch of Ward Creek, to now an unpolluted watershed,

- The Middle Branch of Ward Creek is a small watershed, far more sensitive than Grizzly, having a smaller areal extent and less capability of dilution).

All in all, the Staff proposal sounds remarkably like the Federal proposals regarding the Kesterson problem (i.e., to plug the San Luis Drain with no full consideration of the consequences).

Staff posture seems to be, they would rather insist on perfection than accept a partial solution that would allow gradual restoration of the fishery. As a result, lines have been drawn, an adverserial relationship is now established, one party will "win" and the other party will "lose" and, in the meantime as years pass, absolutely nothing will be accomplished. The Staff proposal to seal the mine is, at best, a temporary solution. The day of reckoning would be postponed but, as in every other case we are familiar with where temporary expediency was served by literally pushing a waste management problem underground, that day will eventually arrive.

ALTERNATIVES TO SEALING THE MINE

We realize that it is easier to offer criticism of a proposal than it is to offer constructive alternatives to that proposal. We have, however, prepared such alternatives and are submitting them to the Board in a seperate report. Only brief comments are offered here.

As has been mentioned, the historic record of mines of this type in California clearly demonstrates that AMD is not a problem while those mines are operating. The owner of the Walker has expended considerable effort to encourage such activity here. Some measure of success has been enjoyed and considerable progress in mine rehabilitation has occured. At the present time, additional interest in mine development is present. Efforts in this regard should be encouraged by the Board, not discouraged.

There are constructive alternatives to sealing the mine. Past efforts to intercept and divert surface flows from entering the mine in the first place are a good beginning. Further efforts in that regard are possible. In addition, good use can be made of the recent SRK observations of high quality water flowing deep within the mine. Copper loading in those flows was observed to be 0.3 - 0.5 mg/l; pH was observed to be in the 7.5 range. It is considered highly feasible to capture those high quality flows and direct them to the portal without their taking the current detour through the lower workings to collect acid and metal. We estimate that over 90% of current copper loading in discharge could be avoided in this fashion.

In the same sense, the low quality flows observed in the mine can similarly be collected and directed into the lower workings. It is believed that if the only inflow into the lower workings is the few gpm of low quality water, discharge from those workings may cease. This of course cannot be established for sure until tried, but a strong possibility exists.

In addition, it has been learned that the US Bureau of Mines is establishing an acid mine discharge study in their Spokane office. We contacted that office and have learned that the Bureau would be interested in doing work at the Walker Mine to assist the owner and the Board in resolving the AMD problem.

Finally, we would like to address the subject of treatment of discharge. The owner has two proposals in hand for metal treatment plants. Whether these would work on improved quality discharge of the type noted above is not known. Further investigation of those plants should, however, proceed.

In conclusion, there is strong evidence that alternatives to sealing the mine offer a greater potential of alleviating the current poor quality discharge from the Walker Mine, without causing long term threats to other watersheds, than does the Staff proposal to seal the Main Access Tunnel.

Respectfully Submitted,

Peter H. Dohms

Peter H. Dohms
Registered Geologist
California # 3829
17 February, 1986

SEAL

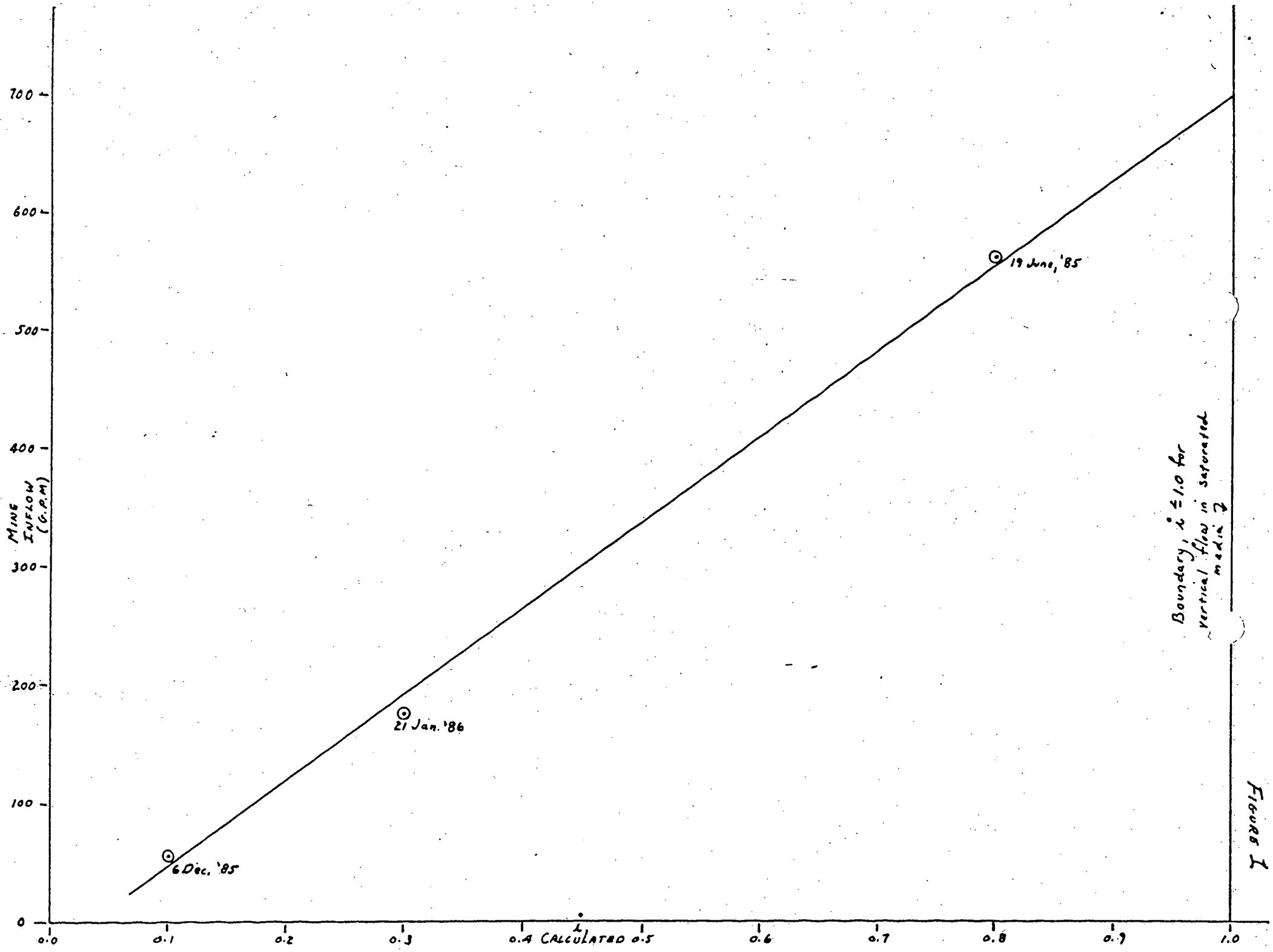
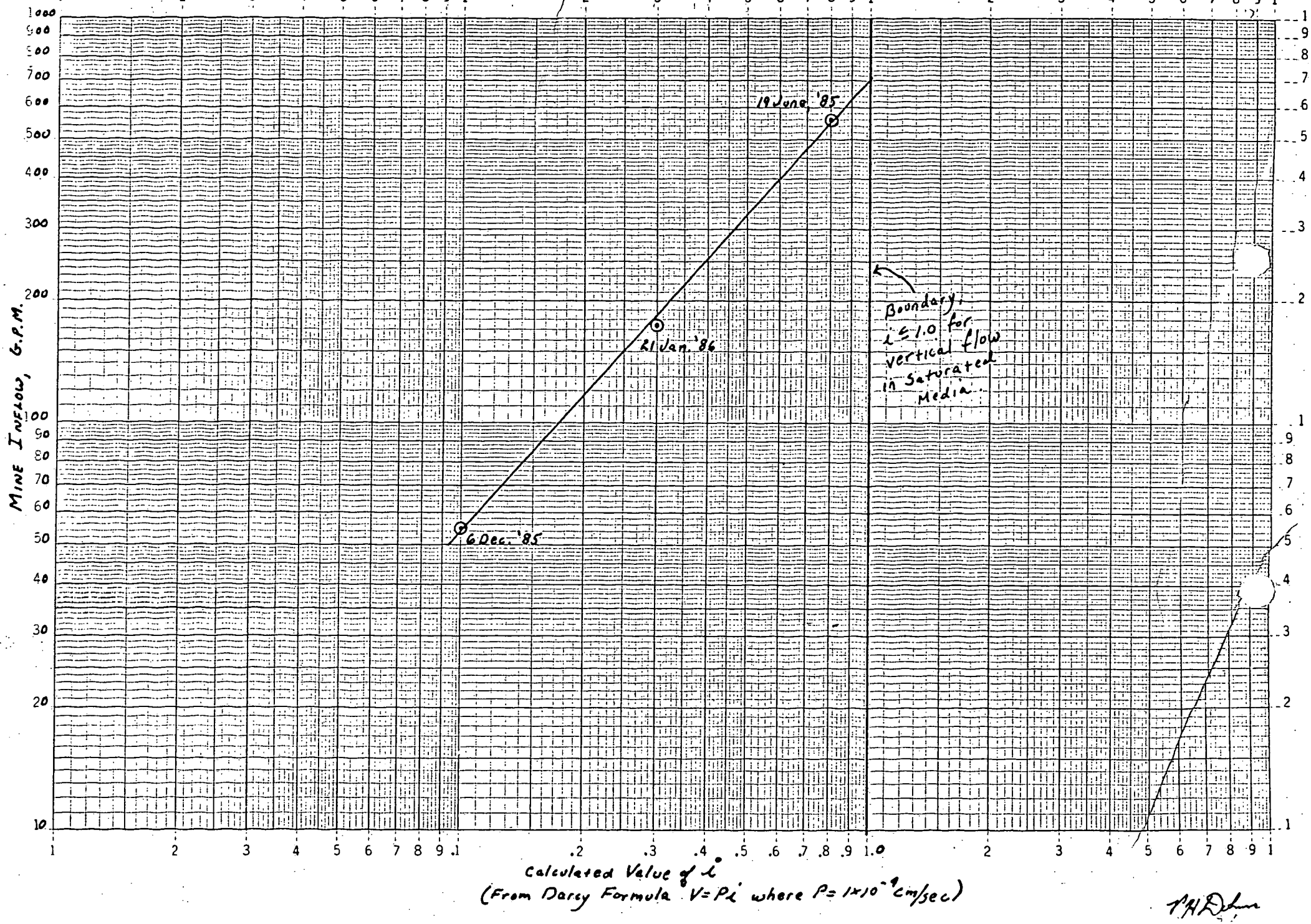

MINE INFLOW (G.P.M)
700
600
500
400
300
200
100
0
0.0
0.1
0.2
0.3
0.4
CALCULATED
0.5
0.6
0.7
0.8
0.9
1.0
6 Dec. '85
21 Jan. '86
19 June, '85
Boundary, i ≤ 1.0 for vertical flow in saturated media

FIGURE I

KEUFFEL & ESSER CO. MADE IN U.S.A.

FIGURE 2



PROPOSED REMEDIATION PLAN
WALKER MINE DRAINAGE
PLUMAS COUNTY, CALIFORNIA

INTRODUCTION

The California Regional Water Quality Control Board, Central Valley Region, (the Board) has proposed to seal the Main Access Tunnel of the Walker Mine in Plumas County in an attempt to halt the discharge of acid mine drainage (AMD) into Dolly and Little Grizzly Creeks. Previous submittals to the Board from this office have demonstrated the technical and environmental flaws of the Boards plan.

This report will attempt to demonstrate that alternative remediation plans can be developed which would significantly lower the amounts of acid and metal discharged from the Walker Mine without causing threats to previously unaffected drainages, without causing destruction of the mine and loss of non-renewable resources and at a significantly lower capital outlay.

STATEMENT OF THE PROBLEM

The Walker Mine was operated by a subsidiary of the Anaconda Copper Company (an Atlantic Richfield company) from 1916 to 1941, when it was closed and the site was abandoned. In the 1950's, it was noticed that significant amounts of metal and acid laden water were being discharged from above the caved portal of the Main Access Tunnel (the 700 Level) and that adverse effects from this discharge could be observed in Dolly and Little Grizzly Creeks.

From 1974 to 1978, the mine portal was opened and the Main Access Tunnel was rehabilitated to its present status. Now that the mine is open for inspection and study, it is possible to develop realistic models of mine flows and to develop feasible plans for remediation of the problem.

FLOWS IN THE WALKER MINE

This section of the report is based on the observations made by Steffen, Robertson & Kirsten in their inspections of the mine in 1985 and on observations made by the author during a visit in January, 1986. The points listed below were noted by both parties.

1. More water was observed to be entering the Walker Mine than flows out the portal of the Main Access Tunnel. Based on three sets of measurements (springtime high flow, late fall minimum flow and winter medium flow), it appears that between 35% and 50% of the flows measured within the mine discharge through the portal. Discharge of the remainder was not directly

observed but is assumed to be to groundwater.

2. Flows from deep within the mine seem to collect on the 700 Level at a point north of the Central Orebody; the flow runs south on the 700 Level and discharges to mine openings below that level at a number of points. There is essentially no flow in the 700 Level from about the south end of the Central Orebody to the "Y" in the Main Access Tunnel where flow returns from overflow discharging from stopes at the south end of the South Orebody. It is assumed that the water seen discharging into the lower stopes in the Central Orebody siphons through known connections with the lower levels of the South Orebody and thus returns to the 700 Level at the south end of the South Orebody.

3. The flow on the 700 Level through the Central Orebody area was observed to carry considerably less acid and metal content than the flow returning to the Main Access Tunnel from the south end of the South Orebody. This is very significant. It establishes that much of the acid and metal content of the water discharging from the portal is collected while the mine water is in residence within and siphoning through the lower stopes between the Central and South Orebodies.

4. A number of low-volume, poor quality inflows were noted to be entering the main 700 Level flow stream from stopes above the 700 Level.

In a similar manner, a number of unresolved questions regarding flows in the Walker Mine remain. They include:

1. The source of most of the good quality flow on the 700 Level.

2. The mechanism of discharge to groundwater from the Walker Mine. This point has been addressed in other submittals made to the Board.

PROPOSED REMEDIATION PLAN

Any remedial work undertaken will have to address the goals of reduced copper and acid discharge and watershed restoration as well as each of the points raised above. The following plan will make significant improvements in the quality of water discharging from the Walker Mine portal. Until similar remedial efforts are made, however, for the tailings at the confluence of Dolly and Little Grizzly Creeks, significant improvements in aquatic habitat, particularly in Little Grizzly Creek, may not be possible.

The plan proposed herein consists of the following steps:

- Intercept surface water before it enters the Walker Mine; direct those flows away from mine entry,
- Collect high quality, in-mine flows; direct those flows in a constructed channel directly to the portal,
- Collect poor quality flows as they enter the 700 Level, direct

those flows through existing flow paths into the stopes below the 700 Level,

- Continue underground rehabilitation of the 700 Level; as water inflows are encountered, direct them into the appropriate flow path, depending on quality,
- Continue study of mine flows and discharges; evaluate need for treatment of intercepted "good quality" flows prior to discharge; evaluate discharges from tailings and from bed and bank loads of Dolly and Little Grizzly Creeks.

Each of these subjects is discussed further below.

INTERCEPT SURFACE WATER FLOWS

In the past, considerable effort has been expended to effect cutoff of surface water inflows into the Walker Mine. These efforts have apparently met with only partial success; improvements are possible.

Surface water enters the Walker Mine principally through a series of mine subsidences localized above the Central and Piute Orebodies which are located in the drainages of the South Branch and Middle Branch of Ward Creek, respectively. Previous studies have established that inflow into the Central Orebody subsidences from the South Branch Ward Creek are from direct surface inflow and, additionally, from underflow in streambed alluvium. Flow into the Piute workings from Middle Branch Ward Creek are principally from surface water, not from underflow.

The lack of success of previous attempts to more completely divert inflow of surface water can be attributed to two factors:

- Direct precipitation into the subsidences, and,
- Inflow into the Central workings from alluvial underflow.

Additional work to further reduce surface water inflow should concentrate on these factors.

It is proposed that the following steps be undertaken:

1. Fill each of the subsidences. It is suggested, based on past experience with subsidence stabilization, that they can be filled inward from the edges using native material. An experienced, capable dozer operator is required.
2. Cover each subsidence area with a membrane seal. To illustrate the capability of these systems, we know of a recent case where such a seal was emplaced to stabilize a creeping hillside on a +100% slope beneath a penstock.
3. Evaluate the need to emplace a slurry or grout cut-off wall upgradient of the Central Orebody subsidence which lies in the bottom of the South Branch Ward Creek drainage,
4. Institute a regular program of diversion ditch care and

maintainence.

It should be remembered that it is not yet known for certain (although it is very high probability) that surface inflow is indeed the principal source of Walker Mine flows. Further rehabilitation of the mine workings northward to the Piute and above the 700 Level is required to confirm that hypothesis.

COLLECT HIGH QUALITY IN-MINE FLOWS

Recent investigations have established that flows in the mine are significantly (one to two orders of magnitude) higher in quality than current mine discharge. The SRK report of January, 1986, in Table 3, demonstrates this point quite well. Flow points 2 and 3 (essentially the same flow-stream) had the following characteristics when measured on December 5, 1985:

Flow Point	Flow(gpm)	pH	EC	TDS	Cu(mg/l)
2	41	7.41	242	88	0.33
3	55	7.46	217	153	0.54
Portal (for comparison)	21	5.31	256	195	8.7

The field data we collected on January 21, 1986 confirmed these values during a period when flows were approximately three times those measured by SRK, as follows:

Flow Point	Flow(gpm)	pH	EC	TDS	Cu(mg/l)
(same as) 2	175	6.53*	240*	n.m.	n.m.
(same as) 3	130	6.38*	200*	n.m.	n.m.
Portal (for comparison)	60	4.7	249	160	7.91**

Locations are estimated to be the "same as" SRK points 2 & 3; "n.m." - not measured; measurements marked with * indicate field readings; ** denotes laboratory analysis, sample was not filtered.

It is apparent that intercepting these high quality, in-mine flows and directing those flows to the mine portal would make an immediate, dramatic improvement in the quality of Walker Mine discharge. This could be accomplished in the following manner:

- Construct an open channel along the west wall of the 700 Level tunnel from the intersection of the Main Access Tunnel northward to a point at least 250 feet past the Central Shaft Hoist Station. This channel should be at least 1.5

ft x 1.5 ft. Since the tunnel is constructed at a grade of 0.5%, a channel this dimension would have the capacity of carrying over 3900 gpm (Calculated using the Manning formula), which is greater than the maximum observed discharge of the Walker Mine (3000 gpm observed in Spring, 1978, the year the drought broke.

- Place a barrier across the 700 Level at the upper end of this channel; this barrier should be constructed to have the ability to direct all 700 Level flow into the channel.

Recommendations for monitoring the flow rates and quality of this discharge are included in a later section of this report.

COLLECT LOW QUALITY IN-MINE FLOWS

In a similar manner to the collection of high quality flows, the low quality inflows to the 700 Level should be captured and directed. In this case, however, the low quality flows should be directed into the lower mine workings where they will do the least amount of harm. The following tabulation lists the inflows measured by SRK and by ourselves:

DATE	LOCATION	FLOW(gpm)	pH	EC	Cu(mg/l)
12-06-85	S. end North orebody	2	3.44	436	12.1
01-22-86	300' N. jct. Main Access & 700	1	3.88*	330*	n.m.
01-22-86	250' N. Central Orebody Hoist Sta.	5-7	3.30*	250*	n.m.

Values noted by * from field measurement; "n.m." - not measured.

These low quality inflows were noted during the January, 1986 visit to be issuing from drawpoints below old stopes. It was judged that collecting these flows and directing them into existing openings into the mine workings below the 700 Level should be relatively simple. Simple catchments and drains should be sufficient to direct these flows into the existing flow paths used by mine drainage. Those flowpaths currently discharge into the lower workings.

In addition, a drainage control barrier should be constructed in the south branch of the "Y" from which water currently returns to the Main Access Tunnel. The purpose of this barrier will be for flow control of the low quality, highly mineralized water in the lower stopes. The barrier should be fitted with a valve for possible release of low quality water for treatment. Provision should be made for piping this water to the portal (possibly using HDPE pipe) to prevent its mixing with the good quality

discharge.

In addition, an in-mine elevation survey should be performed prior to construction of this barrier so that a safe height for its construction can be determined (i.e., so that water impounded behind the barrier does not find another outlet and possibly mix with high quality discharge water). Recommendations for monitoring the water level behind the barrier and in the stopes are discussed in a later section of this report.

CONTINUE UNDERGROUND REHABILITATION

Currently, mine rehabilitation has been carried to a point about 450 ft. northward in the 700 Level past the intersection with the Main Access Tunnel. Past this point, most of the track remains in place but timber falls and other blockages cover the track in places. Rehabilitation is judged to be relatively easy to a point about 250 ft. northward from the Central Shaft Hoist Station where a major fall exists.

The mine owners are presently attempting to fund continued mine rehabilitation. This process should be encouraged as it offers the best hope of:

- Answering the questions remaining about Walker Mine hydrology, particularly the source of the major portion of the inflow, and,
- Emplacing a mechanism by which the remedial work can proceed and the facilities put in place can be kept in good repair.

It is the historic record of sulfide-bearing, metal mines of this type in California that AMD is not a problem while the mine is in active production. A high degree of exploration interest has been shown to the Walker Mine in the recent past, the AMD problem notwithstanding. If a cooperative attitude can be fostered between agencies, owners and exploration companies, long term remedies can be developed to the satisfaction of all.

FURTHER INVESTIGATIONS

Further investigations can be categorized in two types: 1) Monitoring conditions within the mine following emplacement of these facilities, and, 2) Performing research to further the efforts at watershed restoration. Each is discussed below.

- Monitoring Within the Mine -

In conjunction with emplacement of the remedial facilities described above, a number of monitoring programs are recommended to track their performance. They can be divided into both continuous and periodic types.

For monitoring the discharge of high quality water from the mine portal, a stillwell fitted with a continuous recorder is recommended. This device can be placed adjacent to and in hydraulic continuity with the discharge stream; calibration of the relationship between water level in the stillwell and the rate of discharge is relatively simple. Battery operated recorders with more than 30 day capacity are available.

In a similar sense, field environment, continuously recording pH meters are available. Unattended operation of up to three months is possible for certain of these units. Installation of such a unit is recommended for monitoring of the mine discharge.

Finally, it is recommended that a continuous recorder be installed for monitoring the elevation of the poor quality water residing in the stopes below the 700 Level. In this case, special consideration of the construction is necessary due to the corrosive environment into which the level sensor will be placed. If the level of this water begins to rise, sufficient warning should be possible to effect installation of some type of treatment facility.

Maintainence of these items will require periodic visits to the mine year-round. A 30 day frequency or greater will be the goal of instrumentation selection. During the maintainence visits, it is recommended that water quality samples be collected for laboratory analysis and that field parameter measurements be made for flow rate, pH, EC and temperature as a check on the recorders.

A minimum of one year of data collection is recommended following emplacement of the initial remediation before any decisions are taken with respect to additional work within the Walker Mine. Provision should, however, be made to install an interim treatment facility if the level of poor quality water in the lower mine threatens to rise to the top of its containment. Contingency planning in anticipation of this possibility is recommended.

- Additional Research -

A number of avenues of additional research are needed. Some of these are the responsibility of the mine owner, some should be performed by the Forest Service and some could best be coordinated by the Board.

The ability of Dolly Creek to receive the improved quality discharge will need attention. It is suggested that mass balance calculations be used for guidance. These should be based on Dolly Creek flow rate and copper content above the mine and the flow rate and copper content of the improved discharge. The reason for this recommendation in lieu of direct measurement of Dolly Creek quality below the point of discharge is the contribution that bed load- and bank load-copper will make to Dolly Creek below the mine. Measurements of the quality of that water will be affected by continuous loading from those sources for years to come.

The Forest Service and the Board will have to continue their investigations regarding the contribution of metal and acid to Little Grizzly Creek from the tailings impoundment. The historic record clearly indicates that a significant fraction of the copper in Little Grizzly has this source. Since Dolly Creek traverses the tailings (subsurface in part), this loading can be expected to continue no matter what is done in or to the Walker Mine.

Finally, research is needed to determine whether the bed loads and bank loads of copper which have accumulated in Dolly and Little Grizzly Creeks over the years can either be stabilized in place or safely removed. Alternatively, it is entirely possible that it will be determined that natural cleansing will be the best method of aquatic habitat restoration.

CONCLUSIONS

We have attempted to present a conceptual plan for dramatically improving the quality of the discharge from the Walker Mine which avoids the environmental threats associated with a mine seal and which allows continued access to and development of the mine. Implementation of this plan, together with continued research into the dynamics of the total hydrologic system of the mine area and watershed, will go far towards satisfaction of the goal of restoration of the Little Grizzly Creek aquatic habitat and fishery.

Respectfully Submitted,

Peter H. Dohms

Peter H. Dohms
Registered Geologist
California No. 3829

17 February, 1986

CMM
CONDOR MINERALS MANAGEMENT INC.

Feb '86

001084

BUFF SHEET

ITEM: 3

SUBJECT: Walker Mine, Robert R. Barry, Calicopia Corporation and The Standard Bullion Company, Plumas County.

a. Consideration of a Resolution to approve a Negative Declaration.

b. Consideration of a Resolution directing the Executive Officer to seal the mine.

REPORT: Walker Mine is a nonoperating copper mine in Central Plumas County. An acidic, heavy metal-laden discharge from the main portal has eliminated fish and aquatic life downstream in Dolly and Little Grizzly Creeks. Mining operations ceased in 1941.

A Board consultant has evaluated the feasibility of installing a mine seal to stop the discharge. The consultant recommends a concrete seal in the main adit of the mine and the rehabilitation of diversion channels around the sinkholes. The single mine seal will provide the most cost-effective method of pollution abatement and provide the best protection for the surrounding surface waters and watersheds.

An Initial Study was conducted to determine if the project may have any significant effect on the environment. Staff has completed an Initial Study and proposes that the Board approve the Negative Declaration pursuant to Title 14, California Administrative Code, Section 15074.

RECOMMENDATIONS: Adopt Resolutions:

(1) Approving the Negative Declaration.

(2) Directing the Executive Officer to seal the mine in accordance with the consultant's recommendations.

HEARING PROCEDURE

WALKER MINE, ROBERT R. BARRY, CALICOPIA CORPORATION AND THE STANDARD BULLION COMPANY, INC., PLUMAS COUNTY

THIS IS THE TIME AND PLACE FOR A PUBLIC HEARING TO CONSIDER TAKING ACTION TO SEAL WALKER MINE PURSUANT TO SECTION 13305 OF THE CALIFORNIA WATER CODE.

