# THE BORNITE PROJECT
# EXECUTIVE SUMMARY

The Bornite Project proposed by Plexus, Inc. of Salt Lake City, Utah is an underground copper mine. The mine will incorporate development and operation of a highly mechanized, 1,400-ton per day underground mine, operating five days per week. A on-site flotation concentrator will produce 100 tons of copper concentrate per day.

The site is located 50 miles east of Salem, Oregon in the Willamette National Forest on public land managed by the Detroit Ranger District. The project is located in the Cedar Creek drainage, a glaciated valley.

Bornite has a ten year planned life. That includes at least eight years of mining, milling, and concentrating operations, preceded and concluded by a year each of construction and reclamation. About 46 acres would be affected. See Figure 1 for the location of the project.

Some 2.5 million tons of ore will be mined and processed in the project's life. Another 260,000 tons of nonmineralized rock will have to be moved to get at the ore. That non-mineralized material will be used in the construction of mine facilities or stockpiled and used as cemented backfill material underground.

The copper concentrate from the flotation concentrator will be hauled to a deep water port for shipping to a smelter outside of Oregon. A transportation agreement will be obtained from the Forest Service to allow commercial haulage of material on Forest roads.

The non-copper rock, or "tailings", separated from the copper minerals during the flotation process, will be deposited underground as cemented backfill or deposited in a tailings impoundment. Over the life of the mine, 1,267,000 tons of material can be put underground as backfill. The remaining 990,000 tons will be put in the tailings impoundment.

Electric power will be provided by overhead line. Source will be the Tumble Creek power substation near Detroit. Part of the line may be buried for greater reliability.

The transportation route will be from Oregon State Highway 22 near Mehama, up Marion County Road 960 to the Willamette National Forest Boundary. The route then follows Forest Service gravel roads 2290 and 2207 to the mine site. No road construction is required for the project.

The Bornite Project will employ 79 during its eight-year life. During the construction period, additional personnel will be employed. Plexus will hire workers locally except where specialized technical expertise is needed. About 80 percent of the workforce can be recruited locally.

The Bornite site is in the Cedar Creek drainage, characterized as a typical glaciated valley. Cedar Creek is a tributary to the Little North Santiam River. Mine and mill will be 2,250 feet above sea level. The area is characterized as having a Pacific Maritime climate (USFS, 1990), with generally dry, cool summers and mild, wet winters. Most precipitation comes in winter months as rain and snow. Heavy snowfall is common. Mean temperatures range from 30 to 40 degrees Fahrenheit in January to 60 degrees F in August (USFS, 1990).

Site soils have formed in parent materials from weathering of volcanic bedrock, and were influenced by weathering over the Pleistocene glacial epoch. The cool, moist climate, with 70 to 80 inches of annual precipitation, have leached basic cations from the soil. Some of the heavily mineralized soils were covered by thick organic soil cap. However, logging in the early 1950's caused erosional loss of both the organic and A horizon soils over the site.

Vegetation in the Western Cascades is composed primarily of coniferous forests. The mine site contains three plant community types: Douglas fir forest, red alder upland, and red alder riparian. The Douglas fir forest covers 97 percent of the 46-acre mine site. The red alder upland comprises two percent. Since the mine site was timbered in the early 1950's, there are no old growth groves that could be affected by the Bornite Project. No threatened or endangered plant species were found on the mine site, transportation corridor, or electric power corridor.

Wetlands have been delineated in the mine site area. Most of the 3.6 acres jurisdictional wetlands are located adjacent to surface water flows in the mine area. Only 0.89 acres of wetlands will be disturbed by the mine development when surface streams are relocated. This area of wetlands will be replaced by an equivalent acreage or greater.

Three streams occur on or adjacent to the mine site. One stream named "Vanishing Creek" flows over the site and infiltrates into the ground. Cedar Creek flows adjacent to the project site and is a tributary to the Little North Santiam River. Bornite Brook is a tributary to Cedar Creek as it leaves the mine site.

Groundwater at the site consists of water contained in colluvial material, and water contained in the bedrock surrounding the ore deposit. The colluvium is up to 110 feet

Experience
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# Bornite Mining Project Proposed