THIS HEARING WILL NOT BE CONDUCTED ACCORDING TO THE TECHNICAL RULES OF EVIDENCE. THE BOARD WILL ACCEPT ANY EVIDENCE OR TESTIMONY WHICH IS REASONABLY RELEVANT AND NOT REPETITVE. APPROPRIATE CROSS-EXAMINATION OF EACH WITNESS WILL BE ALLOWED. AT THIS TIME, EVIDENCE SHOULD BE INTRODUCED ON THE FOLLOWING ISSUES:

1. HAVING CONSIDERED THE INITIAL STUDY AND COMMENTS RECEIVED ON A PROJECT TO SEAL THE WALKER MINE, SHALL THE BOARD APPROVE A NEGATIVE DECLARATION PURSUANT TO THE CALIFORNIA ENVIRONMENTAL QUALITY ACT, SECTION 15074?

   THE PUBLIC REVIEW PERIOD FOR THE NEGATIVE DECLARATION RAN FROM JANUARY 2 THROUGH JANUARY 31, 1986. THEREFORE, NO EVIDENCE ON THE ENVIRONMENTAL IMPACTS OF THE PROJECT WILL BE RECEIVED UNLESS IT COULD NOT HAVE BEEN SUBMITTED BY 31 JANUARY.

2. SHALL THE BOARD ADOPT A RESOLUTION DIRECTING THE EXECUTIVE OFFICER TO HAVE THE MINE SEALED IN ACCORDANCE WITH THE CONSULTANT'S RECOMMENDATIONS?

ALL PERSONS EXPECTING TO TESTIFY, PLEASE STAND AT THIS TIME, RAISE YOUR RIGHT HAND, AND TAKE THE FOLLOWING OATH:

"DO YOU SWEAR THE TESTIMONY YOU ARE ABOUT TO GIVE IS THE TRUTH?" IF SO, ANSWER "I DO."

TESTIMONY WILL BE RECEIVED FROM STAFF, THE DISCHARGER, AND ANY OTHERS WISHING TO COMMENT. PLEASE STATE YOUR NAME, ADDRESS, AFFILIATION, AND WHETHER YOU HAVE TAKEN THE OATH BEFORE TESTIFYING.

ORDER FOR CONDUCTING HEARING:

CALL FOR TESTIMONY OF ALL STAFF WITNESSES
CALL FOR CROSS-EXAMINATION OF STAFF
CALL FOR TESTIMONY OF ALL DISCHARGER WITNESSES
CALL FOR CROSS-EXAMINATION OF DISCHARGER WITNESSES
CALL FOR TESTIMONY OF INTERESTED PERSONS
CALL FOR CROSS-EXAMINATION OF INTERESTED PERSONS
CALL FOR CLOSING STATEMENT BY DISCHARGER
CALL FOR CLOSING STATEMENT BY OTHER INTERESTED PERSONS
CALL FOR CLOSING STATEMENT BY STAFF
CLOSE HEARING
DELIBERATION BY BOARD

(2 VOICE VOTES REQUIRED)

1. TO ADOPT PROPOSED RESOLUTION APPROVING THE NEGATIVE DECLARATION.
2. TO ADOPT RESOLUTION DIRECTING E.O. TO HAVE WALKER MINE SEALED AS CONSULTANT RECOMMENDS.

TABLE OF CONTENTS

		Page
1.	Staff Report	4-1
2.	CEQA Document a. Proposed Negative Declaration and Initial Study b. Comments received on proposed Initial Study and Negative Declaration c. Response to comments received on Initial Study and Negative Declaration	4-7
3.	Letters and names of persons who have responded to the Walker Mine Hearing Notice	4-42
4.	Proposed Resolution approving Negative Declaration	4-46
5.	Proposed Resolution directing the Executive Officer to take steps to seal the Walker Mine	4-47
6.	Public Notice	4-50

STAFF REPORT

WALKER MINE

Location

The Walker Mine, owned by Mr. Robert R. Barry, Calicopia Corporation, is an inactive copper mine approximately 20 miles east of Quincy in Plumas County.

History

Walker Mine was actively mined for copper from 1916 to 1932, and from 1935 to 1941. Since the mid-40s, the mine has discharged acid and heavy metals to Dolly Creek. Discharge from the mine has resulted in the elimination of aquatic life downstream in Dolly Creek and Little Grizzly Creek. These creeks have been affected by this discharge for approximately 12 miles. Above the mine, these creeks contain abundant levels of aquatic insects and fish. Only through dilution at the confluence of Grizzly Creek and Indian Creek is the quality of these waters improved sufficiently for aquatic habitat.

Waste discharge requirements were first adopted in 1958. The mine has continuously violated these and subsequent requirements, except for short periods in extremely dry years when the discharge ceased.

The following chronology provides a brief history of actions at the Walker Mine:

8 Apr 1959	Cleanup and Abatement Order adopted
23 Jun 1960	Referred 8 April 1959 C&A Order to Attorney General
18 Jul 1963	Cease and Desist Order adopted
26 Oct 1970	Abatement Order issued (Section 13305 of the CWC)
8 Sep 1971	C&A Order issued by Executive Officer
28 Jul 1972	Referred 8 September 1971 C&A Order to Attorney General
23 May 1975	NPDES Order No. 75-119 adopted
30 May 1980	NPDES Order No. 80-058 adopted; C&A Order No. 80-070 adopted; Referred to Attorney General; Order No. 80-071 adopted
21 Dec 1983	Abatement Order issued (Section 13305, CWC)
25 Jan 1985	NPDES Order No. 35-033 adopted

Prior Attempts to Abate Pollution

Proposals to abate the pollution and operate the Walker Mine are not new. In 1969, Norandex, Inc., a major mining company, proposed to open the mine and submitted a letter stating how pollution would be abated. In 1974, mining consultant William McClung proposed remedial measures on behalf of Mr. Barry. In 1975, a tin tank was able to cut effluent copper concentrations from 14 mg/l to 9.7 mg/l. This process is no longer in operation. Continental Oil Co. (CONOCO) did extensive exploration work at the mine in 1978 and 1979. During July of 1980, staff requested access to construct remedial diversion work in the glory hole areas with Clean Water Bond funds. Conoco, the lessee at that time, provided a bulldozer and operator for one day to complete the diversion work. However, no pollution abatement procedures were implemented. Mr. Barry, the mine owner, and the Standard Bullion Company, the current lessee, presented a new abatement proposal in January 1985. However, no pollution abatement was accomplished at the mine during the summer of 1985. Untreated acid mine waste continues to discharge from the mine. No detailed plans or time schedules have been submitted by Mr. Barry or his lessee.

Alternative Methods for Stopping Acid Mine Drainage

Several alternatives for abating the acid mine drainage problem have been studied. As part of a 208 Area-wide Planning Program, D'Appalonia Consulting Engineers completed a feasibility study on these alternatives The 208 Study recommended that a chemical treatment plant be built to remove heavy metals and neutralize the acid mine drainage. The Regional Board obtained a grant under the Clean Water and Water Conservation Bond Act of 1978 (SAP) for design and construction of facilities to stop the acid mine discharge. Pearson and Associates were hired to design and supervise construction of the chemical treatment plant recommended in the 208 report. The Pearson report, completed in April 1984, showed that the treatment plant was very expensive in terms of operations and maintenance. Pearson estimated that 2.6 staff-years per year would be required to staff the treatment plant. Construction costs were estimated at $336,000.

As previously stated, mine owner, Robert Barry, and lessee, Standard Bullion Company, proposed a chemical treatment process also. However, neither Mr. Barry nor Standard Bullion have shown that they have the resources to install or operate the treatment system which they proposed.

Before taking action on the Pearson report, staff decided to reexamine the option of sealing the mine. The sealing option had been dismissed in the 208 Study because sealing would preclude an active mining operation. The Board hired Steffen, Robertson and Kirsten Mining Engineers (SRK) to design and construct a seal, if feasible. SRK finished its report in January 1986. Construction of the mine seal was estimated at $165,000. Operation and maintenance of the seal was very low compared to the chemical treatment option. Seal maintenance consists of reading pressure gauges at the seal and surveying the mine area for springs which may result from increased water levels in the mine.

Walker Mine owner, Robert Barry, may have sufficient assets to pay for the pollution abatement work. Water Code Section 13305 enables the Board to abate a condition of pollution or nuisance by correction of the condition at the property owner's expense. The Board adopted Order No. 83-148, Request to Abate Pollution, under Section 13305 on 9 December 1983. If the mine seal is installed, Board staff will seek reimbursement of Board costs from Mr. Barry and Calicopia Corporation.

CEQA Compliance

An Initial Study has been completed for the proposed pollution abatement project pursuant to Title 14, California Administrative Code, Section 15063. A Negative Declaration was prepared pursuant to California Adminstrative Code, Sections 15070 through 15073. The public review period began 2 January 1986 and ended 31 January 1986. All comments received during this period were considered and are attached to the Negative Declaration. The following agencies have made minor comments on the Initial Study. These comments and their respective responses are attached:

1. Native American Heritage Commission

2. California Department of Conservation, Division of Mines and Geology

Mr. Peter Dohms, of Condor Mineral Management Inc., submitted major comments on the Initial Study. Mr. Dohms is addressing the Initial Study as the consultant for Mr. Robert Barry, the mine owner. The following is a summary of his comments:

1. The proposed seal has little chance of ending the acid and metal discharge to Dolly and Little Grizzly Creek because of the contribution from the USFS tailings.

2. (a) The seal has the potential to cause a discharge into an uncontaminated watershed.

   (b) Water buildup in the mine will be degraded to the point that, if it is released, it will cause more damage than the current discharge.

   (c) Increased hydraulic head behind the seal will accelerate the discharge of mine water to ground water.

3. The seal will adversely affect the nonrenewable resource (mine ores).

4. The project may achieve short-term benefits to the disadvantage of long-term environmental goals.

In response to Mr. Dohms' summary comments, Regional Board staff contends the following:

1. The seal will prevent almost all of the heavy metal-acid mine discharge to Dolly and Little Grizzly Creek. In the past, the Department of Fish and Game have been able to show that fish can live in Little Grizzly Creek when the mine is not discharging. This would suggest that the USFS tailings do not contribute enough heavy metals to be toxic to fish.

2. (a) Discharge to Ward Creek is rated highly unlikely by SRK. In the case of a threatened discharge, pipes in the seal could be opened to drain the mine through a treatment plant into Dolly and Little Grizzly Creeks instead of Ward Creek.

   (b) Water released to Dolly and Little Grizzly Creeks can do no more damage than the current discharge. However, a regulated discharge through the seal and/or treatment plant could be an improvement over the current unregulated discharge.

   (c) Discharge to ground water may be accelerated, but the metals in this discharge will be neutralized by water-rock reactions (primarily with feldspars). Metals will be precipitated and/or scavenged by clays, oxyhydroxides, and other phases present in the country rock which is mostly granadiorite.

3. The mine may be reopened after the seal is built. Mine waters may be treated and discharged from the mine under the existing NPDES permit.

4. Mr. Dohms does not show how long-term environmental effects will occur.

It has been determined that, although the proposed project could have a significant effect on the environment, mitigation measures have been included in the project that will avoid the effects or mitigate the effects to a point where there will be no signifcant adverse effects. The Board must consider the proposed Negative Declaration, together with any comments received, during the public review period. After approval of the proposed Negative Declaration, the Board may consider approval of the pollution abatement project.

Community Concern

Staff have received twenty-eight letters expressing concern over the ongoing pollution problem at Walker Mine and their support of a Resolution directing staff to seal the adit of Walker Mine to abate the polluting discharge. One letter was received from a Ward Creek property owner expressing his concern over the protection of the Ward Creek Watershed.

Recommendation

Staff recommends adoption of the Final Negative Declaration and a Resolution ordering staff to take steps necessary to install the seal in the main Walker Mine adit in accordance with the SRK report.

CEQA DOCUMENT

1. Proposed Negative Declaration and Initial Study
2. Comments received during the review period on the Initial Study and proposed Negative Declaration
3. Responses to comments received during the review period on the Initial Study and proposed Negative Declaration

001093

NEGATIVE DECLARATION
Pursuant to Section 21108
Public Resources Code

To: Office of Planning and Research
State Clearinghouse
1400 Tenth Street
Sacramento, CA 95814

From: Regional Water Quality
Control Board
Central Valley Region
3201 S Street
Sacramento, CA 95816

PROJECT TITLE: Water Pollution Abatement at Walker Mine

APPLICANT: Regional Water Quality Control Board, Central Valley Region

PROJECT DESCRIPTION:

The proposed project will be: construction of a mine seal, rehabilitation of surface diversion structures and the implementation of a surface water survey for the purpose of abating acid mine drainage discharging from Walker Mine.

LOCATION: 20 miles east of Quincy, Plumas County, Section 7, T24N, R12E, MDB&M. See attached map.

The Central Valley Regional Water Quality Control Board has determined that, although the proposed project could have a significant effect on the environment, there will not be significant adverse effect in this case because the mitigation measures described in the attached Initial Study have been added to the project. A NEGATIVE DECLARATION WILL BE PREPARED.

Mitigation measures outlined in the Initial Study include the implementation of the "Surface Water Survey" and the rehabilitation of the diversion structures.

Contact Person: William A. Croyle Telephone: 445-0270

APPROVAL OF THE ABOVE IS RECOMMENDED BY:

William A. Croyle 12/27/85 William J. Rinehart 12/27/85

Signature Date
Water Resoucres Control Engineer
North Mountain Unit

Signature Date
Senior Water Resource Control
Engineer, North Mountain Unit

APPROVED

Signature Date
Executive Officer

INITIAL STUDY

FOR

WALKER MINE, PLUMAS COUNTY

The California Regional Water Quality Control Board, Central Valley Region (Board) is proposing a pollution abatement project at Walker Mine. This project entails the placement of a seal in the main adit of the mine, the rehabilitation of diversion structures above the mine, the implementation of a water quality monitoring program in the Little Grizzly Creek and Ward Creek watersheds and the formulation of a contingency plan for any threatened discharge. The Board has received the final Feasibility and Design report from Steffen, Robertson and Kirsten (hereafter SRK). The objective of this report was to evaluate the feasibility of sealing the Walker Mine main adit to prevent a direct discharge of acid and heavy metal laden water from the underground workings. The Board has assumed the lead agency role for this project under the California Environmental Quality Act and has completed this Initial Study in accordance with Section 15063, Title 14, of the California Administrative Code, "CEQA: The California Environmental Quality Act, Law and Guidelines, January 1984".

STATEMENT OF PROBLEM

The Walker Mine discharges acid and heavy metal laden water from an adit into Dolly Creek, which is a tributary to Little Grizzly Creek. The discharge from the mine has totally eliminated aquatic life in Dolly Creek, and in Little Grizzly Creek for a distance of approximately ten miles downstream from the mine.

The primary goal of the Board is to restore Little Grizzly Creek and Dolly Creek to a condition capable of supporting a diversity of aquatic life and protect all other water courses in the Walker Mine area.

PROPERTY HISTORY

Copper ore was first discovered at the Walker Mine site in 1904. Production commenced in 1916, continuing until 1932 and again from 1935 to 1941, when it was closed down by the operator, Walker Mining Company, a subsidiary of Anaconda Copper Company. Mining started on the 200 Level (approximately 6,670 feet elevation) near the outcrop of the Central Orebody. The Main Access Adit on the 700 Level (approximately 6,200 feet elevation) was driven in the early 1920's. This adit went from the millsite at Dolly Creek, northerly for some 3,000 feet where it intersected the South Orebody. From there, the adit was driven north by northwest, following the vein through the Central, North, 712 and Piute Orebodies. Approximately 10,000 feet from the portal, the Piute Shaft was raised in the vein from the 700 Level to surface in 1927/28. The portal of the 700 Level Main Access Adit remains the lowest point at which the underground workings reach the surface.

No stoping was done below the 700 Level until the 1930's. The deepest level from which ore was mined was the 1000 Level (approximately 5,720 feet elevation) and the deepest exploration winze was sunk to below the 1200 Level (approximately 5,400 feet elevation) on the Central Orebody.

A total of 5,319,000 tons of ore was mined between 1916 and 1941, from which 83,890 tons of copper were recovered (an average recoverable grade of 1.58% Cu with 0.03 oz/ton gold and 0.68 oz/ton silver recovered as by-products).

Soon after cessation of mining in November, 1941, all the mining equipment was removed and the surface plant was dismantled. When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage water flowing from the main Access Adit Portal on the 700 Level began to affect Dolly Creek and Little Grizzly Creek. Increasing concern over the detrimental effects of the acid mine drainage prompted the Board to commission several investigations.

DESCRIPTION OF THE PROJECT

A recent feasibility study has shown that using a mine seal is the most cost-effective way of preventing acid mine drainage from discharging to surface water-courses.

To abate the ongoing pollution discharge from Walker Mine, the Board will place an engineered concrete seal in the Main Access Adit approximately 2,700 feet from the 700 Level portal. This seal will effectively remove the main source of heavy metal and acid contamination in Dolly Creek and Little Grizzly Creek.

The project will largely consist of underground construction. A small concrete batch plant will be set-up on the surface at the 700 Level portal. Construction materials will be stockpiled at the 700 Level portal and used as required to complete the project.

The function of the seal will be to prevent a direct discharge of acid and heavy metal laden water from the underground workings and provide an immediate relief from the contaminated discharge.

The project will also consist of rehabilitating the diversion structures around the glory holes and implementing the "Surface Water Survey" in Ward Creek and Little Grizzly Creek Watersheds. Rehabilitation of the diversion structures will be performed as recommended by the Board's consultants; Steffen, Robertson and Kirsten, and Pearson and Potter Associates. This work will reduce the amount of surface water seeping into the underground workings. The "Surface Water Survey" will provide water quality baseline data and will monitor surface waters before and after seal construction. The survey will be designed to provide an early warning of any threatened discharge to Ward Creek.

ENVIRONMENTAL SETTING

Walker Mine is located approximately 20 miles by road from Portola, in Plumas County. The mine is situated in hilly country at an altitude of between elevation 6,000 and 7,000 feet. Access is by well-graded gravel road through the Plumas National Forest from California Highway 70 at Portola. The elevation of the main portal is approximately 5,720 feet. The mine site is subject to heavy snowfall in the winter and is generally inaccessible between November and April. The site is typical of mid to high elevation Northern Sierra Nevada climate. Wintertime low temperatures are well below freezing and summertime high temperatures are in the 90's. Average annual precipitation is about 40-50 inches. Average annual evaporation is 45 inches.

OTHER ENVIRONMENTAL FEATURES

The Walker Mine area includes portions of two watersheds; Little Grizzly Creek and Ward Creek. The Ward Creek Watershed experiences excellent water quality and contains an abundance of aquatic biota. Portions of Little Grizzly Creek Watershed have experienced the total elimination of aquatic life. This is largely due to the discharge from the Walker Mine main portal. Both watersheds have areas that are frequented by those who enjoy fishing, swimming, hunting, sightseeing, and picnicking, especially during the summer months. Logging activities are performed throughout the area. The U.S. Forest Service has informed the Board that there will be a contract logging operation directly adjacent to the Walker Mine site and proposed seal construction staging area during the target construction period.

ENVIRONMENTAL EFFECTS

Attached is a completed "Environmental Checklist Form" for the proposed project.

DISCUSSION OF ENVIRONMENTAL EVALUATION

WATER

Water quality is the major environmental concern with regard to the proposed project. The purpose of this project is to abate a polluting discharge which has eliminated aquatic organisms in portions of two watercourses.

The proposed project will result in a change in the direction of water movement; drainage patterns, and/or rate and amount of surface runoff; and the amount of surface water in local creeks. It is the Regional Boards' intent to prevent a discharge from the main adit of Walker Mine and to prevent surface water (i.e., snow and/or surface runoff) from seeping into underground workings. In doing so, the direction of water movement in the mine will be directed to deep ground water recharge and the surface waters normally seeping in the sinkholes will be diverted to surface waters (i.e., Ward Creek). The amount of surface runoff due to the

diversion structures is small and will not cause significant erosion. The amount of surface water in Dolly Creek and Little Grizzly Creek will decrease due to the seal placement. No significant adverse impacts are expected, due to the reduction. The changes in these creeks are viewed as beneficial impacts.

The proposal will result in a change in the discharge into surface waters and in surface water quality due to the placement of the mine seal. By eliminating the mine's discharge, Dolly Creek will contain only natural spring water, snowmelt and/or precipitation. This condition will improve water quality.

The proposed project will result in a change in the rate of flow of ground water, but not result in a change in usable ground water quality. Steffen, Robertson and Kirsten, the Board's consultants, have investigated the hydraulic characteristic of the underground workings on two occasions. They suggest that there is conservatively twice as much ground water recharge deep within the mine as flow from the mine. By raising the water head behind the seal, ground water recharge will increase. Ground water recharge will prevent a surface discharge from the other adits. Flooding the mine will also have the following water quality benefits:

1. Reduce oxidation of the ore body.

2. Allow the natural attenuation process to treat the low pH and heavy metal water in the earth-ground water system.

To assure protection of surface water from a polluted ground water discharge, the Regional Board will conduct a "Surface Water Survey" throughout the Ward Creek and Little Grizzly Creek Watersheds. This survey will assess water quality before and after seal construction. It will be designed to provide an early warning should a threatened ground water discharge exist. Survey data will be used to insure that water quality in both Ward Creek and Little Grizzly Creek Watersheds is being maintained or improved.

PLANT AND ANIMAL LIFE:

The proposed project will not adversely affect the diversity or species, or number of species of plant and/or animal life.

The purpose of the mine seal is to stop the discharge of acid and heavy metal-laden water to Dolly Creek and Little Grizzly Creek. By eliminating the toxic barrier caused by the discharge, plant and animal populations would be able to reestablish themselves in the affected area. Thus, the seal will beneficially impact these organisms. The rehabilitation of the diversion structures and implementation of the "Surface Water Survey" will result in a beneficial impact. These phases of the project will prevent erosion and provide background water quality data, respectively.

The plants and animals of the Ward Creek Watershed will be protected against a toxic discharge by implementing the "Surface Water Survey" and assessing the water quality before and after mine seal construction. This survey will be designed to provide an early warning of any threatened discharge to Ward Creek. The Survey will also be used to check water quality in the Ward Creek Watershed, as well as Little Grizzly Creek and Dolly Creek.

Should there be a threatened discharge in any watershed, the contingency plan will provide the mine owner and/or Regional Board staff with the available options. One option would be to open valves in the seal and return the hydrologic system to its pre-seal condition.

It is the intention of the Regional Board to first protect the Ward Creek Watershed and, second to protect the Dolly Creek and Little Grizzly Creek Watersheds.

PUBLIC SERVICES

The proposed project will not have a significant effect upon, or result in a need for new or altered governmental services in the areas of fire protection; police protection; schools; parks or other recreational facilities; maintenance of public facilities, including roads.

There will be a temporary impact on the Central Valley Regional Water Quality Control Board due to the implementation of surface water and mine seal monitoring program. Temporary staff requirements will be met by existing Regional Board staff.

RECREATION:

The proposed project will not adversely affect the quality or quantity of existing recreational opportunities. Recreation will be enhanced by the removal of acid mine drainage from Little Grizzly Creek and the reestablishment of a fishery.

ARCHEOLOGICAL/HISTORICAL RESOURCES:

After consultation with Mr. Joe Pope of the State Water Resources Control Board and through him, the Office of Historic Prservation, it was determined that, due to previous destruction and removal of mill buildings, other town site buildings and other alterations at the site, an archeologica/historical resources survey will not be required. As a result of these alterations to the mine and mine site since closure in the 1940s, there is no resource value.

COMPATIBILITY WITH ZONING AND POLICY

The proposed project will be consistent with existing zoning, plans and other applicable land use controls and policies since there has been no change in land use. (General forest and 10 acre rural).

RECOMMENDATION

Based on the preceding study, I recommend that a Negative Declaration be prepared for this application.

William A. Croyle

WILLIAM A. CROYLE
Water Resources Control Engineer
North Mountain Regulatory Unit

12/24/85:WAC:gs

PERSON/AGENCIES PROVIDING ASSISTANCE OR INVOLVED IN THE PREPARATION OF THE INITIAL STUDY:

William A. Croyle, Area Engineer, California Regional Water Quality Control Board, Sacramento.

Edwin Z. Crawford, Area Engineer, California Regional Water Quality Control Board, Sacramento.

William J. Marshall, Senior Engineer, California Regional Water Quality Control Board, Sacramento.

Jack E. DelConte, Supervising Engineer, California Regional Water Quality Control Board, Sacramento.

Colin Smith, Project Manager, Steffen, Robertson and Kirsten, Lakewood, Colorado

Don Poulter, Project Engineer, Steffen, Robertson and Kirsten, Lakewood, Colorado

Joe Pope, Archeologist, State Water Resources Control Board, Sacramento

Plumas County Planning Department, Quincy

Office of Historic Preservation, via Joe Pope, Sacramento

WAC:gs

ENVIRONMENTAL CHECKLIST FORM

(To Be Completed By Lead Agency)

I. Background

1. Name of Proponent Regional Water Quality Control Board, Central Valley
2. Address and Phone Number of Proponent (916) 445-0270
   3201 S Street, Sacramento,CA 95816-7090
3. Date of Checklist Submitted _____
4. Agency Requiring Checklist Self
5. Name of Proposal, if applicable Water Pollution Abatement at Walker Mine

II. Environmental Impacts

(Explanations of all "yes" and "maybe" answers are required on attached sheets.)

	Yes	Maybe	No
1. Earth. Will the proposal result in:			
a. Unstable earth conditions or in changes in geologic substructures?			X
b. Disruptions, displacements, compaction or overcovering of the soil?			X
c. Change in topography or ground surface relief features?			X
d. The destruction, covering or modification of any unique geologic or physical features?			X
e. Any increase in wind or water erosion of soils, either on or off the site?			X
f. Changes in deposition or erosion of beach sands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?			X

	Yes	Maybe	No
g. Exposure of people or property to geologic hazards such as earthquakes, landslides, mudslides, ground failure, or similar hazards?			X
2. Air. Will the proposal result in:			
a. Substantial air emissions or deterioration of ambient air quality?			X
b. The creation of objectionable odors?			X
c. Alteration of air movement, moisture, or temperature, or any change in climate, either locally or regionally?			X
3. Water. Will the proposal result in:			
a. Changes in currents, or the course of direction of water movements, in either marine or fresh waters?	X		
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	X		
c. Alterations to the course or flow of flood waters?			X
d. Change in the amount of surface water in any water body?	X		
e. Discharge into surface waters, or in any alteration of surface water quality, including but not limited to temperature, dissolved oxygen or turbidity?	X		
f. Alteration of the direction or rate of flow of ground waters?	X		
g. Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?		X	
h. Substantial reduction in the amount of water otherwise available for public water supplies?			X
i. Exposure of people or property to water related hazards such as flooding or tidal waves?			X

	Yes	Maybe	No
4. Plant Life. Will the proposal result in:			
a. Change in the diversity of species, or number of any species of plants (including trees, shrubs, grass, crops, and aquatic plants)?	X		
b. Reduction of the numbers of any unique, rare or endangered species of plants?			X
c. Introduction of new species of plants into an area, or in a barrier to the normal replenishment of existing species?			X
d. Reduction in acreage of any agricultural crop?			X
5. Animal Life. Will the proposal result in:			
a. Change in the diversity of species, or numbers of any species of animals (birds, land animals including reptiles, fish and shellfish, benthic organisms or insects)?	X		
b. Reduction of the numbers of any unique, rare or endangered species of animals?			X
c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?			X
d. Deterioration to existing fish or wildlife habitat?			X
6. Noise. Will the proposal result in:			
a. Increases in existing noise levels?			X
b. Exposure of people to severe noise levels?			X
7. Light and Glare. Will the proposal produce new light or glare?			X
8. Land Use. Will the proposal result in a substantial alteration of the present or planned land use of an area?			X
9. Natural Resources. Will the proposal result in:			
a. Increase in the rate of use of any natural resources?			X

	Yes	Maybe	No
b. Substantial depletion of any nonrenewable natural resource?	___	___	X
10. Risk of Upset. Will the proposal involve:			
a. A risk of an explosion or the release of hazardous substances (including, but not limited to, oil, pesticides, chemicals or radiation) in the event of an accident or upset conditions?	___	___	X
b. Possible interference with an emergency response plan or an emergency evacuation plan?	___	___	X
11. Population. Will the proposal alter the location, distribution, density, or growth rate of the human population of an area?	___	___	X
12. Housing. Will the proposal affect existing housing, or create a demand for additional housing?	___	___	X
13. Transportation/Circulation. Will the proposal result in:			
a. Generation of substantial additional vehicular movement?	___	___	X
b. Effects on existing parking facilities, or demand for new parking?	___	___	X
c. Substantial impact upon existing transportation systems?	___	___	X
d. Alterations to present patterns of circulation or movement of people and/or goods?	___	___	X
e. Alterations to waterborne, rail or air traffic?	___	___	X
f. Increase in traffic hazards to motor vehicles, bicyclists or pedestrians?	___	___	X
14. Public Services. Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:	___	___	X
a. Fire protection?	___	___	X
b. Police protection?	___	___	X
c. Schools?	___	___	X

	Yes	Maybe	No
d. Parks or other recreational facilities?			X
e. Maintenance of public facilities, including roads?		X	X
f. Other governmental services?		X	
15. Energy. Will the proposal result in:			
a. Use of substantial amounts of fuel or energy?			X
b. Substantial increase in demand upon existing sources of energy, or require the development of new sources of energy?			X
16. Utilities. Will the proposal result in a need for new systems, or substantial alterations to the following utilities:			
a. Power or natural gas?			X
b. Communications systems?			X
c. Water?			X
d. Sewer or septic tanks?			X
e. Storm water drainage?			X
f. Solid waste and disposal?			X
17. Human Health. Will the proposal result in:			
a. Creation of any health hazard or potential health hazard (excluding mental health)?			X
b. Exposure of people to potential health hazards?			X
18. Aesthetics. Will the proposal result in the obstruction of any scenic vista or view open to the public, or will the proposal result in the creation of an aesthetically offensive site open to public view?			X
19. Recreation. Will the proposal result in an impact upon the quality or quantity of existing recreational opportunities?	X		
20. Cultural Resources.			
a. Will the proposal result in the alteration of or the destruction of a prehistoric or historic archaeological site?		X	

	Yes	Maybe	No
b. Will the proposal result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?		X	
c. Does the proposal have the potential to cause a physical change which would affect unique ethnic cultural values?			X
d. Will the proposal restrict existing religious or sacred uses within the potential impact area?			X
21. Mandatory Findings of Significance.			
a. Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?			X
b. Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals? (A short-term impact on the environment is one which occurs in a relatively brief, definitive period of time while long-term impacts will endure well into the future.)			X
c. Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect of the total of those impacts on the environment is significant.)			X
d. Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?			X

III. Discussion of Environmental Evaluation

See INITIAL STUDY

IV. Determination
(To be completed by the Lead Agency)

On the basis of this initial evaluation:

I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared. [ ]

I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because the mitigation measures described on an attached sheet have been added to the project. A NEGATIVE DECLARATION WILL BE PREPARED. [X]

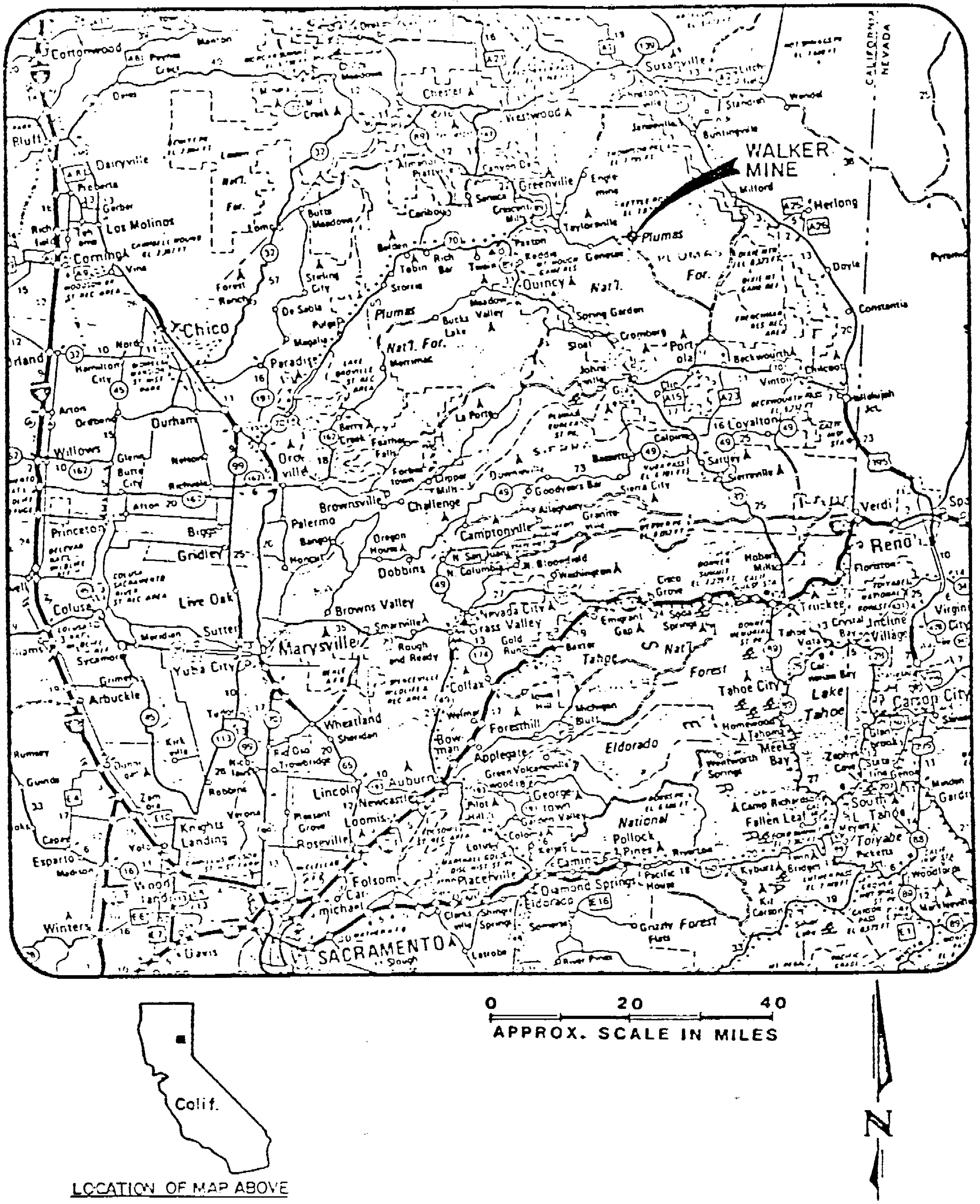
I find the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required. [ ]

12/27/85
Date

William C. Cox
Signature

For _____

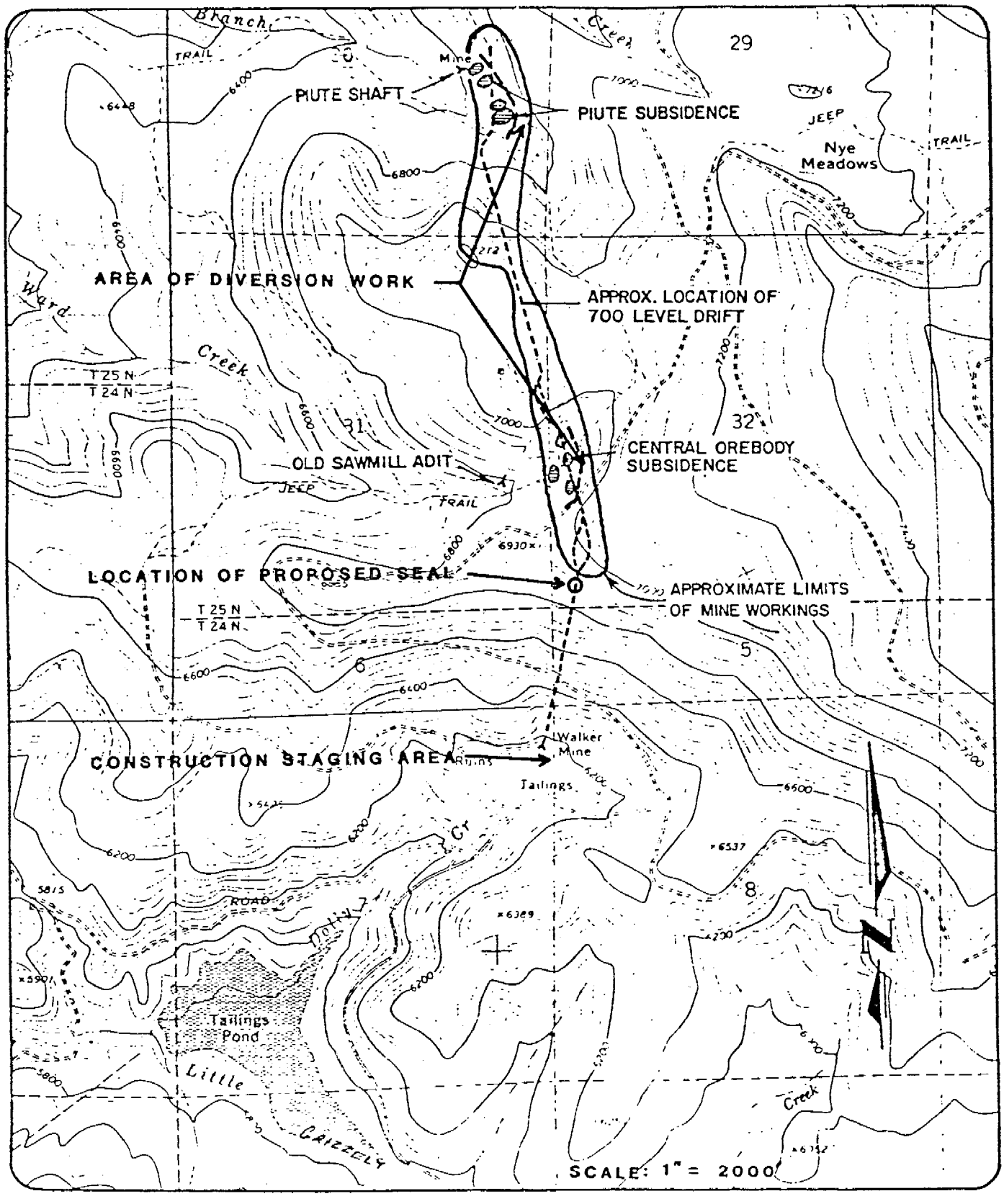
001008



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	General location map Northern California
DATE 3/85		
REVISION NO. 0		FIGURE 1

4-23

001009



PROJECT NO. 06901	PREPARED BY: STEFFEN ROBERTSON & KIRSTEN Consulting Engineers	WALKER MINE, PLUMAS COUNTY
DATE 3/85		Section 7, T24N, R12E MDB&M
REVISION NO 0	4-24	Mt. Ingalls, CA USGS 7.5 Quad.
		FIGURE 2

COMMENTS AND RESPONSES TO COMMENTS

REGARDING THE NEGATIVE DECLARATION

Comments Were Received During The

January 2 through January 31 1986 Review Period

001011

STATE OF CALIFORNIA GEORGE DEUKMEJIAN, *Governor*

NATIVE AMERICAN HERITAGE COMMISSION
915 Capitol Mall, Room 288
Sacramento, California 95814

(916) 322-7791

January 21, 1986

William A. Croyle
Regional Water Quality Control Board
3201 S. Street
Sacramento, CA 95816

Re: Water Pollution Abatement at Walker Mine
SCH# 85123111

The Native American Heritage Commission appreciates the opportunity to express its concerns and comments in the environmental review process. As you may know, the Commission is mandated to preserve and protect places of special religious or cultural significance to Native Americans pursuant to Section 5097 et seq of the Public Resources Code.

The Commission has the further responsibility of assisting Native Americans in cemetery and burial protection pursuant to Section 5097.94(k) of the Public Resources Code. Should human remains of Native American origin be encountered during the project, we request that the County Coroner's Office be contacted pursuant to the procedures set forth in Section 7050.5 of the Health and Safety Code.

In order to mitigate potential impacts to California Indian ancestral burials and other cultural resources during the course of this project, we request that you consult with Indian individuals and/or groups in the project area.

Please do not hesitate to contact the Commission for any assistance relative to the above.

Very truly yours,

John Darwin Smith
Executive Assistant

4-26

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JAN 23 10 14 AM '86

State of California

THE RESOURCES AGENCY OF CALIFORNIA

001312

Memorandum

To: Dr. Gordon F. Snow
Assistant Secretary for Resources

Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, CA 95816

Date : January 27, 1986

Subject: Acid Mine Drainage Abatement - Walker Mine - Plumas County (#85123111) (Negative Declaration)

From : **Department of Conservation—Division of Administration**

In response to your request, the California Department of Conservation's Division of Mines and Geology has reviewed the documents submitted for the Acid Mine Drainage Abatement - Walker Mine - Plumas County (#85123111) (Negative Declaration). A site visit was not conducted.

The following advisory comments were completed on January 17, 1986 and are offered to the Water Quality Control Board in its role as a lead agency:

1) The proposed project is well designed and should improve water quality in Dolly Creek and Grizzly Creek.

2) We recommend that further mine reclamation be accomplished as a result of this project: revegetation associated with the "rehabilitation of surface diversion structures" could greatly enhance the total project.

We would very much appreciate it if you could send a copy of the "Feasibility and Design Report" from "Steffen, Robertson and Kirsten" (SRK) for the Division of Mines and Geology reclamation program files; it would serve as a reference report for other acid mine drainage problems. These files are open to the public and maintained as required by the Surface Mining and Reclamation Act. Please send the report to Paul Marshall (Senior Mining Engineer - Mine Reclamation Program Manager).

If you have any questions, please phone Paul Marshall, Division of Mines and Geology, Reclamation Program Manager, at (916) 323-8565.

Dennis J. O'Bryant
Environmental Program Coordinator

cc: Rudy Strand
Paul Marshall

RECEIVED
JAN 29 1986
State Clearinghouse

4-27

Responses to Comments by the Native American Heritage Commission

Paragraph No. 1 and 2

These comments are informational and are acknowledged.

Paragraph No. 3

Staff has contacted the Commission for assistance in consulting with Indian individuals and/or groups in the project area. Most of the project work will be underground in the mine adit, where no impacts to California Indian ancestral burials could occur.

Responses to comments by the California Department of Conservation's Division of Mines and Geology

Comment No. 1

Comment is acknowledged.

Comment No. 2

Revegetation of surface diversion structions will be considered during preparation of the construction contract.

CMM

001014

CONDOR MINERALS MANAGEMENT INC.

2141 Mono Way
P.O. Box 3905
Sonora,
California, 95370
(209) 532-0361

January 30, 1986

Mr. William Marshall
Senior Water Resource Control Engineer
California Regional Water Quality Control Board
Central Valley Region
3201 S Street
Sacramento, CA 95816

Dear Mr. Marshall,

Attached you will find comments drafted in response to the Initial Environmental Assessment on the Board's Walker Mine Project, Plumas County, California. Please add them to the record.

If you have any questions or need any clarification, please feel free to call me at the number captioned above.

Very Truly Yours,

Peter H. Dohms

Peter H. Dohms
Registered Geologist
California No. 3829

PHD:sp

cc:State Clearinghouse
R. Barry
file
XX:Initial.Wal

4-29

(Comments by Mr. Peter Dohms; Regional Board responses indicated by **)

COMMENTARY
on the
INITIAL STUDY
for
WALKER MINE, PLUMAS COUNTY

INTRODUCTION

This document is a commentary on the Initial Study prepared by the California Regional Water Quality Control Board, Central Valley Region (the Board) concerning their proposal to install a permanent seal in the main access tunnel of the Walker Mine to block discharge of water from the mine. The first section of this commentary is an item by item response to the Environmental Checklist Form. The next section comments on the Initial Study and the final section summarizes the first two and recommends additional environmental review.

COMMENTS ON ENVIRONMENTAL CHECKLIST

The following comments are keyed to the Environmental Checklist Form prepared by the Lead Agency (the Board). They are in order.

Section II. Environmental Impacts

Item 1.a. - We suggest that the question be answered "maybe" instead of "no" for the following reasons: 1) Filling the mine with water will saturate a significant volume of earth that is not now saturated. Saturated earth in mountainous terrain is inherently less stable than is unsaturated earth. 2) Filling the mine with water will relieve some of the lithostatic load through hydrostatic buoyancy.

** Response - After the seal is put in place, the ground water system will be returned to its pre-mine condition. Since the Walker Mine area does not show evidence of landslides or unstable geologic formations prior to mining, we cannot see how a return to the pre-mine condition can cause unstable earth conditions.

Item 1.c. - The answer should be "yes"; cutting new trenches and rehabilitating existing trenches will both change the topography and ground surface relief features.

** Response - A large portion of the proposed diversion work will be the rehabilitation of existing trenches. Topography and ground surface relief features have been significantly altered by past mining and timber operations The surface diversion work does not represent a significant change in the area topography.

Item 1.e. - The answer should be changed to "maybe" from "no". It was noted in the March, 1983 report by Pearson and Associates (Regional Board Project 1-043-150-0) that rehabilitation of diversion trenches was reponsible for significant amounts of accelerated erosion (Page 1 & Figure 3)."

** Response - Diversion trenches (swales) were constructed on the Middle and South branches of Ward Creek. Erosion occurred only in one section of one of these ditches. It is this erosion which the proposed project will correct.

Item 1.g. - The answer should be changed from "no" to "maybe" for the reasons cited in Item 1.a. above.

** Response - Refer to responses to Item 1.a.

Item 3.c. - We believe that the answer should be changed from "no" to "yes". Construction and rehabilitation of the diversion works, particularly those in the South Branch of Ward Creek, will alter the course of flood waters.

** Response - The diversion ditches intercept sheet flow runoff and channel it away from the subsidence areas. No flood water "type" flows are associated with this area. Ward Creek will be unaffected by the proposed diversion work.

Item 3.e. - It is our understanding that the Board's answer of "yes" is based on their assumption that discharge from the mine would cease with construction of the plug. Unfortunately, discharge of acidic, metal laden water from the tailings pond located at the confluence of Dolly and Little Grizzly Creeks would continue. Thus, we suggest that the answer be changed to "maybe".

** Response - Any reduction in heavy metal discharge from Walker Mine will improve the existing polluted condition of downstream waters. Any discharge of metal from the USFS tailings area is a separate project. During a previous period when the Walker Mine adit was blocked, the Department of Fish and Game planted fish in Little Grizzly Creek. These fish survived until a discharge from the Walker Mine was reestablished by the mine owner. This would suggest that the USFS tailings do not contribute enough heavy metal-laden water to Dolly and Little Grizzly Creek to kill fish.

Item 3.g. - This item touches on a point which we consider to be a significant adverse impact which will result from implementation of the project, as proposed. On page 4 of the Initial Study, it is stated, "The proposed project will result in a change in the rate of flow of groundwater, but not result in a change in useable ground water quality." The answer to the question should, therefore, be "yes". In addition, we believe that implementation of the project will cause significant degradation of ground water quality. Further discussion of this point is made later in this commentary.

** Response - See later discussion under Response to Comment 3.

Item 5.a. - We suggest that the answer should be changed from "yes" to "maybe". It is our understanding that the Board's answer of "yes" is based on the belief that stopping discharge of water from the mine will allow restoration of aquatic life in Little Grizzly Creek. Until and unless discharge of acid and metal laden water from the old tailings pond at the confluence of Dolly and Little Grizzly Creek stops, that restoration will be impossible.

** Response - Refer to response for Item 3.e.

Item 8. - The answer should be changed from "no" to "yes". A planned land use, mining, will be foreclosed by implementation of the project, as proposed.

** Response - Mining will not be foreclosed by this project. The mine owner has indicated that plans are in the works for an open pit operation. The mine owner's consultant has stated that further exploration must be done and the price of copper and gold must increase before a mining operation can be planned. The proposed project has incorporated a means by which the mine can be dewatered. Should mining become feasible, valves that will be installed in the seal could be opened, allowing mine water to drain. The water draining from the mine would require treatment before being discharged to surface waters. Mine dewatering is frequently required before opening old mines in this mining region.

Item 9.b. - The answer should be changed from "no" to "yes". Implementation of the project, as proposed, will result in the direct loss of 3.5 million tons of measured mineral reserves which contain some 105 million pounds of copper, 2.5 million ounces of silver and 0.1 million ounces of gold. Loss of other reserves, which are less well defined at this time, could also be significant.

** Response - The mineral reserves will remain in the ground and will not be lost as a result of the mine seal. Once dewatering operations have been completed, the mine adit may be opened. The pollution of Little Grizzly Creek and Dolly Creek for over 40 years is not justified by the mine owner's desire to have easy access to a mineral resource which cannot currently be economically removed from the mine.

Item 10.a. - We believe the answer should be changed from "no" to "maybe". As discussed in detail in a later section of this document, if the Board is wrong in its belief that all discharge from the Walker Mine would permanently cease with implementation of the project as proposed, then there will be discharge of mine water to the Ward Creek watershed. That water will carry higher contents of acid and heavy metals than is now discharging into Dolly Creek.

** Response - SRK'S addendum report, dated January, 1986, specifically addresses the possibility of discharge to Ward Creek. The report concludes that it is highly unlikely that copper rich water could flow from a plugged mine to Ward Creek from the Piute shaft.

Item 19. - We believe that the Board's response of "yes" is based on the belief that implementation of the project as proposed will allow restoration of the sport fishery in Little Grizzly Creek below Dolly Creek. Until discharge of acid and metal laden water from the tailings impoundment located at the confluence of those two creeks ceases, restoration of the sport fishery will be impossible. The answer should be changed to "maybe" or "no".

** Response - Refer to response for Item 3.e.

Item 21.a. - In evaluating the Board's response to this question, the key word is "potential". Based on the reasons itemized above in Item 10.a. and later in this commentary, there is a potential for significant spilling of acid and metal laden water to the Ward Creek watershed if the project is implemented. The answer should be changed from "no" to "yes".

** Response - See response below.

Item 21.b. - As above, the key word is potential". As previously discussed and expanded later in this commentary, we believe that emplacement of a seal in the mine is a temporary expediency which will result in a significant long term threat to surface water quality in the Ward Creek watershed as well as long term degradation of groundwater quality. The answer should be changed from "no" to "yes".

** Response - see response below.

Item 21.d. - Due to the uncertainties identified above, the answer should be changed from "no" to "maybe".

** Response - Based on the SRK reports, we believe that there is not a potential to substantially reduce the habitat of fish species in Ward Creek. Any threat of discharge to Ward Creek from the Piute shaft may be eliminated by opening the valves in the seal and returning the mine to its pre-seal condition.

Mr. Dohms fails to show how any seal effects could be long term. He also fails to consider the possibility that the valves in the mine seal could be opened to prevent a discharge to Ward Creek.

Section IV. Determination

On the last page of the checklist, we believe that the wrong finding was checked. Based on the discussion above, we believe the third finding should be marked and that preparation of an Environmental Impact Report is necessary.

** Response - We believe the comments made by Mr. Dohms on the environmental checklist have been considered in the Initial Study and project evaluation. Because of these considerations and findings, we believe the finding is appropriate.

COMMENTARY ON INITIAL STUDY

Much of the basis of the Initial Study is included in the Final Feasibility and Design Report which was prepared by Steffen, Robertson and Kirsten (SRK). A detailed response to both that report and a supplemental report prepared by SRK is in preparation and will be submitted to the Board at an appropriate time. This commentary will be limited to points raised in the Initial Study.

Comment 1 - On page 2 of the Initial Study, it is stated, "When mineral processing stopped, the neutralizing effect of the water discharged from the plant was lost and the acid mine drainage water flowing from the main Access Adit Portal on the 700 level began to affect Dolly Creek and Little Grizzly Creek". It is the historic record of this and other copper mines in California that acid mine drainage is not a problem while a mine is in operation. The owner of the Walker Mine has made repeated attempts to have the mine activated in recent years. Those attempts are continuing and, with the cooperation of the Board, the mine drainage problem can be alleviated without resorting to the drastic measure of permanently sealing the mine.

** Response - The Walker Mine owner has not made any serious attempts to reopen the mine. No serious proposals to stop the acid mine discharge have been made. Previous attempts by the owner to lessen the metal discharge are not now in operation. The mine owner has presented many ideas, but has not shown the financial capability to implement these proposals. Mr. Dohms infers that the Board needs to cooperate with Mr. Barry. The Board has been cooperative. For many years, the Board has encouraged Mr. Barry to install his own pollution abatement program so that Board involvement would be unnecessary. The Board's consultants have designed the seal in such a manner that the mine can be dewatered and the seal removed.

Comment 2 - Under the heading "Description of the Project" on page 2, the first sentence reads, "A recent feasibility study has shown that using a mine seal is the most cost-effective way of preventing acid mine drainage from discharging to surface...watercourses". The feasibility study in question is not identified. If the author of the Initial Study is referring to the SRK report, it should be noted that a comparative cost analysis of both the proposed mine seal and alternative methods of handling mine drainage was NOT a part of that study. The only comparative cost analysis of which we are aware is that performed in 1979 by D'Appalonia. That analysis was based on conceptual designs of both a mine seal and a treatment plant. The cost numbers therein are long since outdated.

** Response - While the cost numbers of the D'Appalonia report are outdated, they do show relative costs of different projects. The D'Appalonia report did not eliminate the mine seal on the basis of cost, but on the basis of the mine owner's desire to reopen the mine. However, the mine owner is no closer to reopening the mine today then when the D'Appalonia report was written.

Comment 3 - On page 3, under the heading "Water", it is stated, "In doing so, the direction of water movement in the mine will be directed to deep ground water recharge...". On page 4, it is further stated, "The proposed project will result in a change in the rate of flow of ground water, but not result in a change in useable ground water quality." This comment is directed at both of those statements.

A number of thoughts come to mind. The Board seems to be proposing to accelerate the amount of acid, metal laden water that will discharge to ground water. It may be assumed that a greater flow of this water will degrade the ground water to a certain extent. That ground water is presumably protected by the Porter-Cologne Act.