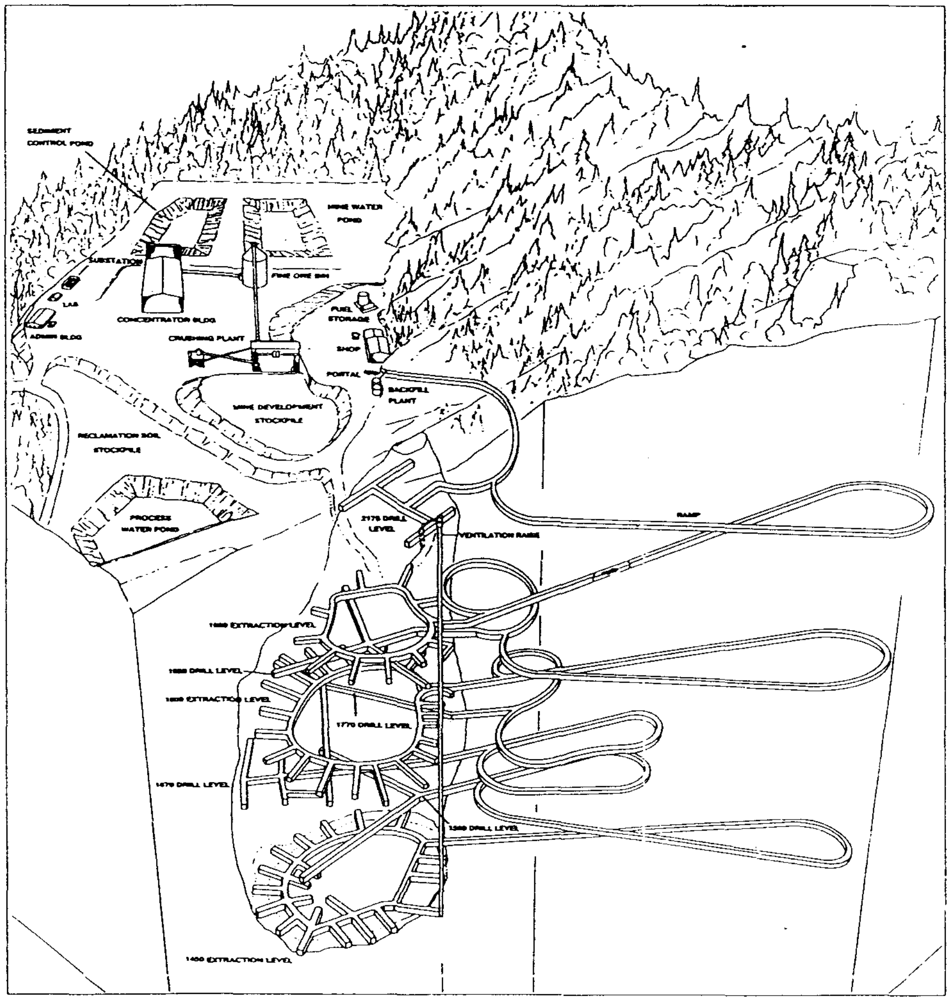
*by Patti Rodgers*

The Willamette National Forest has received a plan of operation for a copper mine on the Detroit Ranger District from Plexus Incorporated of Salt Lake City. The Bornite Project, named for the copper-yielding ore, proposes an underground mine in the Cedar Creek drainage of the Little North Fork of the Santiam. Plexus expects the project to produce 137 million pounds of copper and substantial gold and silver by-products over a minimum 8-year life.

Plexus officials say results from exploratory drilling support an operation with several unique features:

- •No use of cyanide
- •No leaching of ore
- •No acid-generating potential
- •No acid drainage
- •50% of the tailings will be returned underground
- •Minimal surface disturbance
- •Groundwater protection program
- •Complete reclamation will be done

Bornite is an iridescent purple or blue copper iron sulphide, also known as peacock ore. The ore is in a cylindrical rock formation known as a breccia pipe, which is 400-450 feet in diameter and extends more than 1,000 feet below the surface. The deposit near Cedar Creek has been dated at 10.1 millions years.




*Underground mine and plant site perspective--Bornite Project, Plexus, Inc.*

Plexus officials expect the project to employ 80 to 100 workers with base wages from $10 to $15 per hour. Many of the jobs will call for skills that may be available from local populations, and Plexus has made a commitment to worker training and retraining programs.

An Interdisciplinary Team is being formed to oversee the prepartion of

(Cont. on Page 2)

thick in places, and overlies the bedrock. The colluvial aquifer is the dominant aquifer and fluctuates in rapid response to precipitation events. The groundwater aquifer is confined to fissures or openings in the bedrock. The aquifers exhibit different potentiometric levels, water chemistry, and physical aquifer properties. Vanishing Creek infiltrates into the colluvium. Downgradient seeps and springs appear as the colluvial aquifer discharges into Cedar Creek.

Many species of wildlife inhabit the area in and around the mine site. No threatened or endangered species were found at the mine site. The area provides no unique habitat for any threatened or endangered species of animal or aquatic life forms. Fish were found in Cedar Creek adjacent to the project site, but Bornite Brook and Vanishing Creek do not contain any fish. No threatened or endangered macroinvertebrate species were found on the mine site.

The Bornite Project's reclamation goal is to return the site to a forest condition and use. The area is now managed as general forest by the USFS. Reclamation of the site will start during the construction process, with most activity at the end of the project. The topsoil will be salvaged and stored at the beginning of mine development. The area will be revegetated with plants common to the area.