Secondly, it is entirely possible that ground water discharged in this fashion will carry higher levels of acid and metal than at present. It is apparent from study of in-mine flows that water quality degrades with time. The SRK flow model, upon which the above cited Board beliefs are based, requires that discharge to ground water would only occur after the water had the maximum amount of time to collect acid and metal. Other flaws in that flow model are discussed later in this section.

** Response - Based on both Board staff and SRK's independent works, it can be shown that the faster water moves through the mine, the greater the amount of heavy metals which will enter those waters. It is not apparent that water quality degrades with time. During the flow periods when water moves more slowly through the mine, the heavy metal concentrations are lower than in the spring when high flows move rapidly through the mine. An inundation of the mine will deprive the ore deposits of the current readily available air supply which aids in oxidation of the ores.

Sealing the mine will return the hydrologic system closer to a pre-mine state. Porter-Cologne provides for protection of beneficial uses. However, it is unlikely that anyone would want to drill through the mine's ore body in an attempt to find a fresh water supply. However, the cleanup of Little Grizzly Creek would supply immeidate recreational, aesthetic and water supply benefits to downstream residents. The Regional Board has received many letters from members of the Genessee Woods Recreation Association and others, indicating their desire to see Little Grizzly Creek cleaned up. However, we know of no one who would desire to use ground water from beneath the Walker Mine ore deposits.

Comment 4 - On page 4 of the Initial Study, it is stated, "By eliminating the mine's discharge, Dolly Creek will contain only natural spring water, snowmelt and/or precipitation". That is incorrect; over the years, Dolly Creek has collected a heavy load of metal, much of which will remain in the bed of the stream. Copper staining is visible on the rocks; particulate copper-bearing minerals are undoubtedly present in the streambed and banks. Release of that metal will continue for years.

** Response - Release of heavy metals from Dolly Creek's streambed depends on pH. These metals were deposited when the pH of discharging acid mine waters was low. Elimination of acid mine discharge will increase the pH. A lower pH would be required to dissolve these precipitated metals.

Comment 5 - On page 4 of the Initial Study, it is stated, "They (SRK) suggest that there is conservatively twice as much ground water recharge deep within the mine as flow from the mine. By raising the water head behind the seal, ground water recharge will increase. Ground water recharge will prevent a surface discharge from other adits." Our model of the hydrogeology of the Walker Mine, which will be presented to the Board when they consider implementing the project, does not agree with these statements. The remainder of this comment will summarize our findings as they relate to the above cited statements quoted from the Initial Study.

First off, SRK is apparently misquoted. On page 60 of the SRK report, it is stated, "...of about 560 gpm flowing into workings above the 700 Level (during the visit of June 19, 1985), less than 300 gpm were being discharged through the main 700 Level Adit. The balance is presumed to return as recharge to the ground water system." In other words, ground water recharge on that day was about equal to mine discharge, not twice as much. Spring time flows cause substantially more discharge from the mine than any possible ground water recharge.

Raising the water head behind the seal would cause some minor increase in ground water recharge, but that recharge would not be as dramatically increased as SRK and the Board believe. To summarize the hydrogeologic model we have developed, the following points are noted:

- Existing head at the bottom of the mine is on the order of 500 feet, the vertical difference between the top of standing water in workings below the 700 Level and the bottom of the mine.

- Vertical distance from standing water to the nearest known outlet above the 700 Level (which is the Piute Shaft Landing Tunnel, at 6585 feet elevation) is less than 400 feet. A degree of uncertainty exists whether or not there are other mine outlets at lower elevations than this elevation.

- Discharge is specified by SRK to be preferentially directed downward into the mineralized zone. Permeability in that direction is estimated at between 1 x $10E^{-4}$ cm/sec and 1 x $10E^{-5}$ cm/sec. We agree with SRK's estimates.

- Area of discharge is specified by SRK to be 6000 ft. x 40 ft., or 240,000 square feet.

Performing the necessary calculations, based on Darcy's Law, yields the result that the 400 foot increase in head to the elevation of the Piute Shaft Landing Adit (if that is, indeed, the next lowest outlet of the mine) is inadequate to increase the ground water recharge sufficiently to prevent the rising level of water from spilling out that adit. Our calculations indicate that, given normal precipitation patterns, mineralized water could begin spilling in as little as four years. Once spilling from upper workings begins, flow out the upper adit will instantly equal surface flow into the mine. Since most of the surface flow enters the glory holes above the Central Ore Body, it is certain that spill from the Piute Shaft Landing Adit will be highly mineralized, due to flow path length. It should be mentioned that such a spill would direct mineralized water into the Ward Creek watershed. Ward Creek is, to date, unaffected by mine discharge. Due to its smaller watershed, it can also be presumed to be more sensitive to adverse impact from such drainage.

** Response - Mr. Dohms' flow model, which is discussed above, has not been submitted for review and comment. This should have been submitted during the comment period. If Mr. Dohms is correct, this would reduce the threat to any underlying ground water. Also, in the event Mr. Dohms is correct and a spill is imminent, valves in the seal could be opened to prevent a spill from the Piute shaft. Mr. Dohms indicates that it would be at least four years before a spill could occur. This would give ample warning and enable the valves to be opened.

The "Surface Water Survey" is a major part of the proposed project. This survey is designed to provide baseline data before and after the seal is constructed and to provide a monitoring program for the seal. It is this program which will provide the early warning needed to protect uncontaminated surface waters.

Comment 6 - On page 4 of the Initial Study, it is stated, "Flooding the mine will also have the following water quality benefits:

1. Reduce oxidation of the ore body.

2. Allow the natural attenuation process to treat the low pH and heavy metal in the earth-ground water system."

We disagree with both of these statements. With respect to oxidation of the ore body, it is apparent that oxidation continues while the water moves through the lower workings from the Central Ore Body to its discharge back onto the 700 Level at the south end of the South Ore Body. This is easy to understand since the water entering the mine becomes saturated with oxygen as it cascades downward into the workings.

With respect to "natural attenuation", the Board has resisted such a mechanism when proposed by the industrial dischargers in California for their waste discharge requirements.

** Response

Water moving through the lower ore body can carry oxygen with it. Water entering the ore body may continuously carry new oxygen to the ore body. After the seal is in place, flows in the mine will slow to almost static conditions. This will greatly reduce the amount of new waterborne oxygen reaching the ore body.

The Regional Board has allowed Mr. Barry to use the natural attenuation process. The Walker Mine's NPDES permit contains receiving water limits for heavy metals. By allowing the use of receiving water limits instead of effluent limits, the Regional Board has showed its acceptance of natural attenuation processes.

Comment 7 - On page 4 of the Initial Study, it is stated,"The purpose of the mine seal is to stop the discharge of acid and heavy metal-laden water to Dolly Creek and Little Grizzly Creek. By eliminating the toxic barrier caused by the discharge, plant and animal populations would be able to reestablish themselves in the affected area. Thus, the seal will beneficially impact these organisms." In addition, on page 5, it is stated, "Recreation will be enhanced by the removal of acid mine drainage from Little Grizzly Creek and the reestablishment of a fishery".

These statements are, at best, only partially true. For instance, in the Pearson and Associates' report on Pilot Plant Treatment of Mine Drainage from the Walker Mine, it is noted on page 117 that a signifcant load of metal is added to the creeks from the mine tailings, which are located downstream of the 700 Level portal. In addition, recent work by Board staff suggests that

Dolly Creek, as it crosses the mill tailings at the confluence of Grizzly and Dolly Creeks, picks up additional metal and acid. It is apparent that, until the discharge from the tailings are remedied, beneficial impacts to plant and animal populations and recreational uses will not occur.

** Response - On a mass loading basis, the main Walker Mine adit contributes at least 85% of the heavy metal discharged to Dolly Creek and Little Grizzly Creek. The remaining 15%, or less, coming from the tailings may, in fact, be due to the subsurface flow from the upper portions of Dolly Creek. The heavy metal concentration in upper Dolly Creek is a direct result of the discharge from the main Walker Mine adit. The tailings on USFS property are currently being studied by Regional Board staff. Preliminary results suggest that a very small amount of heavy metal in Little Grizzly Creek originates in the USFS tailings.

In 1961, the Department of Fish and Game (DFG) planted 1,000 catchable trout in Little Grizzly Creek. This was during a time when the main adit was blocked due to a collapse near the entrance. During this period of Walker Mine's history, water would back up in the mine until water levels rose to the elevation of a ventilator shaft not far from the adit opening. Mine waters would overflow from the ventilator shaft late in the spring as a result of snowmelt and high inflow to the mine. During the summer of 1961, the mine did not spill and DFG decided to plant trout. Fishermen reported good success through the end of the fishing season. On 29 May 1962, five healthy trout were observed in Little Grizzly Creek, indicating an overwinter survival of catchable trout. This indicates the USFS tailings may not contribute enough heavy metals to be toxic to fish. There is also no evidence the USFS tailings lower the pH of Little Grizzly Creek. The tailings are covered by separate waste discharge requirements. Staff is currently proposing limits on the heavy metal discharge from the tailings.

Comment 8 - On page 5 of the Initial Study, it is stated, "Should there be a threatened discharge in any watershed, the contingency plan will provide the mine owner and/or Regional Board staff with the available options. One option would be to open valves in the seal and to return the hydrologic system to its pre-seal condition.

Examination of the contingency plan, as outlined in the SRK report, reveals one serious deficiency. No provision is made for maintenance of the 700 Level Portal and the first 1,300 feet of the tunnel. Examination of this portion of the 700 Level indicates that it is driven in "heavy" ground and the supporting timbers require constant care and maintenance. With the seal in place, there will be no incentive for the mine owner to perform this maintenance (what would be the point?). It is likely that the tunnel would collapse in a few years and access to the seal would be lost.

In addition, even if the seal were accessible and the valves could be opened, it is likely that the water that would be discharged after several years residence in the mine would carry considerably more mineralization than present. Simply opening the valves would not "return the hydrologic system to its pre-seal condition", it would create a condition worse than exists today.

This completes the comments regarding the Initial Study.

** Response - It is the Board's understanding that Mr. Barry remains committed to reopening the mine. If this is true, Mr. Barry should continue to maintain the main access tunnel. If Mr. Barry decides to abandon his efforts to reopen the mine, then the Board must make provision to maintain the access. Responsibility for maintenance of the entry tunnel would also be a subject of that litigation unless Mr. Barry abandons the mine property.

Mr. Dohms' comment in regard to possible degradation of Dolly and Little Grizzly Creeks, through release of more highly mineralized water, does not recognized the ability of the mine seal to release water during the springtime when large dilution flows exist nor does it recognize the possibility of treating this regulated discharge. Part of the proposed project includes the development of plans and specifications for treating the mine discharge.

SUMMARY AND RECOMMENDATIONS - The following points summarize our commentary:

1. Placement of a seal in the 700 Level access Tunnel of the Walker Mine has little chance of ending the discharge of acid and metal-laden water to Dolly and Little Grizzly Creek. The benefits of the proposed project are, thus, overstated.

2. Placement of the seal will have the following effects on the hydrogeologic system within the mine:

   - Water will rise behind the seal; it clearly has the potential to rise high enough to spill out of higher mine workings into a heretofore uncontaminated watershed.

   - The increase in hydraulic head as water builds up behind the seal will accelerate the discharge of mineralized mine water to the ground water system

3. Adverse impacts will occur to nonrenewable resouces if the project is implemented as proposed.

4. The project has the potential to achieve short-term, to the disadvantage of long-term, environmental goals. Based on the points cited above, the project could best be categorized as a temporary expediency which will result in an eventual worsening of the Walker Mine situation.

Each of these is judged to be a significant, adverse impact. The mitigations proposed in the Project Description are believed to be inadequate to prevent these impacts or to mitigate them to nonsignificant levels.

It is apparent that the Initial Study falls short of the CEQA goal of "Full Disclosure" of anticipated and potential environmental impacts. In addition to the points cited above, the Initial Study fails to address any alternatives to the proposed action. More investigation is clearly necessary. An Environmental Impact Report is recommended to fully explore the proposed project.

In addition, the Board should order staff to consider alternative remedies to the Walker Mine problem. The environmental consequences of these alterntives should similarly be studied and the superior remedy then can be identified.

** Response

The response to Mr. Dohms' summary and recommendations are contained in the CEQA section of the staff report.

001027

LETTERS AND NAMES OF PERSONS WHO HAVE

RESPONDED TO THE WALKER MINE

HEARING NOTICE

United States Department of Agriculture
Forest Service
Plumas National Forest
159 Lawrence Street
P.O. Box 1500
Quincy, CA 95971

001528

Reply to: 2540

Date: November 22, 1985

California Regional Water Quality Control Board
Central Valley Region
ATTN: Bill Croyle
3201 S. Street
Sacramento, CA 95816-7090

Dear Mr. Croyle:

This letter is a position statement by the USDA, Forest Service, Plumas National Forest, in the matter of the "Staff Report" and proposed Central Valley Region's "Resolution" for cleanup and abatement of pollution from Walker Mine, Plumas County. We request this position statement be entered into the record for the public hearing to be held December 6, 1985, in Fresno, California.

The public lands administered by the Plumas National Forest include the lower reach of Dolly Creek and Little Grizzly Creek, to near its confluence with Indian Creek. The management of the natural resources provided by Little Grizzly Creek, primarily good water quality, the fishery habitat, and the beneficial uses of those resources, requires water free of toxic substances. The Forest Service feels strongly that the degradation of these public waters and associated resources cannot be allowed to continue. We have reviewed the Water Quality Control Board's staff report and proposed resolution to abate this pollution source. We strongly urge the Board to accept the staff report and adopt the proposed resolution to seal the mine, rehabilitate the diversion channels, and prepare the contingency plan as stated on page 2 of the resolution.

The Forest Service commends your staff for the efforts expended to date to resolve this problem. We look forward to continued cooperation in solving this pollution problem.

Sincerely,

Rodney K Sallee
for LLOYD R. BRITTON
Forest Supervisor

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4-43

001329

RESOLUTION NO. 85-3950-A

WHEREAS, Walker Mine is an inoperative copper mine located in Plumas County; and

WHEREAS, drainage from Walker Mine properties has damaged, and continues to periodically damage, aquatic life in Little Grizzly Creek; and

WHEREAS, outdoor recreation is of major economic importance to Plumas County, and Little Grizzly Creek recreational values are necessary and essential to the full development of Plumas County; and

WHEREAS, the waters of Little Grizzly Creek enter Indian Creek and eventually the East Branch North Fork Feather River; and

WHEREAS, these waters are used for domestic supply, irrigation, stock watering, light industry, power generation, and mining; and

WHEREAS, pollution from the Walker Mine properties is a potential threat to public health and to recreational and economic uses of certain waters; and

WHEREAS, the State Department of Health Services, Toxic Substances Control Division, has ranked Walker Mine among the most hazardous waste sites in California; and

WHEREAS, the California Regional Water Quality Control Board, Central Valley Region, has issued waste discharge requirements on several occasions, the most recent being NPDES Order No. 85-033; and

WHEREAS, the owner of Walker Mine, Robert L. Barry, has not complied with Board Orders and has continued to permit the conditions to exist,

NOW, THEREFORE, BE IT RESOLVED by the Board of Supervisors of the County of Plumas that this Board supports the efforts of the California Regional Water Quality Control Board, Central Valley Region, in seeking a solution to the pollution problems at Walker Mine; and

BE IT FURTHER RESOLVED that the Plumas County Board of Supervisors urges the Executive Officer, California Regional Water Quality Control Board, Central Valley Region, to take whatever steps necessary to seal the mine and cause the polluting conditions to be corrected.

The foregoing resolution was duly passed and adopted by the Board of Supervisors of the County of Plumas, State of California, at a regular meeting of said Board held on the 17th day of December, 1985, by the following vote:

AYES: Supervisors: Schramel, Glines, Gossett and Ross

NOES: Supervisors: None

ABSENT: Supervisors: Coates

ATTEST:

County Clerk and ex-officio Clerk
of said Board of Supervisors

4-44

Albert O. Glines

Vice-Chairman, Board of Supervisors

COMMUNITY CONCERN

The following persons have submitted letters of support for the issuance of a Resolution directing the Executive Officer to seal the adit of Walker Mine and cleanup Dolly and Little Grizzly Creek.

Plumas County Board of Supervisors	-	Quincy
Lloyd R. Britton, Forest Supervisor	-	Quincy
Kenneth L. Dotson	-	Sacramento
Jeff Stone	-	Twain
David Schaffer, President of Red Clover Creek Recreation Assn.	-	Quincy
Michaek and Sally Yost	-	Taylorsville
John T. Getz	-	Los angeles
Jerome M. Page	-	Taylorsville
Mr. Jean C. Musick	-	Taylorsville
Paul and Wagda Welber	-	Taylorsville
Jeff Ellermeyer	-	Quincy
Robert and Lou Boschee	-	Taylorsville
Linda Koehne	-	Quincy
Helmut H. Riemer	-	Stockton
Richard L. and Nancy L. Matthie	-	Taylorsville
Ford and Barbara Lewis	-	Sacramento
Salvatore and Nancy H. Catalano	-	Woodland Hills
Elisa Adler, for Friends of Plumas Wildneress	-	Quincy
Diane McCombs	-	Taylorsville
Patricia F. Coyler	-	Sacramento
Ralph W. Koehne, CA. Registered Civil Engineer	-	Quincy
Barbara Bosworth	-	Taylorsville
Dana Fenimore	-	Taylorsville
Robert M. Boardman	-	Salem, Oregon
Christopher D. Stanton, M.D.	-	Portola
Philip Hyde	-	Taylorsville
Bruce Livingston	-	Crescent Hills

The following person has submitted a letter of concern regarding the proposed pollution abatement project and the Ward Creek watershed.

Edwin L. McDowell	-	Taylorsville

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

RESOLUTION NO.

NEGATIVE DECLARATION FOR
WATER POLLUTION ABATEMENT AT
WALKER MINE, PLUMAS COUNTY

WHEREAS, the California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that a condition of pollution exists which has resulted from a nonoperating copper mine owned by Robert R. Barry, Calicopia Corporation and leased by Standard Bullion Corporation, Inc. (hereafter Discharger). The mine is in central Plumas County, about twenty miles east of Quincy, in Sections 19, 29, 30, 31, and 32, T25N, R12E, and Sections 5, 6, 7, and 8, T24N, R12E, MDB&M, and situated within the jurisdiction of this Board; and

WHEREAS, an Initial Study has been completed for the pollution abatement project. The Board has determined that, although the proposed pollution abatement project could have a significant effect on the environment, mitigation measures have been included in the project that will avoid the effects or mitigate the effects to a point where there will be no significant effects; and

WHEREAS, there is no substantial evidence before this Board that the project as mitigated may have substantial adverse effect on the environment; and

WHEREAS, said Negative Declaration has been prepared and is attached hereto as Exhibit A; and

WHEREAS, the Board, on 28 February 1986, in Sacramento, held a public hearing and considered all evidence concerning the Negative Declaration; and

WHEREAS, the Board has considered the proposed Negative Declaration together with all comments received during the review period: Therefore, be it

RESOLVED, that said Negative Declaration be, and it is hereby approved.

I, WILLIAM H. CROOKS, Executive officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on 28 February 1986.

WILLIAM H. CROOKS, Executive Officer

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

RESOLUTION NO.

CLEANUP OF WALKER MINE
PLUMAS COUNTY

WHEREAS, the California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that a condition of pollution exists which has resulted from a nonoperating copper mine owned by Robert R. Barry, Calicopia Corporation and leased by Standard Bullion Corporation, Inc. (hereafter Discharger). The mine is in central Plumas County, about twenty miles east of Quincy, in Sections 19, 29, 30, 31, and 32, T25N, R12E, and Sections 5, 6, 7, and 8, T24N, R12E, MDB&M, and situated within the jurisdiction of this Board; and

WHEREAS, the Board, on 25 January 1985, adopted Waste Discharge Requirements Order No. 85-033 (NPDES No. CAQ080110); on 21 December 1983, adopted Order No. 83-148, Request to Abate Pollution; on 30 May 1980, adopted Order No. 80-071, Referral to the Attorney General; and Order No. 80-070, Cleanup and Abatement Order against the Discharger; and

WHEREAS, the Discharger has violated, and continues to violate, waste discharge requirements established in Order No. 85-033 and Cleanup and Abatement Order No. 80-070. No significant progress has been made by the Discharger towards reduction of the toxic acid mine drainage. The discharge flows to Dolly Creek, tributary to Little Grizzly Creek, which is tributary to Indian Creek, thence the East Branch North Fork Feather River, waters of the United States; and

WHEREAS, unless certain measures are initiated, the mine will continue to discharge acid water containing metals toxic to fish and other aquatic life; and

WHEREAS, Steffen, Robertson and Kirsten (SRK) is currently under contract to determine the feasibility of sealing the mine. The Feasibility and Design Report for the proposed mine seal has been completed; and

WHEREAS, SRK's report has shown that sealing the mine's main portal will provide the most cost-effective method of pollution abatement and provide the best protection for the surrounding surface waters and watershed; and

WHEREAS, $259,050 have been allocated from the Clean Water and Water Conservation Bond Act of 1978 for the purpose of implementing a solution to Walker Mine water quality pollution problem; and

WHEREAS, the projected total cost of the Walker Mine pollution abatement program will be $393,576; and

DRAFT

WHEREAS, due to savings in the West Stanislaus Resource Conservation District State Assistance Program Grant Project, funds are available to cover the increased cost of the Walker Mine pollution abatement program; and

WHEREAS, pursuant to Section 13305 of the California Water Code, the Board may "... request the city, county, or other public agency in which the conditions of pollution...exists to abate it." The Regional Board may give notice that a condition of pollution or nuisance "will be corrected by the...Regional Board at the property owner's expense". "The owner of the property on which the conditions exist...is liable for all reasonable costs incurred...in abating the condition." And, "...the cost for abating the condition...shall constitute a lien upon the property...upon recordation...."; and

WHEREAS, the Board made the Notice called for in the California Water Code Section 13305, on 21 December 1983; and

WHEREAS, the Board has requested Plumas County and the U. S. Forest Service abate the existing pollution. These agencies have notified the Board that they cannot abate the condition of pollution resulting from Walker Mine within a reasonable time. No other local public agency has jurisdiction in the Walker Mine area; and

WHEREAS, on 21 December 1983, the Regional Board filed a complaint in the Plumas County Superior Court for preliminary and permanent injunction and civil penalties against Robert R. Barry and Calicopia Corporation and Does I through XXX, inclusive. This matter has not been brought to trial; and

WHEREAS, an Initial Study has been completed for the pollution abatement project. It has been determined that, although the proposed project could have a significant effect on the environment, there will not be significant adverse effect in this case because the mitigation measures described in the Initial Study has been added to the project. A Negative Declaration has been prepared; and

WHEREAS, the Central Valley Regional Water Quality Control Board has approved the Negative Declaration in Resolution Number _____; and

WHEREAS the Central Valley Regional Water Quality Control Board considers the water pollution abatement proposal at Walker Mine a project; and

WHEREAS, issuance of this Resolution is in compliance with the California Environmental Quality Act and Title 14, Chapter 3, of the California Administrative Code; and

WHEREAS, on 28 February 1986, in Sacramento, after due notice of Finding No. 1 to the Discharger and all affected persons, in accordance with Section 13305, California Water Code, the Board conducted a public hearing and considered all objections and protests to the proposed correction of the condition: Therefore, be it

RESOLVED, that the Executive Officer shall take steps necessary to seal the mine in accordance with the SRK Report; and be it further

RESOLVED, that the Executive Officer is directed to request that the State Water Resources Control Board reallocate $134,466 from the West Stanislaus Resource Conservation District State Assistance Program Grant Project to cover the increased cost of the Walker Mine seal project.

I, WILLIAM H. CROOKS, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Valley Region, on _____.

_____
WILLIAM H. CROOKS, Executive Officer

DRAFT

4-49

001035

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION
3201 S STREET
SACRAMENTO, CALIFORNIA 95816

NOTICE OF PUBLIC HEARING

in the matter of
ROBERT R. BARRY, CALICOPIA CORPORATION
AND STANDARD BULLION COMPANY, INC.
WALKER MINE
PLUMAS COUNTY

The California Regional Water Quality Control Board, Central Valley Region, will hold a public hearing:

DATE: 28 February 1986

TIME: 9:00 a.m.

PLACE: Department of Food and Agriculture
1220 N Street, Room 127
Sacramento, California

to consider adoption of a Negative Declaration and a Resolution directing Board staff to proceed with plans to seal the main adit of the Walker Mine.

The Walker Mine, owned by Robert R. Barry and Calicopia Corporation, is a non-operating copper mine in Section 18, T24N, R12E, MDB&M. Existing waste discharge requirements are contained in Board Order No. 85-033 (NPDES No. CA0080110). Walker Mine has been discharging acid and heavy metals to Dolly Creek for over forty years. Steffen, Robertson and Kirsten (SKR), the Board's mining consultant, have designed a seal to stop the Walker Mine discharge. SRK has also made hydrologic surveys to estimate the effect of sealing the mine. Board staff have prepared a draft Negative Declaration and Initial Study for the mine seal project.

Persons wishing to comment on the mine seal proposal may submit comments in writing no later than 18 February 1986. Interested persons are invited to attend to express their views on the issues relating to the above pollution abatement method. Oral statements will be heard, but for the accuracy of the record, all important testimony should be submitted in writing.

The Regional Board file on the discharge from the Walker Mine may be inspected and copied at the Regional Board office, 3201 "S" Street, Sacramento, California (916) 445-0270, at any time between 8:00 a.m. and 5:00 p.m., Monday through Friday.

Jack E. Del Conte

JACK E. DEL CONTE, Supervising Engineer

1/28/86:WAC:gs

4-50

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

MONITORING AND REPORTING PROGRAM NO. 86-073

FOR
U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE, PLUMAS NATIONAL FOREST
WALKER MINE TAILINGS
PLUMAS COUNTY

Specific sample station locations shall be established under direction of the Board's staff, and a description of the stations shall be attached to this Order.

Prior to construction, plans and specifications for ground water monitoring wells shall be submitted to Board staff for review and approval.

RECEIVING WATER MONITORING

All receiving water samples shall be grab samples. Receiving water samples shall be taken from the following:

Station	Description
R-1	Dolly Creek downstream of drainage discharge from the Walker Mine and above the tailings.
R-2	Dolly Creek immediately below tailings flash board dam.
R-3	Little Grizzly Creek approximately 2000 feet above tailings.
R-4	Little Grizzly Creek approximately 50 feet above confluence with Dolly Creek.

Constituents	Units	Station	Frequency
Flow	cfs	R-1, R-2, R-3, R-4	Monthly, May to October, inclusive
Specific Conductivity	umhos/cm @25°C	R-1, R-2, R-3, R-4	Monthly, May to October, inclusive
pH	pH Units	R-1, R-2, R-3, R-4	Monthly, May to October, inclusive
Copper	mg/l	R-1, R-2, R-3, R-4	Monthly, May to October, inclusive
Zinc	mg/l	R-1, R-2, R-3, R-4	Monthly, May to October, inclusive

Constituents	Units	Station	Frequency
Suspended Solids	mg/l	R-2	Monthly, May to October, inclusive
Settleable Solids	ml/l	R-2	Monthly, May to October, inclusive

REPORTING

In reporting the monitoring data, the Discharger shall arrange the data in tabular form so that the date, the constituents, and the concentrations are readily discernible. The data shall be summarized in such a manner to illustrate clearly the compliance with waste discharge requirements.

Monthly monitoring reports shall be submitted to the Regional Board by the 15th day of the following month.

The results of any monitoring done more frequently than required at the locations specified in the Monitoring and Reporting Program shall be reported to the Board.

Upon written request of the Board, the Discharger shall submit a report to the Board by 30 January of each year. The report shall contain both tabular and graphical summaries of the monitoring data obtained during the previous year. In addition, the Discharger shall discuss the compliance record and the corrective actions taken or planned which may be needed to bring the discharge into full compliance with the waste discharge requirements.

The Discharger shall implement the above monitoring program, effective 1 June 1986.

Ordered by William H. Crooks
WILLIAM H. CROOKS, Executive Officer

28 March 1986
(Date)

Revised:2/10/86:EZC:gs

RECEIVED
BR. OF LAND MGMT.
OCT 21 7 50 AM '86
SACRAMENTO, CALIFORNIA

6. The named unpatented claims and other adjoining patented lode mining claims comprise a contiguous group of lode mining claims owned; that said work was performed for the benefit of each and all of the said mining claims in the group, as a part of a general plan of development, and tends to improve and develop each and all of said mining claims; that said expenditure was made in good faith for the purpose of developing and holding each of the described unpatented claims; and the amount expended for the benefit of each of said claims was in excess of One Hundred Dollars ($100.00).

7. On July 31, 1986, all monuments required by law to have been erected upon said claims and all notices, or copies thereof, required by law to have been posted on said claims were in place; each corner monument for each claim within the group bore or contained markings sufficient to appropriately designate the corner of the mining claim to which it pertains and the name of the claim.

8. That the name, current residence and mailing address of said claim Owners are:

Owners:

Robert R. Barry
P. O. Box Y, Thunderbird Country Club
Rancho Mirage, California 92270

Calicopia Corporation
P. O. Box Y, Thunderbird Country Club
Rancho Mirage, California 92270

Robert R Barry
Robert R. Barry

Calicopia Corp by Robert R Barry
President, Calicopia Corporation

Subscribed and sworn to before me this 20th day of October, 1986.

Betine Lee
Notary Public

Residing at: Woodside, CA

My Commission expires: 4-7-89

OFFICIAL SEAL
BETINE LEE
NOTARY PUBLIC - CALIFORNIA
SAN MATEO COUNTY
My Comm. Expires April 7, 1989

Panama No. 4

59450

BUR. OF LAND MGMT.
RECEIVED
OCT 21 7 50 AM '86
SACRAMENTO, CALIFORNIA

AFFIDAVIT OF LABOR PERFORMED AND IMPROVEMENTS MADE
FOR THE ASSESSMENT YEAR ENDED SEPTEMBER 1, 1986

STATE OF CALIFORNIA)
ss
COUNTY OF SAN MATEO)

ROBERT R. BARRY, being duly sworn, deposes and says that:

1. He resides at 155 Wildwood Way, Woodside, California 94062 and is the co-owner of Walkermine along with Calicopia Corporation of which he is President.

2. The claims are co-owned and held by the above for the valuable minerals contained herein.

3. The annual labor and improvements, required by law, have been performed and made for the benefit of said claims for the assessment year ended at 12:00 o'clock Meridian, September 1, 1986, and such work was done between September 1, 1985 and September 1, 1986.

4. Said labor and improvements, made at the direction and expense of Co-owners; dike construction above and around the main entry tunnel; underground tunnel rehabilitation; grading and leveling of a settling pond; replacement of timbers and roof in the storage area and tunnel portal; engineering studies and preparation of engineering reports on water in mine; sampling of water and chemical and metallurigal tests to determine precious metal and other mineral content; field unit testing for mineral extraction from waters eminating from the mine portal. The total costs exceeded $35,000.00.

5. The said work was performed by the following:

Jan Donato
Parkside Terrace
Portola, California 96122

Robert R. Barry and Calicopia Corporation
P. O. Box Y, Thunderbird Country Club
Rancho Mirage, California 92270

Peter H. Dohm, Geologist
Condor Mineral Management Inc.
2141 Mono Way
Sonora, California 95370

John Prochnau, Mining Geologist
127 Cheney St.
Reno, Nevada 89501

WALKER GOLD-COPPER MINE

PLUMAS COUNTY, CA

INTRODUCTION

At the request of Mr. Robert Barry available historical and technical records of his Walker gold-copper mine, Plumas County, California have been reviewed and summarized. Intent has been to describe and rank both short and long term targets for additional exploration and development. The information used has been drawn from the records in Mr. Barry's possession as well as several brief personal examinations carried out over the past several years.

SUMMARY

The Walker mine was operated semi-continuously by the Anaconda Company between 1923 and 1942 and produced 5,300,000 tons of ore grading 1.55 percent copper, 0.70 opt silver and 0.04 opt gold. The operation was closed in 1942 due to the combination of rising costs and labor shortages because of the war effort.

Mineralization at Walker occurs within a lenticular quartz zone hosted by Jurassic metasediments and metavolcanics. The zone is up to 75 feet thick and has been traced and developed along a strike length of 8000 feet and through a vertical range of about 1200 feet. The developed ore shoots remain open to depth below the existing workings and along strike to the north where they pass under Tertiary volcanics. Blocked underground reserves, as estimated by Anaconda at closure of the mine, are on the order of 1,200,000 tons at historical grades.

The Walker mine property contains a number of near and longer term exploration and development targets. The Piute zone, a low risk geologic target for one to two million tons of near-surface ore averaging 0.06 opt gold, offers best opportunity for near term development if amenable to heap leaching. Potentially enhanced gold grades in other, near-surface portions of the main Walker quartz zone, and in less explored parallel zones elsewhere on the property, offer more speculative but worthwhile exploration opportunities. Re-consideration of Walker's base metal potential, as a conventional underground mine at historical grades, a bulk tonnage open pit operation taking the main zone and flanking lower grade halo mineralization, or perhaps an in-situ leach do not appear very attractive under present economic conditions but represent longer term opportunities.

PENGAD-Bayonne, N. J.
EXHIBIT
86
11/25/89

LOCATION AND PHYSICAL SETTING

The Walker mine is located at south end of the Plumas Copper Belt some 25 miles northwest of Portola, Plumas, County, CA (Figures 1&2). Claims specifically lie within Sections 5-8 incl., T24N, R12E; Section 12, T24N, R11E; Sections 7-8, 17-20 incl., and 29-32 incl., T32N, R12E; and Sections 11-14 incl., 23-26 incl., 35-36 incl., T25N, R11E MDM.

Access is via State Route 70 two miles east from Portola and then by paved or well maintained gravel road up Grizzly Creek, by Lake Davis, about 25 miles to the property.

Terrain and physical setting are typical of the Sierra with elevations at the mine site of 6500 to 7000 feet. Property lies in a heavy snow belt and has an average operating season of mid April through early December.

PROPERTY AND OWNERSHIP

Thirty-four patented mining claims	687 acres
Mill and townsite patents	108 acres
Three hundred forty-seven unpatented claims	7169 acres
Total	7964 acres

Owned by Mr. Robert R. Barry
PO Box Y
Rancho Mirage, California 02270

MINING HISTORY

1905	Discovery.
1910	Initial development by Walker Mining Company.
1916-20	Acquired by International Smelting (Anaconda subsidiary). 700 level adit x-c driven and principal orebodies developed. 75 tpd mill constructed and minor production.
1923-42	500 tpd flotation mill constructed. Principal operating period by International Smelting. Production 5,300,000 tons grading 1.55% Cu, 0.70 opt Ag, 0.04 opt Au.

POST-MINING HISTORY

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1969-70	Noranda. Target; bulk tonnage copper-gold. Work included mapping, geochem, geophysics, 11 core holes.
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1979-81 Conoco. Targets; extensions of main zone at depth and to north under volcanics, parallel "exhalite" zones. Re-interpreted mineralization as volcanogenic. Work included surface surveys and 11 core holes.

1985 Standard Bullion Company/Century 2000. Limited assessment of gold potential of Piute Zone.

MINE DEVELOPMENT, EXISTING FACILITIES AND RECORDS

The Walker mine is developed by a 3600 foot long adit crosscut and 8000 foot haulage drift at the 700 level and an internal shaft to 1200 feet. The 700 level crosscut and drift have been re-opened and maintained in excellent shape. They are accessible by tram to the vicinity of the Central orebody and internal shaft station. Much of the remainder of the 700 level to the North, 712 and Piute orebodies is accessible on foot. The mine is flooded below the adit level. Parts of the mine above the 700 can be entered through raises and stopes from the adit level and limited surface workings. In particular, the Piute shaft and first level are open and partially accessible for examination and sampling.

? The mill was dismantled and sold years ago. However, remaining surface buldings and equipment are in good shape. All of the drill core remains neatly stored on site. Extensive historical records, including the modern exploration data of Noranda, AMAX, and Conoco, are available at Mr. Barry's Redwood City residence.

GENERAL GEOLOGY OF THE MINE PROPERTY

The Walker claims are principally underlain by a five mile long belt of Jurassic metasediments and metavolcanics overthrust by Paleozoic sediments on the west and intruded and terminated by Nevadan granite to the north and south. Tertiary volcanics cap the older rocks, including north and south extensions of the mineralized quartz zone, over most of the east half of the property (Figures 2&3).

The Jurassic units include schists that are probably derived from intermediate to felsic tuffs and agglomerates. They strike consistently north-northwesterly and dip steeply west except in the mine area where dips are reversed to the east. Conoco interpreted the quart-sulfide-magnetite zone hosting the Walker gold-copper orebodies as an exhalite unit in the volcanic assemblage and there is a good deal of evidence to support their conclusions (general geologic environment, conformability of mineralized zone to enclosing rocks, remarkable continuity along strike and down dip, quartz-sulfide-magnetite association). Although debate over whether the deposit is an epigenetic vein or synvolcanic has little impact upon assessment of the direct targets, a synvolcanic origin could suggest a more attractive longer term exploration potential for significant gold or polymetallic mineralization.

Detailed descriptions of the geologic setting at Walker, and more detailed arguments for volcanogenic origin of the mineralization, are available in numerous Conoco reports.

ORE DEPOSITS AND MINERALIZATION

The Walker gold-copper deposits are lenticular "veins" consisting of massive chalcopyrite-pyrite seams and stringers in a granular quartz gangue with locally heavy magnetite. The veins are essentially conformable with the enclosing schists, strike north-northwesterly and dip variably east. Ore shoots rake directly down dip. Where examined in the field, particularly the Piute area, footwall of the quartz zone is sharp against an unmineralized sericitic schist. Hangwall is more gradational through variably silicified and mineralized quartz-mica schist.

The main mineralized zone has an overall strike length, developed by underground workings, of 8000 feet with a little under half this length "making ore" in six distinct shoots. Developed slope length is 1200 feet. Thickness of the quartz zone itself varies up to 75 feet but overall widths of mineralized, or potentially mineralized, silicified rock are up to 200 feet.

Following is a tabulation of ore shoot dimensions taken from Anaconda's historical records.

Ore Shoot	Length (Ft)	Mineable Thickness (Ft)	Slope Length (Ft)
South	250	20	300
South Hangwall	400	6	200
Central	800	30	700
North	1200	40	700
712	200	35	600
Piute	800	60	500

These dimensions, and historical production, suggest an overall ore incidence of about 11,000 tpvf, certainly impressive for this style of mineralization.

Level of oxidation has not been determined throughout the zone but sulfides are apparent in shallow workings below Pit 3 in the Piute area (Figure 4). The effect of sulfides and oxide copper on leach characteristics of the near surface gold ore is not adequately known at this time.

A number of similar quartz zones have been identified west of the Main Walker zone in its structural footwall, and to the north where

the favorable Jurassic host rocks reappear beyond volcanic cover. These zones are poorly known and require more extensive prospecting.

GOLD EXPLORATION - SHORT TERM TARGETS

Piute Gold Zone - The Piute area is most northerly segment of the Main Walker Zone. It has been exposed at surface by trenching for a length of 600 feet and developed underground for about 1000 feet. Gold values on surface average 0.059 opt across an exposed horizontal width of 35 feet (Figure 4). Historical sample data on the first level, at a vertical depth of 105 feet, average about 0.06 opt gold across 40-50 feet if low grade footwall material is excluded (Figure 4a). The zone above this level appears to be mostly intact. Impact of historical mining at greater depth is not known although stoping records may be available in Mr. Barry's files.

These data suggest a probable surface mineable deposit of 350,000 to 450,000 tons to 100 feet. Lower grade hangwall mineralization in the .03 to .04 range can't be accurately measured on basis of present information but could significantly increase contained ounces and reduce stripping costs. The occurrence appears to be open in both strike directions. From the information at hand I believe an ultimate surface mineable deposit in the 1-2 million ton range at a grade of 0.06 opt gold is a realistic expectation at Piute.

Geologic confidence in the Piute gold zone is high. However, sulfides occur at fairly shallow depths and metallurgical characteristics are much more questionable. A 72 hour bottle roll test on oxidized ore from the shaft outcrop, crushed to -¼", yielded a 76 percent recovery with moderate reagent consumption but sulfide-rich material from workings off the No. 3 pit yielded poor recoveries and had high cyanide consumptions. More work is required to determine metallurgical characteristics of the Piute ores.

Walker Vein Zone South of Piute - The surface trace of the Walker Vein Zone is intermittently exposed for a length of 4500 feet between the Piute area on the north and the Central mine area to the south where it again passes under volcanic cover (Figures 2&3).

Surface assay data is limited to a few reconnaissance-type samples which confirm anomalous gold where expected (Figure 3). Anaconda assay plans for shallow workings on the North, South and 712 ore shoots provide more information on potential gold grades. The following data represent simple arithmetic averages of Anaconda samples.

Ore Shoot	#Assays	Est. Thick.	Strike Length	Ave. Gold
North	41	±20'	1050'	0.034
South	28	?	1450'	0.044
712	38	?	820'	0.022

These grades are certainly modest but do suggest the surface remnants of the entire zone above historical workings represent a reasonable target for more detailed work. Impact of former mining operations is not known but, if the Piute is typical, considerable surface pillars are probably intact.

The Central Zone is partially exposed in the series of pits shown on Figure 5. Vein here appears to run about 0.035 opt gold with ±3.0 opt silver. Thickness can't be determined from surface exposures.

A 72 hour bottle roll on vein material crushed to -¼" from the shaft outcrop yielded 73% and 59% recoveries respectively for gold and silver suggesting oxidized ores are probably leachable. However, depth of oxidation is not known.

Other Zones - Conoco's geological mapping of the entire Walker property defined other vein zones and iron formation both west of the Walker zone in its footwall and to the north where the Jurassic rocks are again exposed beyond volcanic cover. Apart from a few drill holes, prospecting and exploration of these zones has been very limited. They certainly represent less direct but reasonable exploration targets for precious metal or polymetallic base/precious metal mineralization.

BASE METAL EXPLORATION - LONG TERM TARGETS

Underground Copper Gold - Mineable reserves blocked out by Anaconda at mine closure in 1942 are 1,200,000 tons grading 1.55% copper, 0.70 opt silver, and 0.04 opt gold. Reserves in all categories were estimated to be 3,000,000 tons at like grades. Much of the mineable reserve is tied up in pillars and on fringes of old stopes and, after 40 years, may not be recoverable at realistic cost.

Anaconda's closure of the mine in 1942 reflected current economic conditions and was not because reserves were exhausted. In fact, there is nothing to indicate the known ore shoots have bottomed and I think one can reasonably predict maintenance of the historical ore incidence of 11,000 tpvf below the existing workings. Apart from two very deep holes by Conoco (respectively 1000 and 1500 feet below the 1200 level) I'm not aware of any drilling below the developed ore shoots, although anyone seriously interested in this target should research the Anaconda records in more detail.

Potential extension of the Walker zone to the north under volcanic cover has been a target of Noranda, AMAX, and Conoco during their exploration programs. However, these efforts have been limited to geophysics followed by only five drill holes, two of which did not get through the volcanics. Considering fact that a new blind ore shoot north of the Piute was discovered and only partly developed at the time of mine closure I'd say chances of developing additional deep underground ore to the north are almost certain. However, in my view, surface exploration in this area, as well as to depth, is probably unrealistic. Effective work is likely going to have to be carried out as part of a major and expensive underground program.

Low Grade Halo Ore - Conventional Open Pit - Potential for developing a large tonnage, low grade copper (gold) deposit by taking the entire Walker Zone was considered and partially tested by Noranda and others. Target here is a tabular zone with a strike length of about 8000 feet, and widths of ±200 feet, capable of generating a deposit on the order of 30 million tons to a depth of 200 feet. Possible grade, as indicated by material in pillars and crosscuts, has been estimated at about 0.70% copper and, say, 0.02 opt gold. However, the few drill holes testing this idea are not so encouraging. The best, WM-1, averaged only 0.46% Cu along 170 feet.

Low grade, open pit copper (gold) target at Walker is not very attractive under current conditions but does constitute a potentially significant future resource.

Low Grade Halo Ore - In Situ Leach - Natural leaching of copper mineralization above the 700 level at Walker suggests that in-situ leaching is a possible option for eventual development of the copper reserve. Because of its attractiveness, both in terms of capital requirements and environmental acceptance, it is an option that should be seriously considered when economics of copper improve. However, at this time we have no hard data regarding efficiency or enconomy of the process on a significant operating scale.

CONCLUSIONS

The Walker mine in Plumas County, California is a major historical producer of copper and gold which was operated semi-continuously by Anaconda between 1923 and 1942. Overall production has been 5,300,000 tons of ore grading 1.55% copper, 0.70 opt silver, and 0.04 opt gold from a quartz-sulfide zone with a developed strike length of 8000 feet, known vertical range of 1200 feet and width up to 75 feet. The property has been explored by a number of major Companies in the 1970's and 80's all of whom considered copper as the principal target commodity.

Given current economic conditions in the mining industry, Walker should be re-evaluated for its considerable gold potential. In particular, the Piute segment of the Main Walker quartz-sulfide zone represents a direct target with good geologic evidence for one to two million tons of near surface ore averaging 0.06 opt gold which can be quickly tested at modest cost. Limited metallurgical test work indicates surface oxidized ores at Piute are leachable but more work must be done to determine extent of oxide zone and metallurgical characteristics of copper-bearing sulfide ores.

Remainder of the main Walker quartz-sulfide zone, representing about 7000 feet of known strike length, and poorly known footwall zones, constitute additional target areas for potential near surface gold deposits similar to Piute, or precious metals-rich polymetallic deposits.

The known copper resources at Walker have potentially important long term potential but are of little interest at current metal prices.

John Prochnau
Consulting Mining Geologist
Reno, Nevada

December 30, 1986

JP:cb

ADDENDUM

ENVIRONMENTAL MATTERS

There has been concern on the part of the California Water Quality Control Board over the past several years regarding acid waters draining the Walker Mine workings and entering Grizzly Creek. Despite considerable expense incurred during the past 20 years by Mr. Barry, and various lessees, in rehabilitating the 700 level adit and directing effluent into settling ponds, some pollutants continue to drain into Grizzly Creek and the CWQCB has unsuccessfully attempted to enforce a seal of the 700 level adit portal.

Such an action would seriously impact long term development of the mine but would not effect the near term development of the Piute area or other shallow gold targets which may be generated through additional exploration.

The status of actions between the CWQCB and Mr. Barry was not a part of this review. However, any serious party can be thoroughly advised of the situation through direct contact with Mr. Barry or his consultant, Mr. Peter Dohms of Condor Mineral Consultants, Sonora, California.

JP:cb

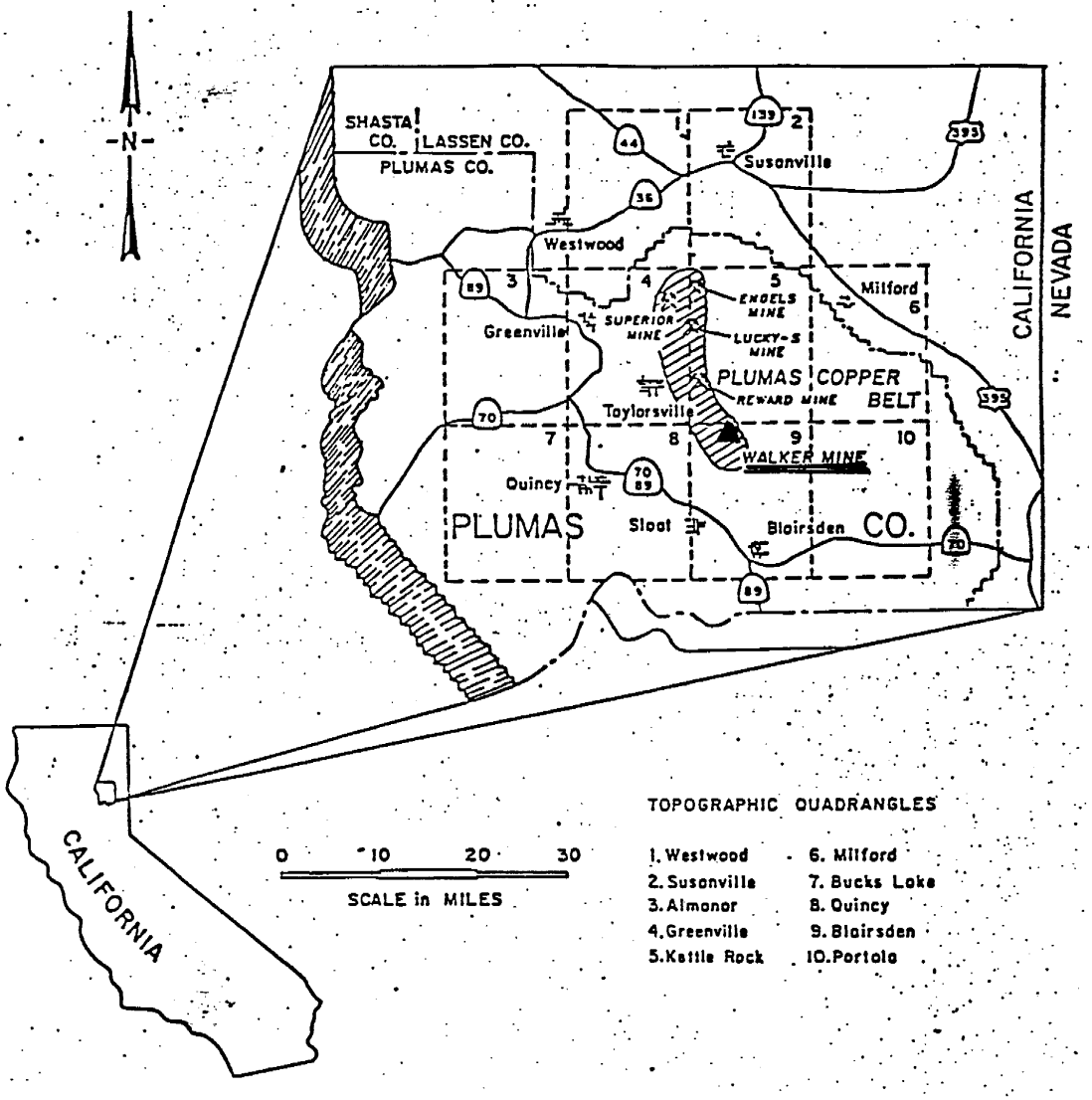

Figure 1
Location Map
Walker Mine
Plumas County
California

500152

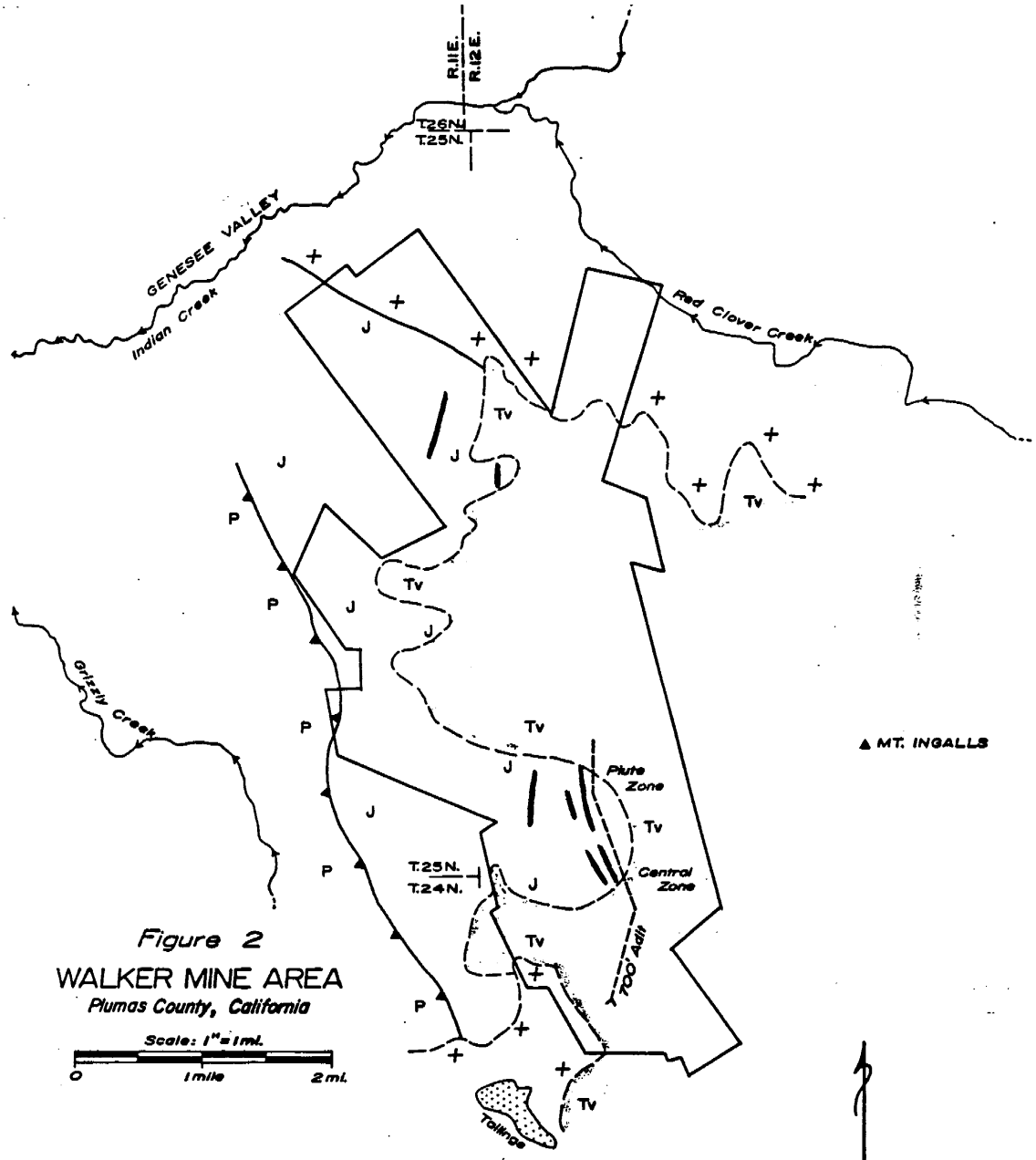

Figure 2

WALKER MINE AREA

Plumas County, California

Scale: 1" = 1 mi.

0 1 mile 2 mi.

Quartz Zone or Fe Formation

Tv Tertiary Volcanics

+ Cretaceous Granite

J Jurassic MetaSediments & Volcanics

P Paleozoic Sediments

Base Map from: BLAIRSDEN & KETTLE FALLS 15' Quad.

500153

WALKER GOLD-COPPER MINE

PLUMAS COUNTY, CA

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The Jurassic units include schists that are probably derived from intermediate to felsic tuffs and agglomerates. They strike consistently north-northwesterly and dip steeply west except in the mine area where dips are reversed to the east. Conoco interpreted the quart-sulfide-magnetite zone hosting the Walker gold-copper orebodies as an exhalite unit in the volcanic assemblage and there is a good deal of evidence to support their conclusions (general geologic environment, conformability of mineralized zone to enclosing rocks, remarkable continuity along strike and down dip, quartz-sulfide-magnetite association). Although debate over whether the deposit is an epigenetic vein or synvolcanic has little impact upon assessment of the direct targets, a synvolcanic origin could suggest a more attractive longer term exploration potential for significant gold or polymetallic mineralization.

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Ore Shoot	Length (Ft)	Mineable Thickness (Ft)	Slope Length (Ft)
South	250	20	300
South Hangwall	400	6	200
Central	800	30	700
North	1200	40	700
712	200	35	600
Piute	800	60	500

These dimensions, and historical production, suggest an overall ore incidence of about 11,000 tpvf, certainly impressive for this style of mineralization.

Level of oxidation has not been determined throughout the zone but sulfides are apparent in shallow workings below Pit 3 in the Piute area (Figure 4). The effect of sulfides and oxide copper on leach characteristics of the near surface gold ore is not adequately known at this time.

A number of similar quartz zones have been identified west of the Main Walker zone in its structural footwall, and to the north where

the favorable Jurassic host rocks reappear beyond volcanic cover. These zones are poorly known and require more extensive prospecting.

GOLD EXPLORATION - SHORT TERM TARGETS

Piute Gold Zone - The Piute area is most northerly segment of the Main Walker Zone. It has been exposed at surface by trenching for a length of 600 feet and developed underground for about 1000 feet. Gold values on surface average 0.059 opt across an exposed horizontal width of 35 feet (Figure 4). Historical sample data on the first level, at a vertical depth of 105 feet, average about 0.06 opt gold across 40-50 feet if low grade footwall material is excluded (Figure 4a). The zone above this level appears to be mostly intact. Impact of historical mining at greater depth is not known although stoping records may be available in Mr. Barry's files.

These data suggest a probable surface mineable deposit of 350,000 to 450,000 tons to 100 feet. Lower grade hangwall mineralization in the .03 to .04 range can't be accurately measured on basis of present information but could significantly increase contained ounces and reduce stripping costs. The occurrence appears to be open in both strike directions. From the information at hand I believe an ultimate surface mineable deposit in the 1-2 million ton range at a grade of 0.06 opt gold is a realistic expectation at Piute.

Geologic confidence in the Piute gold zone is high. However, sulfides occur at fairly shallow depths and metallurgical characteristics are much more questionable. A 72 hour bottle roll test on oxidized ore from the shaft outcrop, crushed to -¼", yielded a 76 percent recovery with moderate reagent consumption but sulfide-rich material from workings off the No. 3 pit yielded poor recoveries and had high cyanide consumptions. More work is required to determine metallurgical characteristics of the Piute ores.

Walker Vein Zone South of Piute - The surface trace of the Walker Vein Zone is intermittently exposed for a length of 4500 feet between the Piute area on the north and the Central mine area to the south where it again passes under volcanic cover (Figures 2&3).

Surface assay data is limited to a few reconnaissance-type samples which confirm anomalous gold where expected (Figure 3). Anaconda assay plans for shallow workings on the North, South and 712 ore shoots provide more information on potential gold grades. The following data represent simple arithmetic averages of Anaconda samples.

Ore Shoot	#Assays	Est. Thick.	Strike Length	Ave. Gold
North	41	±20'	1050'	0.034
South	28	?	1450'	0.044
712	38	?	820'	0.022

These grades are certainly modest but do suggest the surface remnants of the entire zone above historical workings represent a reasonable target for more detailed work. Impact of former mining operations is not known but, if the Piute is typical, considerable surface pillars are probably intact.

The Central Zone is partially exposed in the series of pits shown on Figure 5. Vein here appears to run about 0.035 opt gold with ±3.0 opt silver. Thickness can't be determined from surface exposures.

A 72 hour bottle roll on vein material crushed to -¼" from the shaft outcrop yielded 73% and 59% recoveries respectively for gold and silver suggesting oxidized ores are probably leachable. However, depth of oxidation is not known.

Other Zones - Conoco's geological mapping of the entire Walker property defined other vein zones and iron formation both west of the Walker zone in its footwall and to the north where the Jurassic rocks are again exposed beyond volcanic cover. Apart from a few drill holes, prospecting and exploration of these zones has been very limited. They certainly represent less direct but reasonable exploration targets for precious metal or polymetallic base/precious metal mineralization.

BASE METAL EXPLORATION - LONG TERM TARGETS

Underground Copper Gold - Mineable reserves blocked out by Anaconda at mine closure in 1942 are 1,200,000 tons grading 1.55% copper, 0.70 opt silver, and 0.04 opt gold. Reserves in all categories were estimated to be 3,000,000 tons at like grades. Much of the mineable reserve is tied up in pillars and on fringes of old stopes and, after 40 years, may not be recoverable at realistic cost.

Anaconda's closure of the mine in 1942 reflected current economic conditions and was not because reserves were exhausted. In fact, there is nothing to indicate the known ore shoots have bottomed and I think one can reasonably predict maintenance of the historical ore incidence of 11,000 tpvf below the existing workings. Apart from two very deep holes by Conoco (respectively 1000 and 1500 feet below the 1200 level) I'm not aware of any drilling below the developed ore shoots, although anyone seriously interested in this target should research the Anaconda records in more detail.

Potential extension of the Walker zone to the north under volcanic cover has been a target of Noranda, AMAX, and Conoco during their exploration programs. However, these efforts have been limited to geophysics followed by only five drill holes, two of which did not get through the volcanics. Considering fact that a new blind ore shoot north of the Piute was discovered and only partly developed at the time of mine closure I'd say chances of developing additional deep underground ore to the north are almost certain. However, in my view, surface exploration in this area, as well as to depth, is probably unrealistic. Effective work is likely going to have to be carried out as part of a major and expensive underground program.

Low Grade Halo Ore - Conventional Open Pit - Potential for developing a large tonnage, low grade copper (gold) deposit by taking the entire Walker Zone was considered and partially tested by Noranda and others. Target here is a tabular zone with a strike length of about 8000 feet, and widths of ±200 feet, capable of generating a deposit on the order of 30 million tons to a depth of 200 feet. Possible grade, as indicated by material in pillars and crosscuts, has been estimated at about 0.70% copper and, say, 0.02 opt gold. However, the few drill holes testing this idea are not so encouraging. The best, WM-1, averaged only 0.46% Cu along 170 feet.

Low grade, open pit copper (gold) target at Walker is not very attractive under current conditions but does constitute a potentially significant future resource.

Low Grade Halo Ore - In Situ Leach - Natural leaching of copper mineralization above the 700 level at Walker suggests that in-situ leaching is a possible option for eventual development of the copper reserve. Because of its attractiveness, both in terms of capital requirements and environmental acceptance, it is an option that should be seriously considered when economics of copper improve. However, at this time we have no hard data regarding efficiency or enconomy of the process on a significant operating scale.

CONCLUSIONS

The Walker mine in Plumas County, California is a major historical producer of copper and gold which was operated semi-continuously by Anaconda between 1923 and 1942. Overall production has been 5,300,000 tons of ore grading 1.55% copper, 0.70 opt silver, and 0.04 opt gold from a quartz-sulfide zone with a developed strike length of 8000 feet, known vertical range of 1200 feet and width up to 75 feet. The property has been explored by a number of major Companies in the 1970's and 80's all of whom considered copper as the principal target commodity.

Given current economic conditions in the mining industry, Walker should be re-evaluated for its considerable gold potential. In particular, the Piute segment of the Main Walker quartz-sulfide zone represents a direct target with good geologic evidence for one to two million tons of near surface ore averaging 0.06 opt gold which can be quickly tested at modest cost. Limited metallurgical test work indicates surface oxidized ores at Piute are leachable but more work must be done to determine extent of oxide zone and metallurgical characteristics of copper-bearing sulfide ores.

Remainder of the main Walker quartz-sulfide zone, representing about 7000 feet of known strike length, and poorly known footwall zones, constitute additional target areas for potential near surface gold deposits similar to Piute, or precious metals-rich polymetallic deposits.

The known copper resources at Walker have potentially important long term potential but are of little interest at current metal prices.

John Prochnau
Consulting Mining Geologist
Reno, Nevada

December 30, 1986

JP:cb

ADDENDUM

ENVIRONMENTAL MATTERS

There has been concern on the part of the California Water Quality Control Board over the past several years regarding acid waters draining the Walker Mine workings and entering Grizzly Creek. Despite considerable expense incurred during the past 20 years by Mr. Barry, and various lessees, in rehabilitating the 700 level adit and directing effluent into settling ponds, some pollutants continue to drain into Grizzly Creek and the CWQCB has unsuccessfully attempted to enforce a seal of the 700 level adit portal.

Such an action would seriously impact long term development of the mine but would not effect the near term development of the Piute area or other shallow gold targets which may be generated through additional exploration.

The status of actions between the CWQCB and Mr. Barry was not a part of this review. However, any serious party can be thoroughly advised of the situation through direct contact with Mr. Barry or his consultant, Mr. Peter Dohms of Condor Mineral Consultants, Sonora, California.

JP:cb

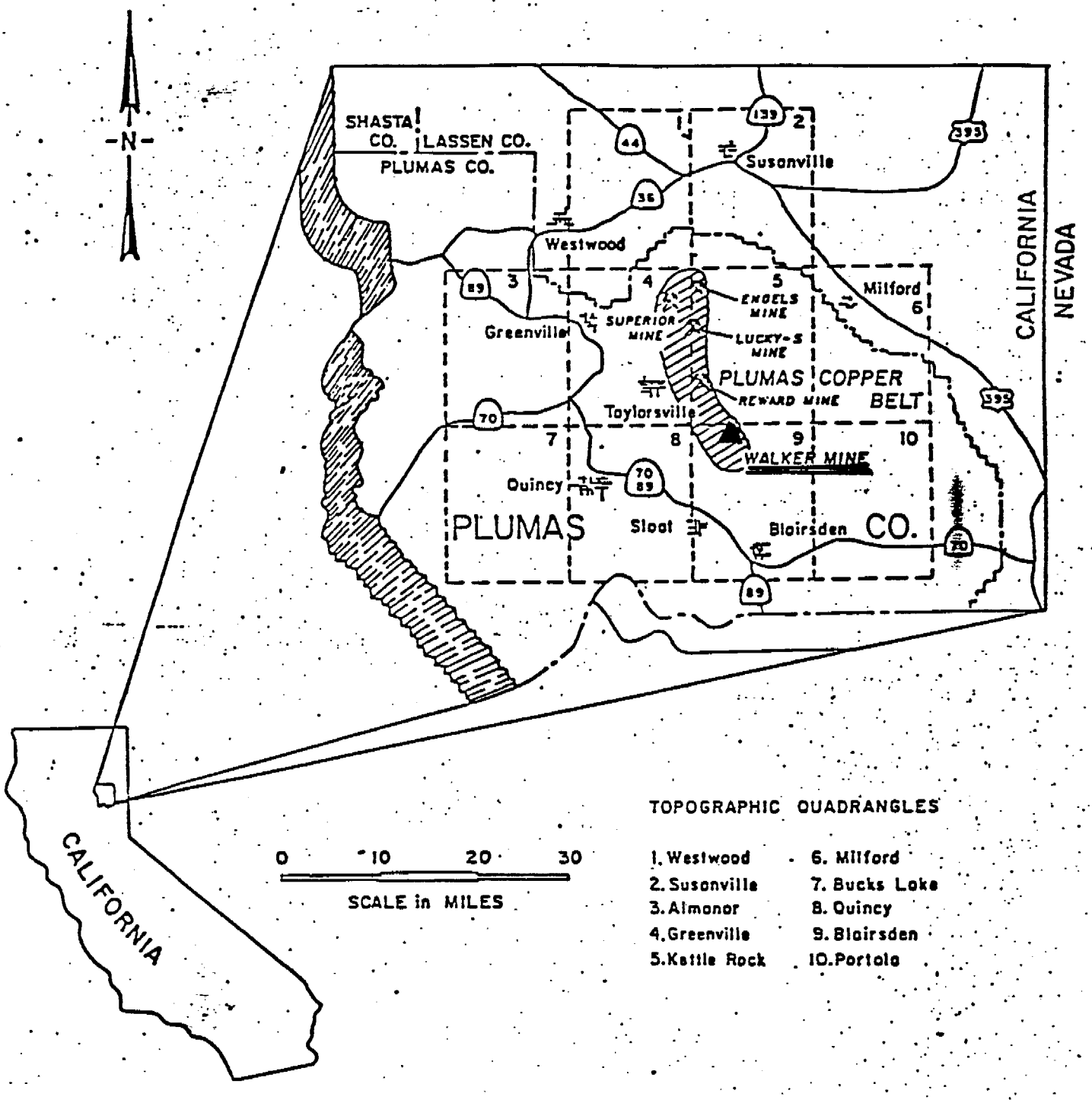

Figure 1
Location Map
Walker Mine
Plumas County
California

500152

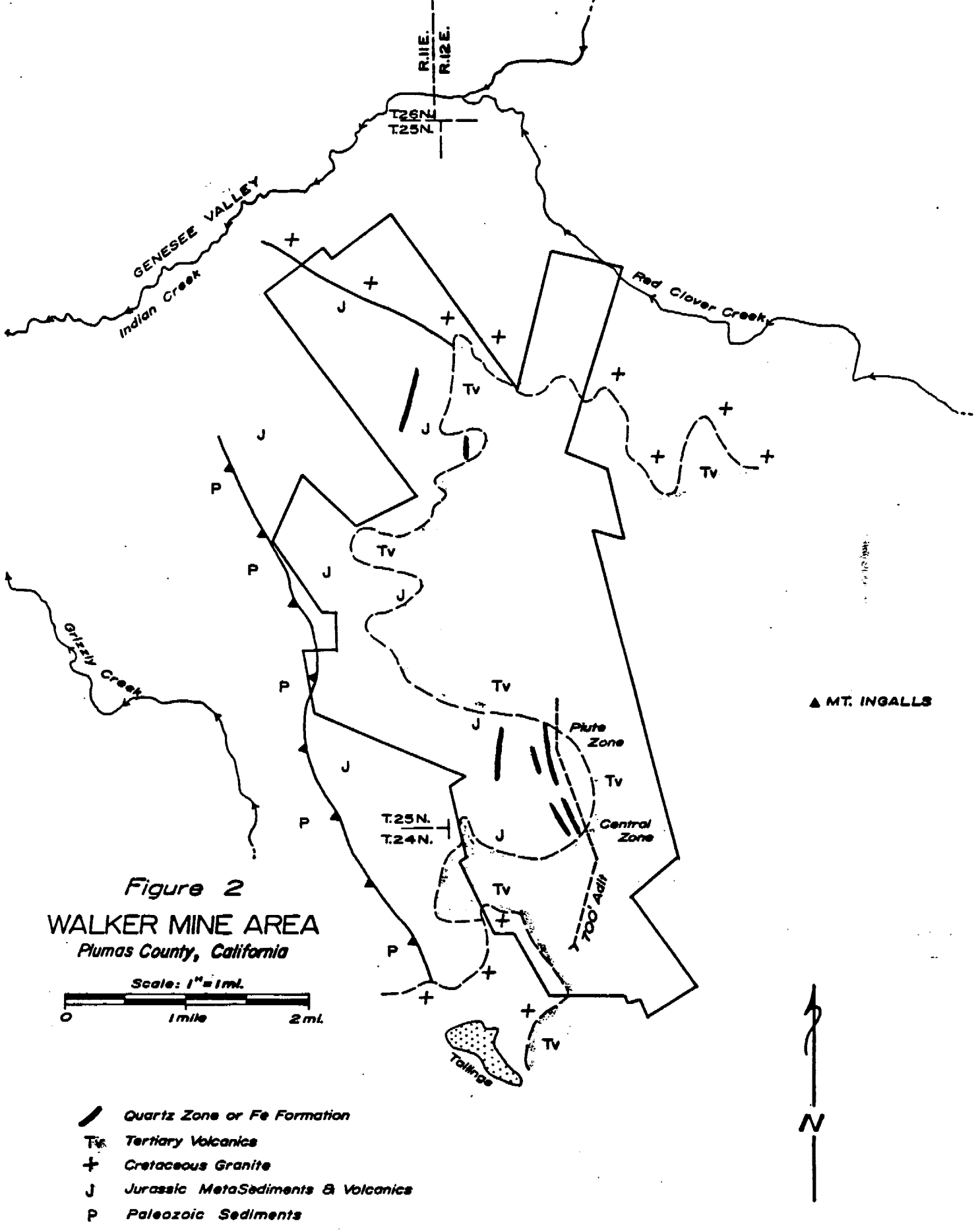

Figure 2

WALKER MINE AREA

Plumas County, California

Scale: 1" = 1 mi.

0 1 mile 2 mi.

Quartz Zone or Fe Formation

Tv Tertiary Volcanics

+ Cretaceous Granite

J Jurassic MetaSediments & Volcanics

P Paleozoic Sediments

Base Map from: BLAIRSDEN & KETTLE FALLS 15' Quad.

500153

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

CLEANUP AND ABATEMENT ORDER ORDER NO. 87-703
FOR
WALKER MINE, ROBERT R. BARRY, CALICOPIA CORPORATION
AND
THE STANDARD BULLION COMPANY, INC.

The California Regional Water Quality Control Board, Central Valley Region, (hereafter Board) finds that:

1. Robert R. Barry, Calicopia Corporation and The Standard Bullion Corporation (hereafter Discharger), own or lease the Walker Mine, a nonoperating copper mine in east central Plumas County, T24N, R4E, MDB&M. Surface water drainage is to Dolly Creek, which is tributary to Little Grizzly Creek, thence Indian Creek, thence the East Branch North Fork Feather River, waters of the United States.

2. The beneficial uses of the Feather River and its tributaries are municipal, industrial, and agricultural supply; recreation; esthetic enjoyment; navigation; ground water recharge; fresh water replenishment; hydroelectric power generation; and preservation and enhancement of fish, wildlife, and other aquatic resources. The aquatic resources of much of Little Grizzly Creek have been eliminated by the discharge of acid mine drainage from Walker Mine.

3. Waste discharge requirements, adopted by the Board on 25 January 1985, in Order No. 85-033, NPDES No. CA0080110, for the Discharger, state in part:

   "B. Sludge and Solid Waste Disposal:

      "1. Sludge and/or solid waste generated by treatment facilities or during mining exploration shall only be disposed at sites which have been approved by the Executive Officer."

   "C. Receiving Water Limitations:

      "2. The discharge shall not cause visible oil, grease, scum, foam, floating or suspended material in the receiving water or watercourses.

      3. The discharge shall not cause concentrations of any material in the receiving waters which are deleterious to human, animal, aquatic, or plant life.

      4. The discharge shall not cause esthetically undesirable discoloration of the receiving waters.

      6. The discharge shall not cause bottom deposits in the receiving waters."

4. During the period of 2 July 1986 to 25 November 1986, the Discharger violated Limitation B.1. by depositing tunnel muck, sludge and mine debris to an unauthorized site in the staging area adjacent to the mine portal. This waste was placed in an area where it is not prevented from entering Dolly Creek. Some of this waste has been discharged to Dolly Creek and more of this waste probably will be discharged to Dolly Creek.

5. During the period of 1 August 1986 to 25 November 1986, the Discharger violated Receiving Water Limitations C.2, C.3, C.4, and C.6, by intentionally discharging sludge into Dolly Creek from an unauthorized settling pond and/or from a diversion structure above the settling pond from where it discharged into Dolly Creek. Dolly Creek is a water of the State.

6. The violations described in Finding Nos. 4 and 5 were caused by the implementation of a mine drainage abatement project. This project was briefly outlined by the Discharger's consultant during the February 1986 Board hearing. The Regional Board and Board staff provided comments and concerns during this hearing. The Discharger implemented this project without determining the quality of waste materials, the construction requirements for waste management unit(s) to contain this type of waste, and without obtaining requirements from the Regional Board for the discharge of waste. The sludge discussed in Finding Nos. 4 and 5 was deposited on an unlined, unprotected surface without spill containment or runoff control. The discharge of sludge to Dolly Creek, a water of the State, was from a settling pond and/or a poorly designed and located diversion structure.

7. The wastes described in Findings 4 and 5 constitute a hazardous waste due to high concentrations of copper. The soluble portions of material deposited on the staging area contain concentrations of copper as high as 1484 milligrams per liter (mg/l) . The sludge discharged to the settling pond via the diversion structure has soluble concentrations which range between 204 and 338 ppm. The State Department of Health Services set the Hazardous Waste - Soluble Threshold Limit Concentration (STLC) for copper at 25 mg/l. Those waste discharges greatly exceed the STLC value. The discharge of waste to Dolly Creek, and the threatened further discharge, have created, and threaten to create a condition of pollution and nuisance.

8. Section 13304(a) of the California Water Code provides that "Any person who has discharged or discharges waste into the waters of this state in violation of any waste discharge requirement or other order or prohibition issued by a regional board or the state board, or who has caused or permitted, causes or permits, or threatens to cause or permit any waste to be discharged or deposited where it is, or probably will be, discharged into the waters of the state and creates, or threatens to create, a condition of pollution or nuisance, shall upon order of the regional board clean up such waste or abate the effects thereof or, in the case of threatened pollution or nuisance, take other necessary remedial action."

CLEANUP AND ABATEMENT ORDER NO. 87-703
WALKER MINE, ROBERT R. BARRY,
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STANDARD BULLION COMPANY, INC.
PLUMAS COUNTY

9. Section 13267(b) of the California Water Code provides that "In conducting an investigation specified in subdivision (a), the regional board may require that any person discharging or proposing to discharge waste within its region or any citizen or domiciliary, or political agency or entity of this state discharging or proposing to discharge waste outside of its region that could affect the quality of waters within its regional shall furnish, under penalty of perjury, those technical or monitoring program reports as the board may specify. The burden, including costs, of these reports shall bear a reasonable relationship to the need for the report and the benefits to be obtained from the reports."

10. Any person affected adversely by this action of the Board may petition the State Water Resources Control Board to review the action. The petition must be received by the State Board within 30 days of the date on which the Board took action. Copies of the law and regulations applicable to filing petitions will be provided on request.

11. Issuance of this Order is exempt from the provisions of the California Environmental Quality Act (Public Resources Code Section 21000, et seq.), in accordance with Section 15321(a)(2), Title 14, of the California Administrative Code.

IT IS HEREBY ORDERED that, pursuant to Sections 13267 and 13304 of the California Water Code, Walker Mine, Robert R. Barry, Calicopia Corporation and The Standard Bullion Company, Inc., shall:

1. By 1 June 1987, sample and analyze tunnel muck, sludge and mine debris for the purpose of waste characterization and classification under the California Administrative Code, Title 23, Chapter 3, Subchapter 15, Section 2571.

2. By 1 August 1987, submit a technical report that includes a proposal to relocate Class A or B mining wastes discharged in violation of Waste Discharge Requirements Order No. 85-033.

3. By 1 August 1987, submit a technical report that includes a proposal to protect Class C mining wastes from erosion.

4. By 1 October 1987, remove Class A or B mining wastes to a waste management unit which is in compliance with the requirements of Subchapter 15.

5. By 1 October 1987, Class C mining wastes shall be protected from erosion.

William H. Crooks

WILLIAM H. CROOKS, Executive Officer

DATED:4/15/87

CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD

INSPECTION REPORT

22 January 1988

Construct Backfill Seal

DISCHARGER: WALKER MINE, ROBERT R. BARRY, ET. AL.

LOCATION & COUNTY: 20 Miles east of Quincy, Plumas County

CONTACTS: Mr. Jan Donato; Mine Caretaker; Mr. Ken Walters, President, K.G. Walters Construction Co., Inc.; Mr Don Poulter, project engineer, SRK;

INSPECTION DATE: 13, 14 December 1987

INSPECTED BY: William A. Croyle

ACCOMPANIED BY: see contacts above

OBSERVATIONS AND COMMENTS:

The purpose of this inspection observe the construction of the Walker Mine seal construction, and conduct a waters quality survey of the watershed down gradiant of the mine portal and on the north side of mine property in the Nye Creek and Ward Creek watersheds.

A review of the file has shown that the Discharger has continually failed to comply with Monitoring and Reporting Program No. 85-033 by not performing and/or submitting water quality monitoring.

INSPECTION SUMMARY:

The Discharger continues to be in violation of Waste Discharge Requirements Order No. 85-033 despite "wheelbarrow and shovel" efforts to implement Condor Minerals Management's mine drainage abatement proposal. It is very obvious that the Discharger and his consultant do not truly intend to implement their abatement proposal in a fashion that beneficially impact water quality. The Discharger is in violation of the following sections of WDR Order No. 85-033:

"A. Effluent Limitations:

1. The discharge shall not have a pH less than 6.5 not greater than 8.5.

C. Receiving Water Limitations:

2. The discharge shall not cause visible oil, grease, scum, foam, floating or suspended material in the receiving waters or watercourses.

3. The discharge shall not cause concentrations of any material in the receiving waters which are deleterious to human, animal, aquatic life, or plant life.

4. The discharge shall not cause esthetically undesirable discoloration of the receiving waters."

"6. The discharge shall not cause bottom deposits in the receiving waters.

7. The discharge shall not increase the turbidity of the receiving waters by more than 20% over background levels.

E. Provisions:

1. Neither the discharge nor its treatment shall cause a nuisance or pollution as defined in Section 13050 of the California Water Code.

4. The Discharger shall comply with attached Monitoring and Reporting Program No. 85-033 as Ordered by the Executive Officer."

WILLIAM A. CROYLE
PROJECT ENGINEER

WAC

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

September 30, 1988
SRK Project No. 06901

California Regional Water Quality Control Board
Central Valley Region
3443 Routier Road
Sacramento, California 95827-3098

Attention: Mr. William A. Croyle

RE: WALKER MINE, PLUMAS COUNTY: CASE NO. 355 - INSPECTION OF COMPLETION OF WALKER MINE SEAL CONSTRUCTION

Dear Bill,

A site inspection was undertaken on Monday, September 19, 1988 by Messrs. Bill Croyle and Tom Pinkos of CRWQCB-CVR and Don Poulter and Colin Smith of Steffen Robertson and Kirsten (Colorado) Inc. (SRK).

The following observations were made by the SRK engineers:

1. At the Seal

Seepage through the concrete plug was seen at three points:

- at the concrete/rock interface along much of the left side of the plug face (as seen from the front);
- at the concrete/rock interface over a short section of the upper right side of the plug face; and
- from the threaded joint at the lower end of the union connecting the pressure gauge assembly to one of the two four-inch diameter pipes through the plug.

Action required:

- Neither of the seepages at the concrete/rock interface is considered to be heavy enough to justify immediate remedial action. It is recommended that these slow seepages should be given the opportunity to continue sealing themselves for

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Tel. (303) 985-1333 Facsimile (303) 985-9947
Other offices in: U.S.A., Canada, United Kingdom and Africa

another year or so. A further inspection should be made in July/August, 1989. If, at that time, there is no marked reduction in the rate of seepage, grouting should be done to seal the concrete/rock interface. Detailed specifications of the grouting procedure (if required) will depend on the persistence, volume and extent of the seepage to be sealed.

- The leakage and corrosion occurring at the threaded joint connecting the pressure gauge assembly to the four-inch diameter pipe must be stopped as soon as possible. Close visual inspection indicated that the one-inch diameter threaded union connecting the tee on the diameter pipe to the one-inch stopcock below the pressure gauge is not stainless steel, as specified, and is corroding. As this piece of pipe is exposed to the full head of water held back by the plug, unprotected by any valve, it is imperative that the defective union should be replaced without delay by the specified stainless steel union. The inspecting group noted that two such stainless steel one-inch diameter unions were lying, unused, on the four-inch valve beside the pressure gauge.

2. Remote Read-Out Cable

The cable linking the pressure transducer to the remote read-out/recorder was lying on the floor of the adit for most of its length, vulnerable to damage by being stepped on, falling rock or moisture.

Action Required:

- Suspension of the cable, from the roof of the adit, over its entire length.

3. Ventilation System

The fiberglass ventilation duct was properly suspended through the timber based section of the adit (about 1,300 ft), but lay on the ground, over the ditch, for most of the remainder of its length. Though it is undesirable for the duct line to lie on the ground, the disadvantages are not severe enough to justify the extensive work that would be required to suspend the ducting from the rib or back of the adit for its entire length.

The discharge end of the duct line was too far from the plug to provide an effective ventilation with the low air flow available. The outlet should be within 50 ft of the face of the plug.

The ventilating fan was not suspended in its permanent position, but had to be manhandled to a position outside the portal door, where it was connected by reinforced flexible ducting to the rigid duct line.

Action Required:

- Improve alignment of the rigid ducting at all deviations from the straight line, to minimize leakage at joints;
- Extend the discharge end of the rigid duct line by two lengths (about 40 ft);
- Suspend the fan from the wall of the adit portal, connecting it to the rigid duct line by a flange/male spigot adapter. The existing flexible ducting should be connected to the fan inlet, extensible, when in use, to the outside of the portal door.

4. Timber Support

The timber sets lining the adit were examined. The timbering is generally wet and is expected to remain so. As there will be no air movement in the adit (except when the ventilating fan is activated to permit entry for inspection), natural deterioration should be slow. Decaying timber was seen at approximately 402 ft, 422 ft, 425 ft, and 500 ft from the portal, manifested mainly in crushing evident at the points where the caps rest on the posts (legs) of each set. The condition of the timbering is substantially the same as it was when last observed in July 1986 and October 1987.

None of the deteriorating sets, or any of the sound sets, were observed to be taking significant weight from the surrounding rock mass, but risked eventual collapse under their own weight and/or that of timber cribbing or blocking above the sets.

No immediate rehabilitation is recommended but careful examination of the sets identified as decaying should be undertaken during each inspection visit. It is anticipated that approximately five sets may need to be replaced during the summers of 1989 and 1990, at a cost of two to three man-days per set plus mobilization and materials, estimated at a total of $600 to $1,000 per set.

5. Recommendations

The construction contractor, K.G. Walters Construction Company, Inc. should be required to perform the following corrective and remedial work, to the satisfaction of the Board before payment of his final invoice and release of retention monies:

a) Remove the defective corroding one-inch diameter pipe union in the pressure gauge take-off from the four-inch diameter pipe through the seal, replacing it with the specified stainless steel union and ensuring a sound joint.

As this work will have to be done under the live head of approximately 32 ft of water, the contractor should submit a detailed plan of operation, which should make provision for preventing water released during remedial work from reaching Dolly Creek. Such release could be minimized by pre-assembly of the replacement union and stopcock before removal of the defective section.

b) Tighten and seal all pipe connections and valve glands showing signs of leakage.

c) Suspend the instrumentation remote read-out cable clear of the ground, in such a way that the integrity of the insulation and conductor will be preserved.

d) Minimize leaks at the joints between rigid ventilation ducts by reducing any excessive mis-alignment between duct lengths and extend the duct line two lengths (40 ft).

e) Suspend the ventilation fan by light chain looped around each end of the fan housing and bolted to an anchor in the concrete wall/roof of the adit.

The outlet of the fan should be connected to the inlet of the rigid duct line by a custom-made fiber glass connecting piece which will bolt onto the fan flange at one end and provide the male spigot connection to the duct line at the other.

The flexible, spiral-reinforced ducting, presently attached to the rigid duct line inlet, should be connected to the fan inlet by a flanged connector in such a way that it can be stowed inside the portal door when it is not in use, but extended for suspension from the existing pipes outside the door during fan operation.

On completion of the corrective action described in items a) through e) above, to the satisfaction of the Board, out-standing retention monies should be released to the construction contractor.

Please address any questions or comments on this inspection report to either Don Poulter at (303) 985-1333 or Colin Smith at (801) 322-8360.

Sincerely,

STEFFEN ROBERTSON AND KIRSTEN
(COLORADO) INC.

Don A. Poulter
Project Manager

for

Colin F. Smith
Associate

CS/rj

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

September 30, 1988
SRK Project No. 06901

California Regional Water Quality Control Board
Central Valley Region
3443 Routier Road
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Action required:

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No immediate rehabilitation is recommended but careful examination of the sets identified as decaying should be undertaken during each inspection visit. It is anticipated that approximately five sets may need to be replaced during the summers of 1989 and 1990, at a cost of two to three man-days per set plus mobilization and materials, estimated at a total of $600 to $1,000 per set.

5. Recommendations

The construction contractor, K.G. Walters Construction Company, Inc. should be required to perform the following corrective and remedial work, to the satisfaction of the Board before payment of his final invoice and release of retention monies:

a) Remove the defective corroding one-inch diameter pipe union in the pressure gauge take-off from the four-inch diameter pipe through the seal, replacing it with the specified stainless steel union and ensuring a sound joint.

As this work will have to be done under the live head of approximately 32 ft of water, the contractor should submit a detailed plan of operation, which should make provision for preventing water released during remedial work from reaching Dolly Creek. Such release could be minimized by pre-assembly of the replacement union and stopcock before removal of the defective section.

b) Tighten and seal all pipe connections and valve glands showing signs of leakage.

c) Suspend the instrumentation remote read-out cable clear of the ground, in such a way that the integrity of the insulation and conductor will be preserved.

d) Minimize leaks at the joints between rigid ventilation ducts by reducing any excessive mis-alignment between duct lengths and extend the duct line two lengths (40 ft).

e) Suspend the ventilation fan by light chain looped around each end of the fan housing and bolted to an anchor in the concrete wall/roof of the adit.

The outlet of the fan should be connected to the inlet of the rigid duct line by a custom-made fiber glass connecting piece which will bolt onto the fan flange at one end and provide the male spigot connection to the duct line at the other.

The flexible, spiral-reinforced ducting, presently attached to the rigid duct line inlet, should be connected to the fan inlet by a flanged connector in such a way that it can be stowed inside the portal door when it is not in use, but extended for suspension from the existing pipes outside the door during fan operation.

On completion of the corrective action described in items a) through e) above, to the satisfaction of the Board, out-standing retention monies should be released to the construction contractor.

Please address any questions or comments on this inspection report to either Don Poulter at (303) 985-1333 or Colin Smith at (801) 322-8360.

Sincerely,

STEFFEN ROBERTSON AND KIRSTEN
(COLORADO) INC.

Don A. Poulter
Project Manager

for

Colin F. Smith
Associate

CS/rj

WALKER MINE -
SITE INSPECTION REPORT

STEFFEN ROBERTSON & KIRSTEN

Consulting Engineers and Scientists

WALKER MINE -
SITE INSPECTION REPORT

Prepared for:
State of California
California Regional Water Quality Control Board
Central Valley Region
3443 Routier Road
Sacramento, California 95827-3098

Prepared by:
Steffen Robertson and Kirsten (U.S.), Inc.
3232 South Vance Street
Lakewood, Colorado 80227

December 1989
SRK Report No. 06901

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STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers and Scientists

December 20, 1989
SRK Project No. 06901

State of California
California Regional Water
Quality Control Board
Central Valley Region
3443 Routier Road
Sacramento, CA 95827-3098

Attention: Mr. William Croyle

RE: WALKER MINE - SITE INSPECTION

Introduction

As arranged with William A. Croyle we conducted a site visit on November 14, 1989. The visit was conducted by Dr. Chris Page, (mining engineer and rock mechanics specialist), and Dr. Ian Hutchison (geohydrologist) and included a general reconnaissance of the area as well as an inspection of the 700 level adit and the plug. Also present during the site visit were Mr. W. Croyle and Mr. J. Tucker from the Central Valley Region. Detailed observations made during the visit are included in this letter and in the photo record attached in Appendix A. A video of the visit is also available on file with the Central Valley Region.

Summary of Findings

The plug is performing well. The concrete is in good condition and the small quantity of seepage around the plug, which is on the order of tenths of a gallon per minute, is well within expectations. According to the dial gage installed on the plug outlet pipe, the water level behind the plug was 97 ft (42 psi). This is still well below the next potential surface discharge point at the Piute shaft which is approximately 450 ft above the 700 portal level. However, the final equilibrium level to which water will rise behind the plug is not yet known.

Within the level 700 adit segment between the portal and the plug, there is no indication of imminent collapse. However, the timbered sections in the first 1,300 ft cannot be considered secure in the medium term. The unsupported adit segment is in very good condition.

The surface diversions placed around the Piute shaft and central orebody subsidence areas are in reasonable condition but are probably only effective in diverting some of the higher storm or snowmelt flows. Improving the efficiency of these diversions would require relatively costly engineering works to provide effective flow cutoffs through the upper soil cover and additional surface flow channels.

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A brief reconnaissance of the area immediately above and to the east of the portal did not reveal any obvious signs of outflow of acid drainage from the plugged workings.

Recommendations

The long term stability of the 700 level adit needs to be addressed. This can either be accomplished by replacing the timber support and continuing to maintain the adit and the plug, or by grouting up the pipes through the plug, sealing off the portal, and allowing the adit to deteriorate and to ultimately collapse. Due to the large cost differential between these two alternatives, the latter is recommended. However, before it is implemented, at least two or three more years of site data should be collected to determine the equilibrium water level behind the plug and confirm the absence of any mine water seepage that could cause environmental problems.

Provided the plug continues to operate satisfactorily there is no need to improve the surface drainage around the upper two sinkhole areas. This would be very costly to undertake and would not provide any benefits. However, consideration should be given to sealing some of the openings because of the physical hazard they pose. In most cases this could be done by blasting protruding or overhanging rock formations.

In order to keep the plugs operating satisfactorily in the short-term, the mild steel parts used on the valves should be replaced by stainless steel parts. Arrangements should also be made to obtain a minimum of quarterly water level readings behind the plug by either manually reading a pressure gage or reinstalling or repairing the recording gage.

Detailed Observations

(a) Tunnel Condition

The first 1300 feet of the adit is supported with closely spaced timber setts with full timber cladding behind the setts for the walls and roof. Very little rock surface is visible in the timbered section. The remaining 1400 feet is unsupported and is probably contained within unweathered rock.

The following points are pertinent to the timbered section:

- It is difficult to assess how much loose material is resting on the timbers. In a few places it was observed that the loose material is several feet thick both in the roof and the walls;

- There are several sections of tunnel which have been spiled. This involved driving timbers at a slight angle above horizontal into the roof to provide cover for the next sett in very weak or loose ground;

- It is difficult to gauge the age of the timber but it seems that much of the support was in place in the early 1940's;

- A considerable amount of the cladding is completely rotten and some of the caps and legs appear to be in poor condition;

- Most of the timber setts are undistorted although there is some punching of legs into caps and bending of caps and legs;

- There is a significant amount of distortion of the cladding behind the setts but this timber is much thinner and, therefore, more rotten;

- There are some areas of significant adit enlargement resulting in large spaces behind the timber or where several layers of timber have been used to fill the spaces;

- There is evidence of rock deterioration with considerable weathering in the areas close the portal; and

- The first 200 ft of the adit appears to be cut and fill with very little cover material.

The following tentative conclusions may be drawn in reference to the timbered section:

- The condition of the timber is remarkably good given the age and degree of rotting;

- The presence of spiling, indicates very weak or loose rock conditions behind the timber. There are sections where quantities of loose material are visible;

- There is no indication of imminent collapse; however, it is clear that the timbered section cannot be considered secure over the medium- or long-term; and

- It is not possible to predict how long safe entry may be possible, but 10 to 20 years should be regarded as very optimistic.

The unsupported section of the adit is in very good condition with no indication of any recent, significant deterioration. The rock mass is well jointed, but the joints are rough (high friction) and tight in most cases, although unfavorably oriented with respect to adit stability. The adit is old and the lack of deterioration suggests that it should remain in good condition for a long time. However, as for the timbered section, it is difficult to judge what stability will be with the passage of time. However, there are no sections of tunnel which intersect rock masses that would totally close the tunnel if a rock fall occurred.

(b) Plug Condition

The plug is in good condition with very little leakage. Most of the leaking is confined to the interface between the plug and the roof. The 42 psi (97 ft) registered by the pressure gauge is well below the 610 psi (1400 ft) for which the plug was designed. Very little of the rock/plug interface grouting has apparently been carried out. There appears to be no leakage through the rock around the plug.

(c) Geohydrologic Evaluation

The water level behind the plug still appears to be rising with time. Available data has been collected and is plotted on Figure 1. This Figure illustrates that annual rises in groundwater levels have been between 30 and 90 ft. Furthermore, there may be seasonal fluctuations of the order of 10 to 20 ft. There is no indication yet that a long-term equilibrium level has been reached.

(d) Long Term Security of the Tunnel

The plug and tunnel are being inspected and monitored on a regular basis. In the medium-term (next few years), this can continue as long as it is safe to do so. In the longer-term, additional work will have to be done to provide for safe conditions. There are two basic routes that can be taken. These are:

- Rehabilitate the timbered section; and
- Secure the area around the plug and allow the timbered section to collapse.

The first option would require the removal of all the timber and the installation of suitable support such as grouted rock bolts and reinforced shotcrete. This would cost in the region of $1,000 per foot or more. This amounts to a minimum capital cost of approximately $1.3 million.

The second option would require adding support to the rock immediately adjacent to the plug to prevent rock falls and possible short circuiting of the plug, providing a secondary seal to the valves, and sealing off the portal to any access. This could be accomplished for example, by placing a second concrete plug up against the existing plug and collapsing the cut and fill portion of the adit in order to seal off the portal.

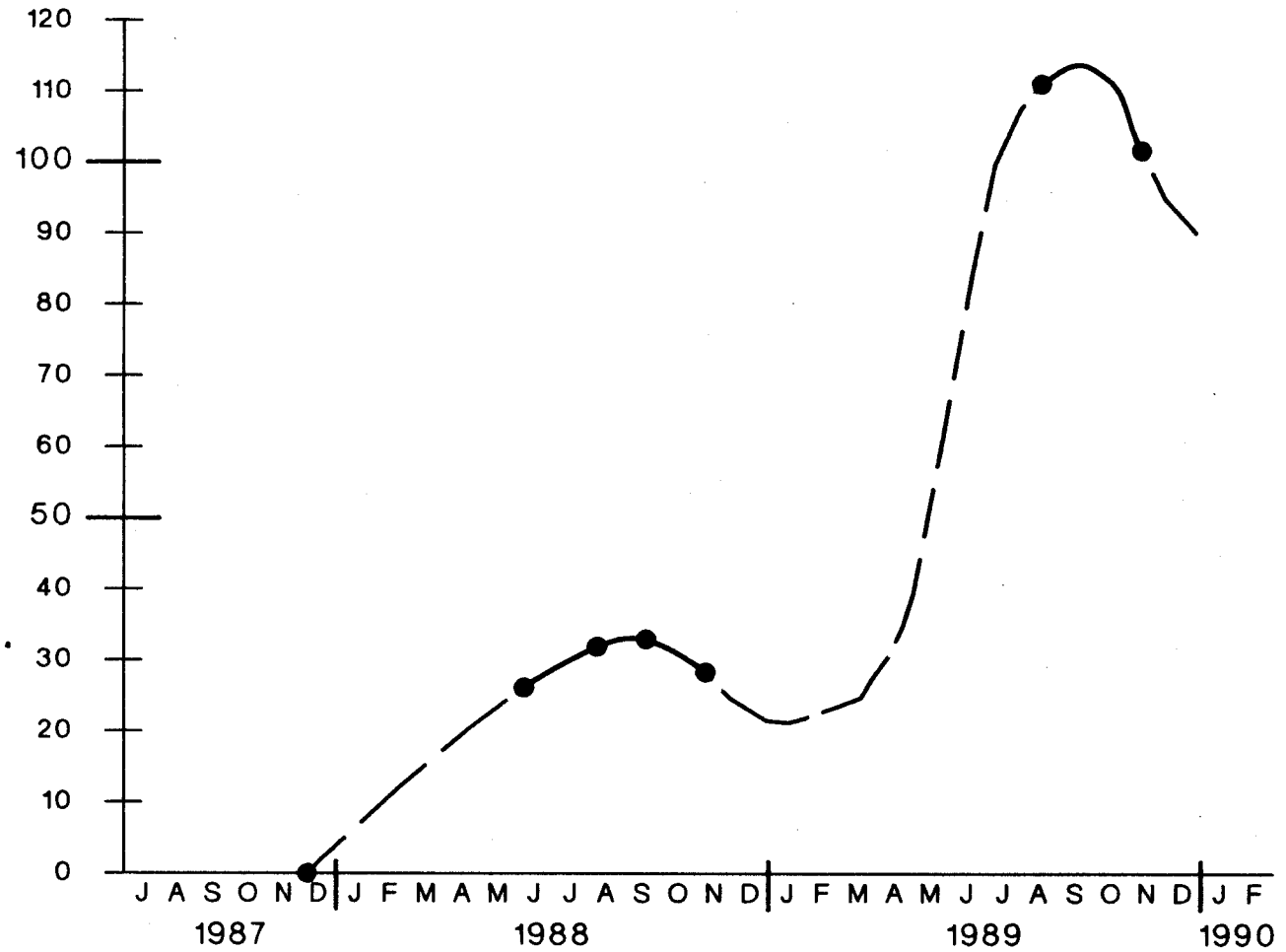
Sincerely,

STEFFEN ROBERTSON AND KIRSTEN
(U.S.), INC.

Ian Hutchison
Division Head
Water

Melissa Pennell
for Chris Page
Division Head
Mining

IH/mlp



PROJECT NO.	PREPARED BY:	FIGURE 1
06901		
DATE 12/89		WATER LEVELS BEHIND THE PLUG
REVISION 0	STEFFEN ROBERTSON & KIRSTEN (U.S.) Consulting Engineers & Scientists	

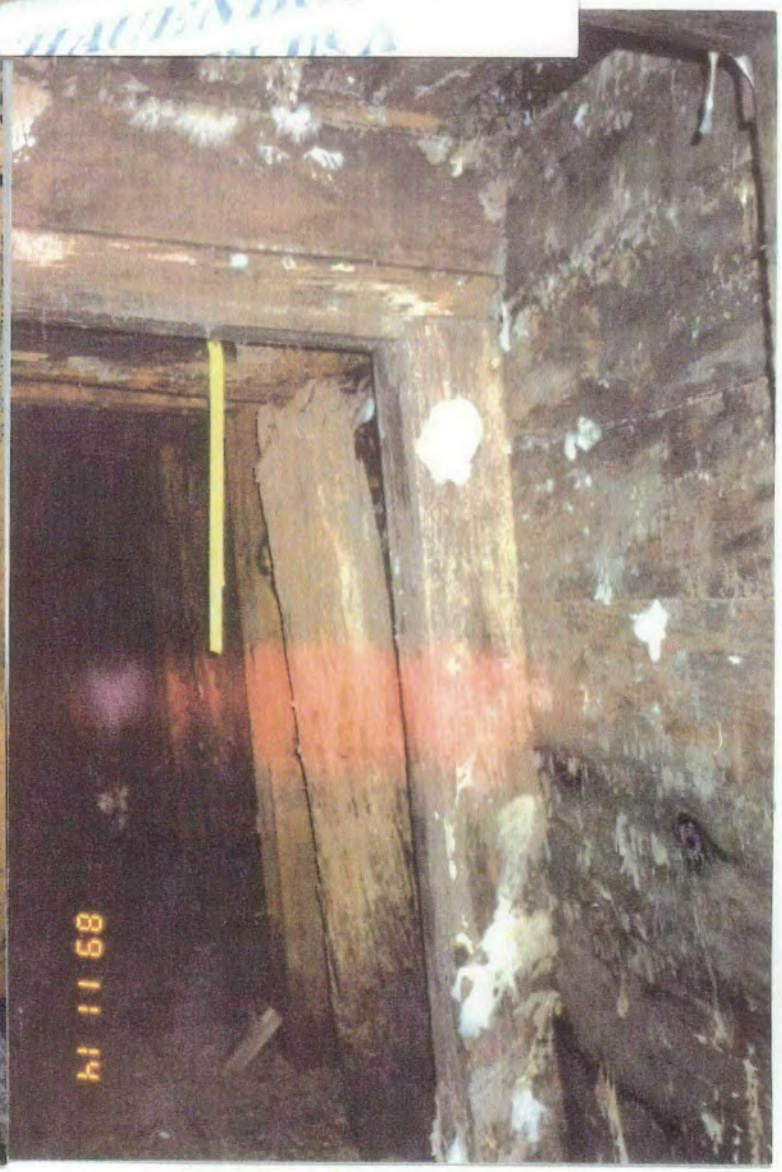
APPENDIX A
SITE PHOTOS:
TAKEN NOVEMBER 14 AND 15, 1989

TAILINGS IMPOUNDMENT

MINE WATER POND

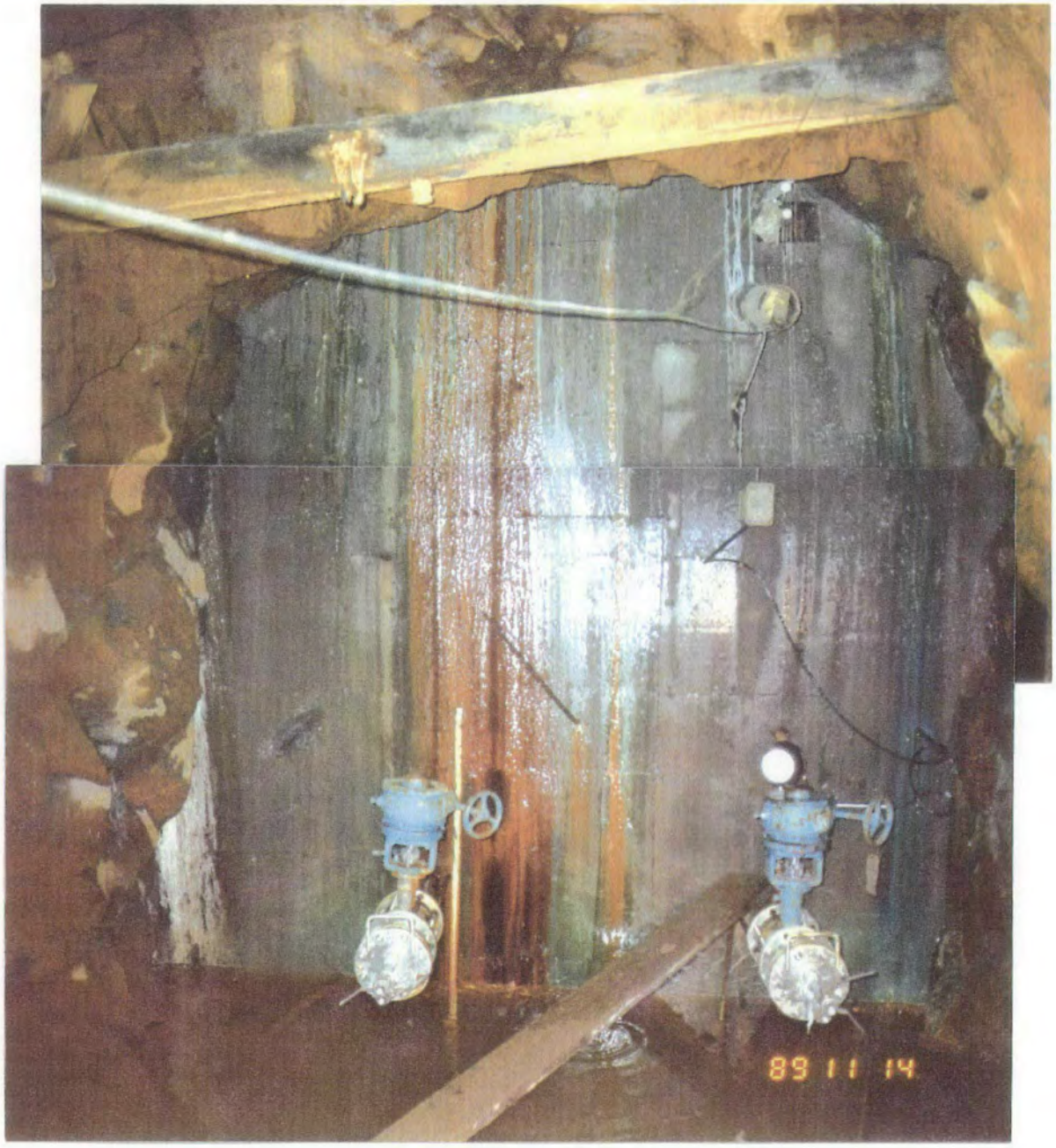
ADIT PORTAL

UNSUPPORTED 700 LEVEL ADIT SEGMENT NEAR THE PLUG

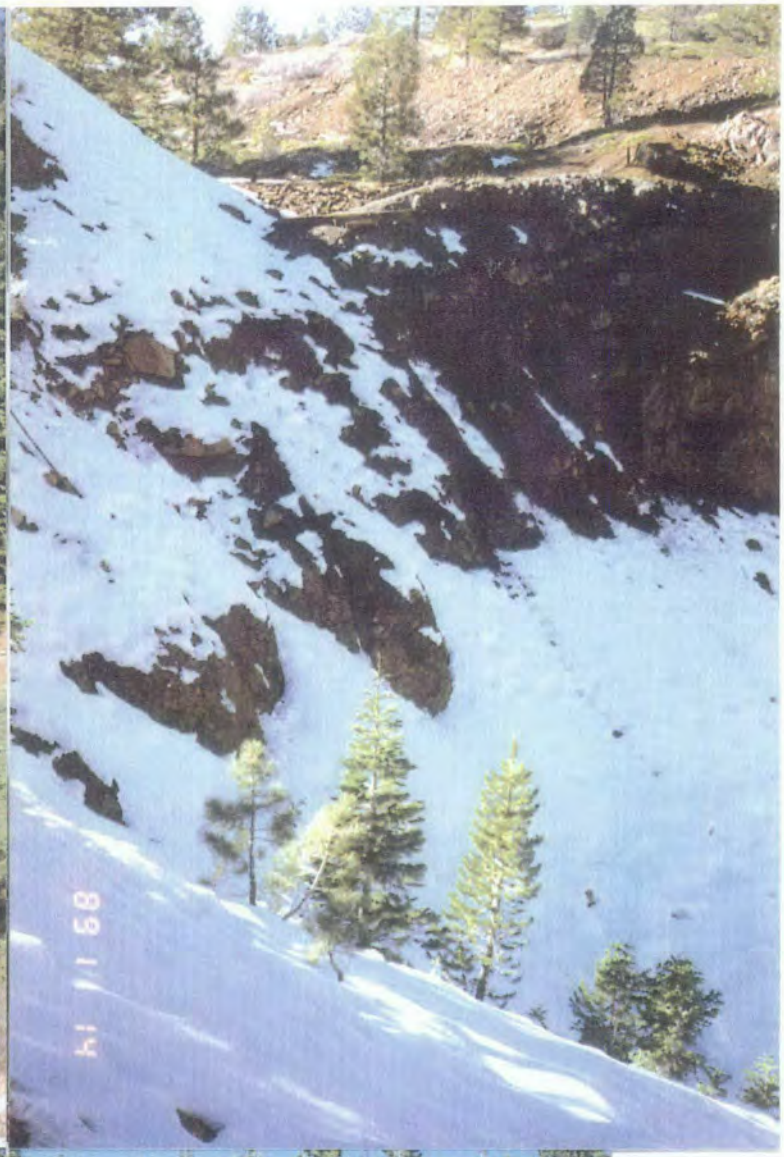


TIMBER SUPPORTED SEGMENTS IN THE 700 LEVEL ADIT

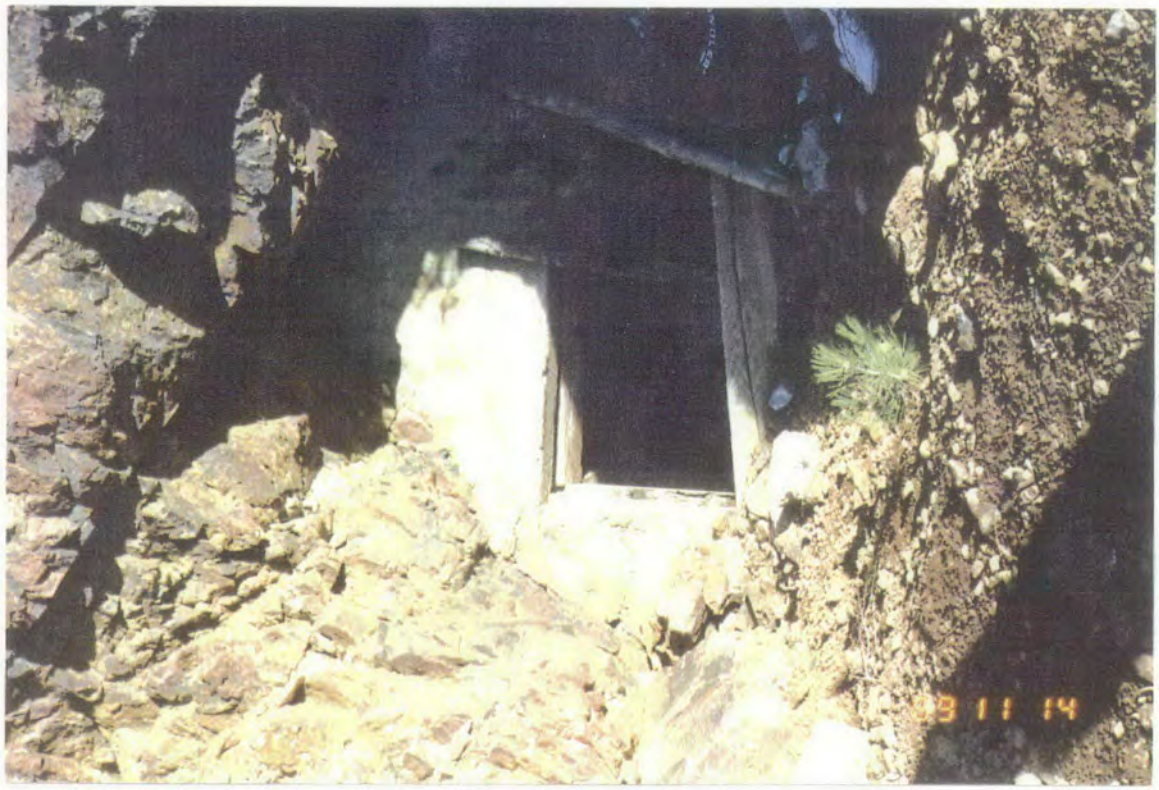
TIMBER SUPPORTED SEGMENTS IN THE 700 LEVEL ADIT



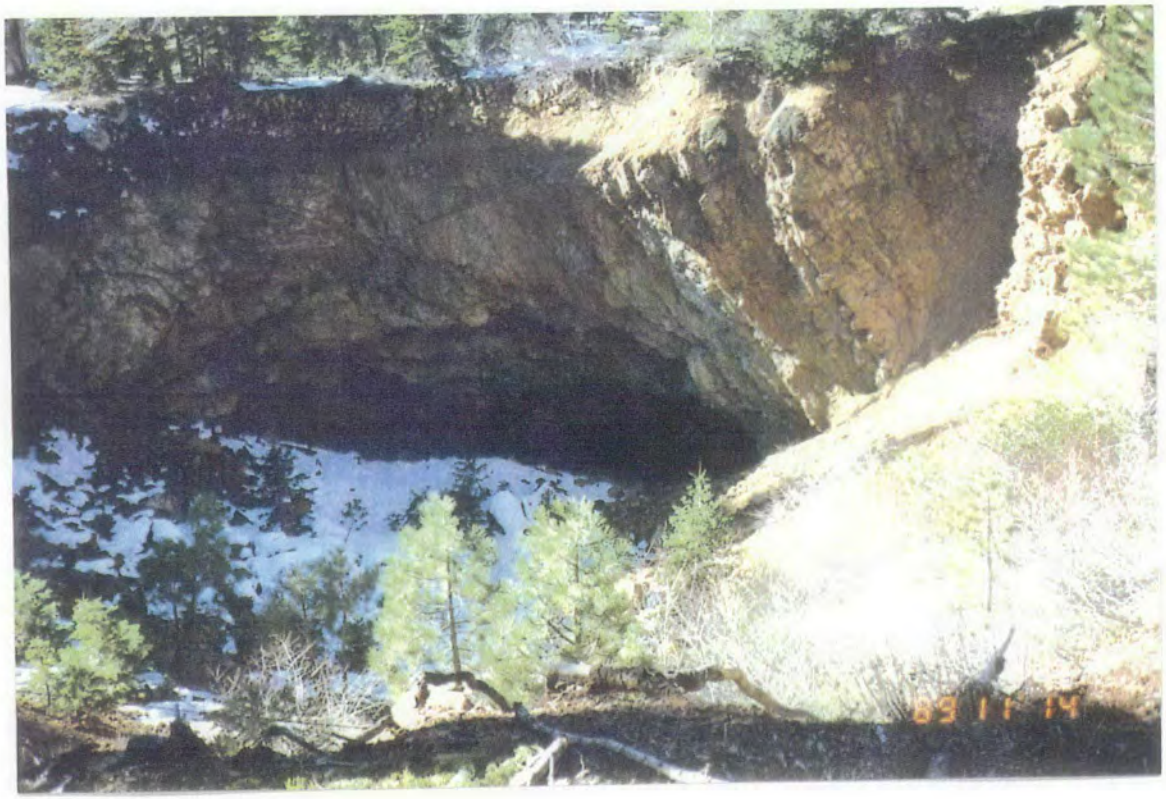
ADIT PLUG



CENTRAL ORE BODY SUBSIDANCE AREA



PIUTE SHAFT



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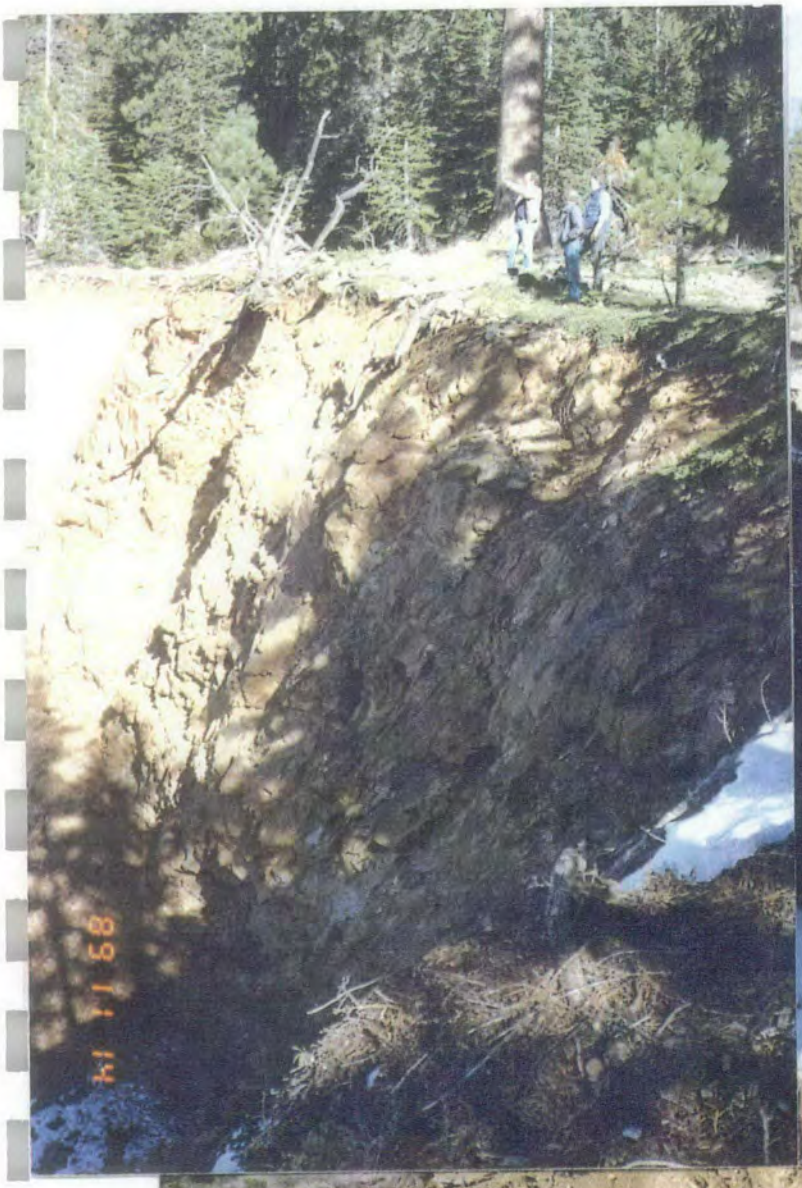

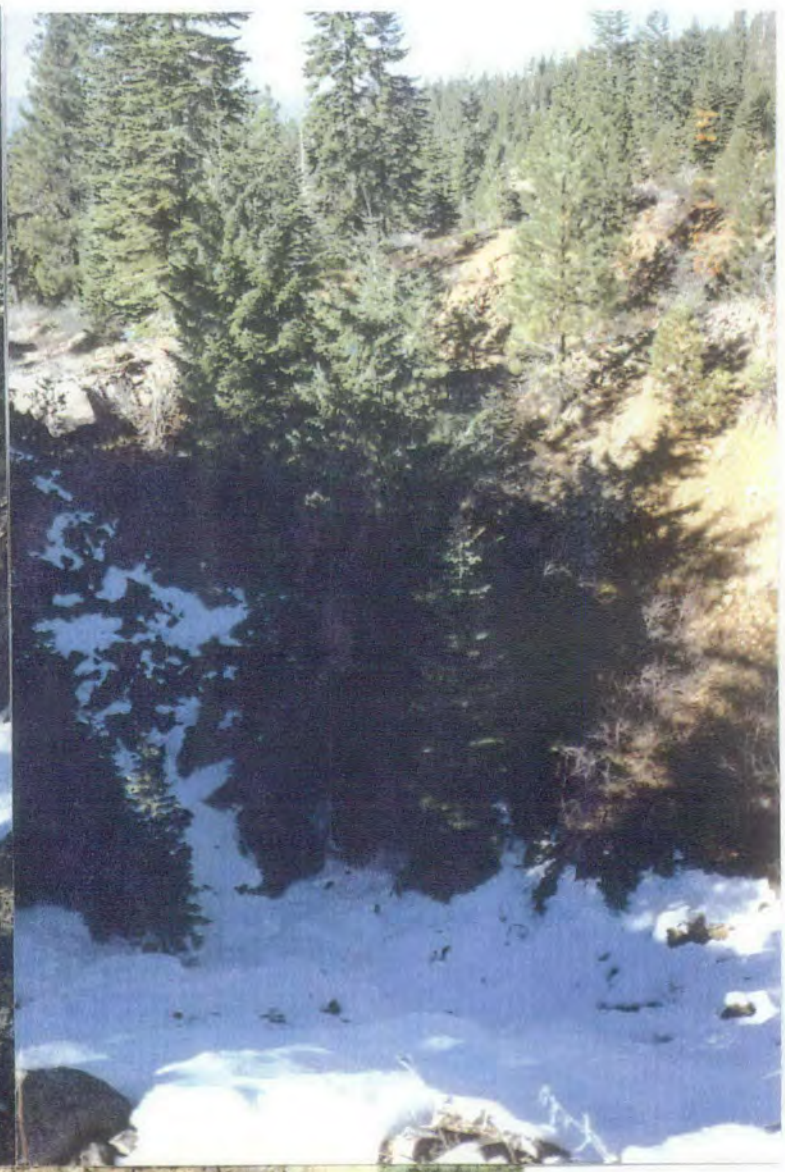

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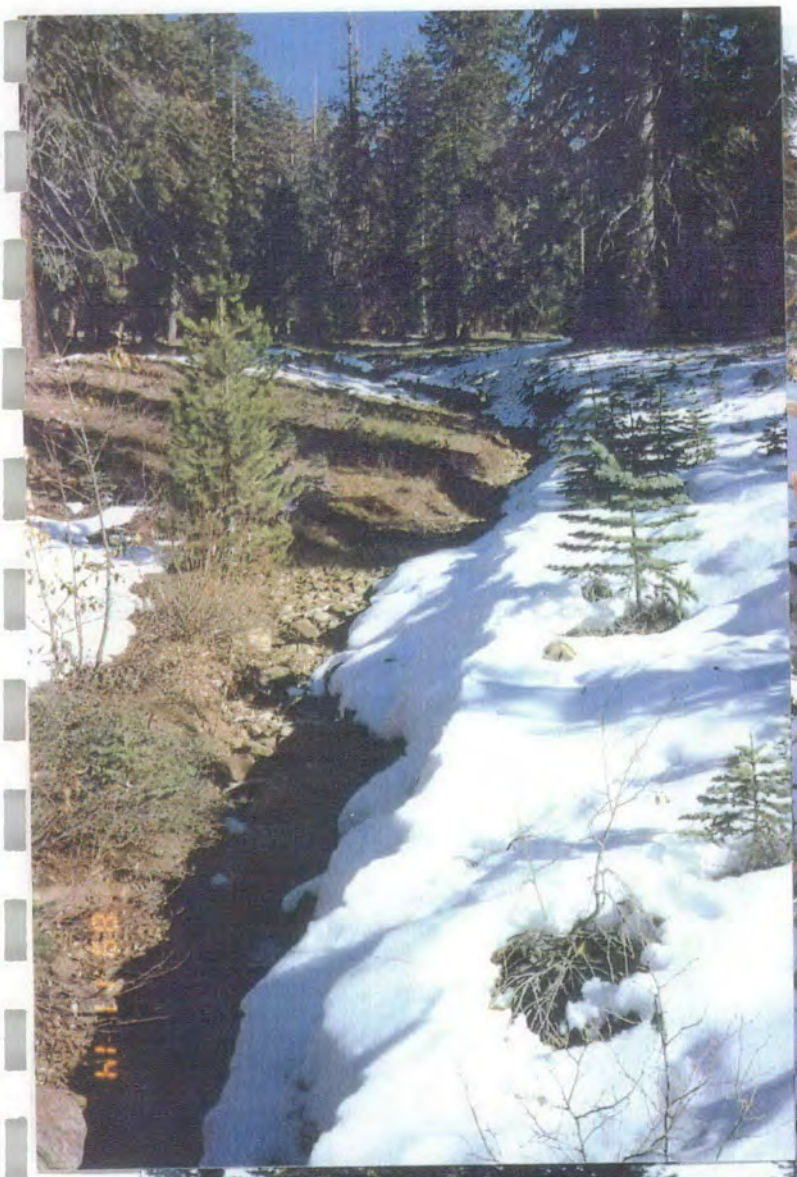
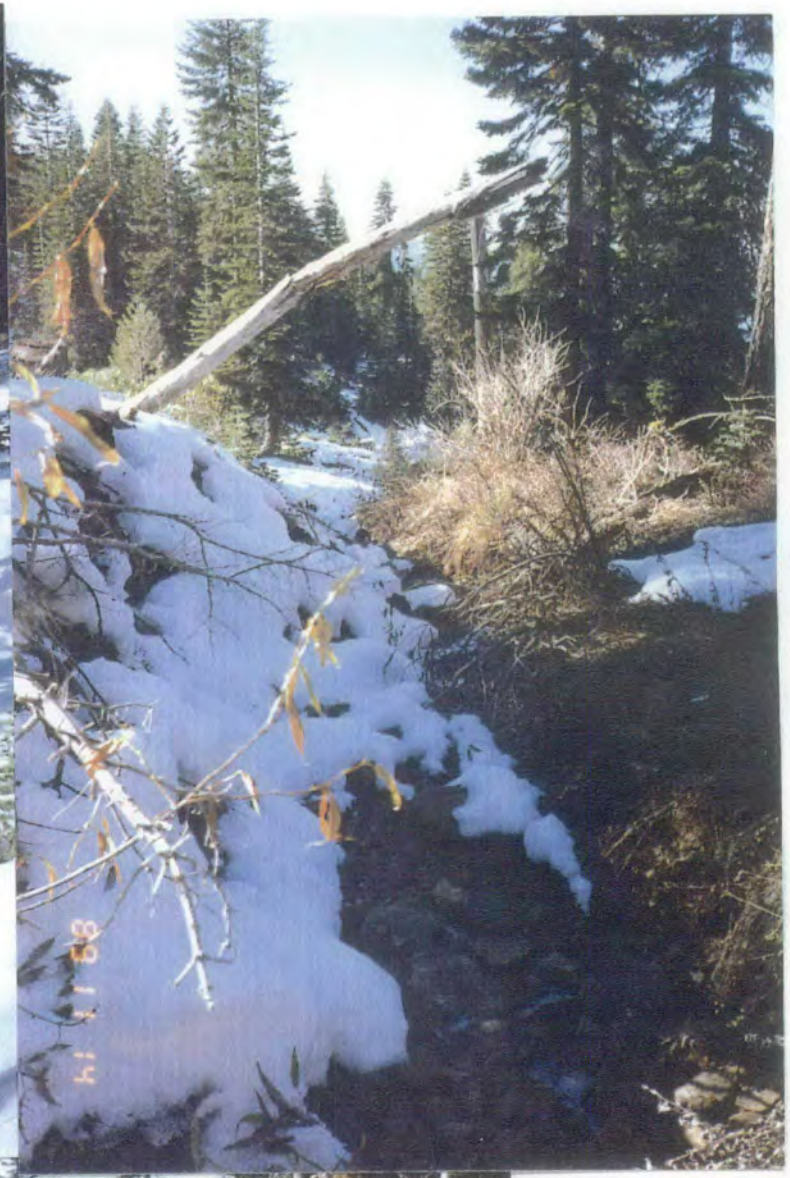
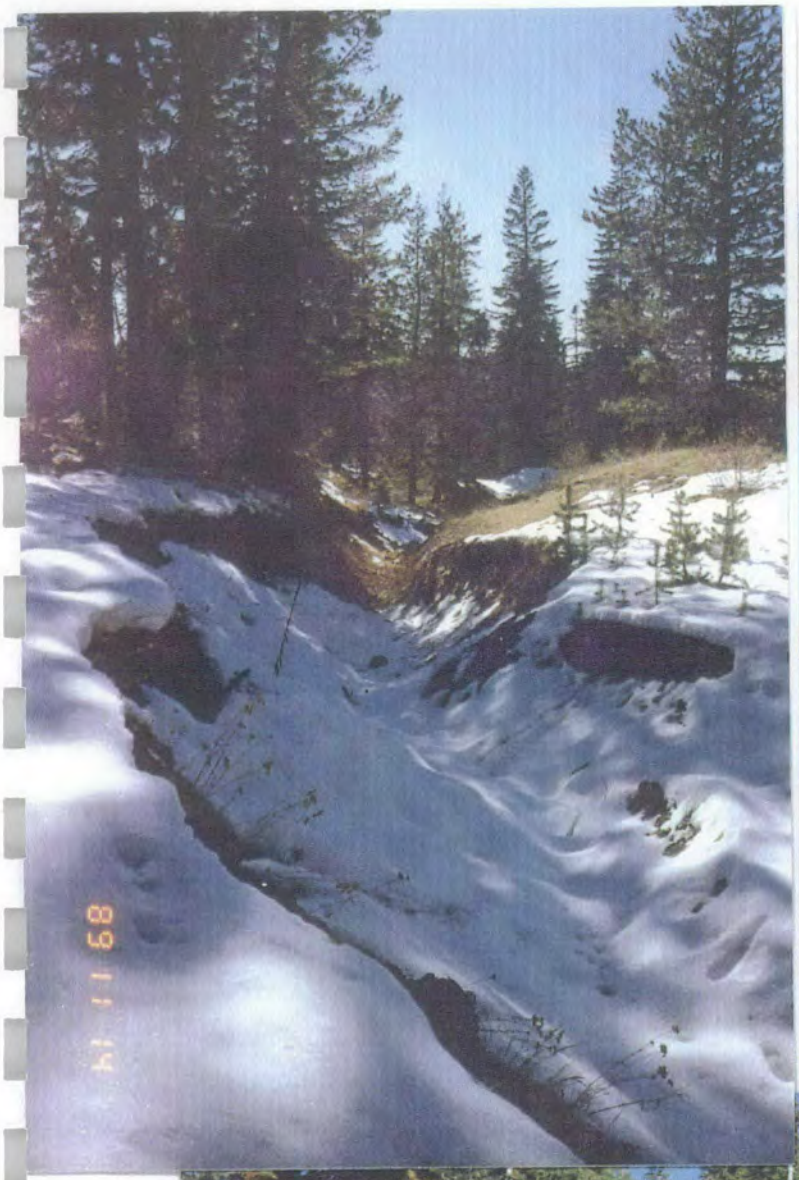
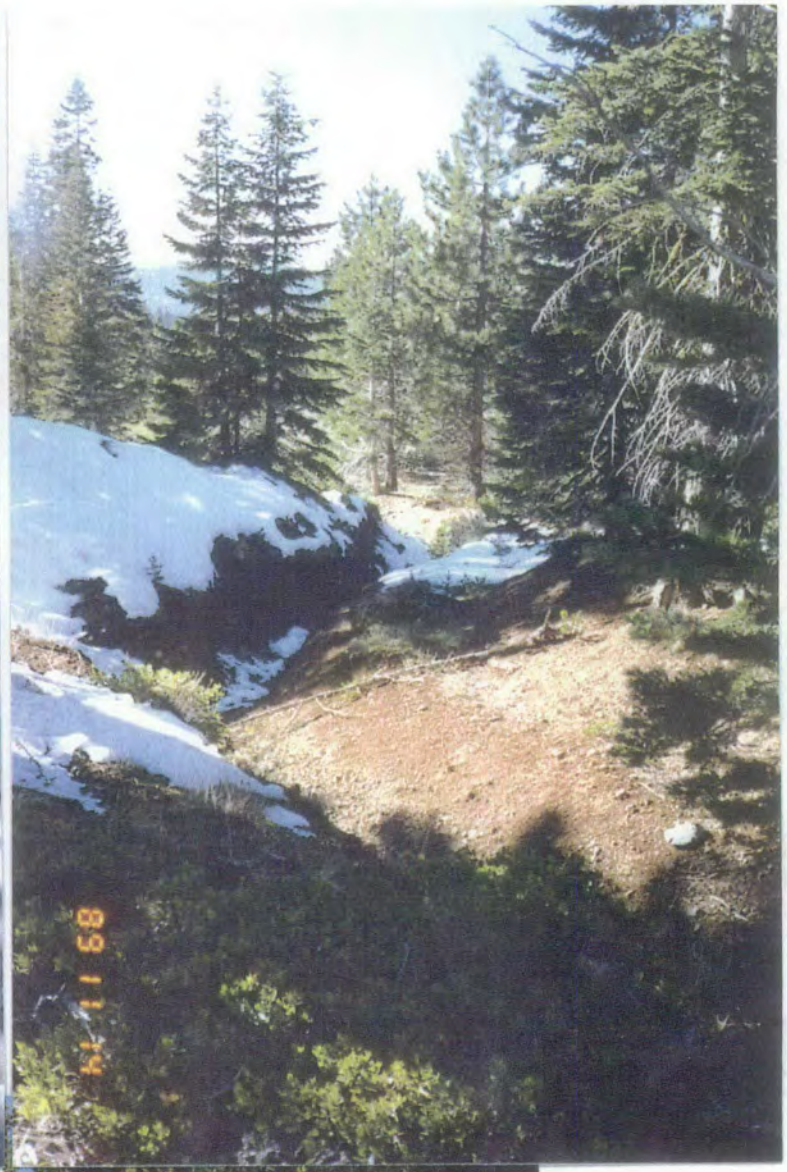




DIVERSION DITCHES AROUND SUBSIDANCE AREAS





DIVERSION DITCHES AROUND SUBSIDANCE AREAS