# THE BORNITE PROJECT
# 1.0 EXISTING ENVIRONMENT

## 1.1 HISTORY

Small mining districts throughout the western Cascades of Oregon and Southern Washington and have been mined and explored since the 1890's. The North Santiam District first attracted attention during this time, but most of the production was intermittent between 1915 and 1930. Limited production from the North Santiam District over a 40-year period between 1890 and 1930 accounts for one percent of total production of the seven Cascade districts identified.

The Bornite deposit was discovered by AMOCO Minerals in 1976 during an extensive exploration project to locate porphyry copper deposits in the northwest United States. Although the Bornite deposit is within the North Santiam district and within two miles of deposits known since the 1890's, the Bornite discovery awaited the newer technology involving a combination of soil geochemistry and geophysics. Geologic trends, structures and mineralization at Bornite are similar, and related, to the same intrusives found in adjacent mineral occurrences.

## 1.2 VEGETATION RESOURCES

The Bornite site is in the western hemlock vegetation zone in relatively mild, low elevations just above the Douglas fir zone and below the silver fir zone. Dominant overstory coniferous trees in the western hemlock zone include western hemlock, Douglas fir, and western red cedar.

Plant community types in the study area were identified and quantitatively sampled during the 1991 growing season (Western Resource Development, 1991b). Those in the transportation and transmission line corridors were mapped and qualitatively described. The study area embraces four plant community types: Douglas fir forest, western hemlock/Douglas fir forest, red alder upland, and red alder riparian. Figure 2 is a map of the plant community types of the study area. Each of the plant communities of the mine study area are summarized below from data in the Baseline Vegetation Study (Western Resource Development, 1991b). Table 1 summarizes the occurrence of plant vegetation community types at the Bornite site.

### 1.2.1 Douglas Fir Forest

Most of the study area and a large surrounding area in the Cedar Creek valley was timbered in the early 1950's and later planted with Douglas fir. Western hemlock, western red cedar, and red alder have all invaded the Douglas fir plantings. Douglas fir, the largest trees, have mean heights to about 50 feet and mean diameter-at-breast height (dbh) of about six inches. They provide more cover than any other plant. The shade-tolerant western hemlock have a greater density, but are smaller in height and dbh. Western red cedar and red alder are minor components of the forest canopy.

### 1.2.2 Western Hemlock/Douglas Fir Forest

The 2.8-acre western hemlock/Douglas fir forest is the only portion of the study area undisturbed by the timbering in the early 1950's. This climax western hemlock forest association is characterized by a rather open stand of large trees with a very shrubby understory and little herbaceous development.

### 1.2.3 Red Alder Riparian

The 4.69-acre red alder riparian community occurs as a narrow band along Bornite Brook and Vanishing Creek and in zones of springs and seeps adjacent to Bornite Brook. The red alder riparian community is dominated by red alder and has a dense understory of shrubs with scattered ferns, several dominant perennial forbs, and a mossy cover on rocks, logs, and soil.

### 1.2.4 Red Alder Upland

Red alder also dominates upland areas not moistened by streams and seeps, forming a seral community following timbering. This community consists of one small stand south of Bornite Brook and includes the dry outer fringes of the red alder riparian community in the zone of springs and seeps. This community, covering four acres, is dominated by red alder and has and understory of shrubs, ferns, and numerous perennial forbs.

### 1.2.5 Threatened, Endangered, or Sensitive Plants

There are apparently no federally-listed threatened or endangered plant species documented in the Willamette National Forest, and none was found during field surveys. There are, however, three Category 1 and 2 federally-listed plants and 11 plants listed by the Oregon Natural Heritage as endangered/threatened in the entire range of the Willamette National Forest. Thirteen other plants, one a federal candidate 2 and 12 listed

by the Oregon Natural Heritage as endangered/threatened have not been documented as present in the Willamette National Forest, but are suspected as occurring.

No threatened, endangered, or sensitive plant species have been found during vegetation surveys. Small, isolated individuals of Pacific yew (*Taxus brevifolia*) up to ten feet tall occur in the western hemlock/Douglas fir and Douglas fir forest. A Pacific yew management plan will be developed with the Forest Service to provide for harvest procedures.

**Table 1. Plant Vegetation Community Types**

| Plant Community Type | Tailings Area (acres) | Mine Facilities | Permit Area (%) | Total Area |
|---|---|---|---|---|
| Douglas Fir | 35.41 | 9.24 | 97 | 44.65 |
| Red Alder Riparian | 0.29 | 0.60 | 2 | 0.89 |
| Red Alder Upland | 0.37 | 0.09 | 1 | 0.46 |
| **Total** | **35.07** | **9.93** | **100** | **46.00** |

### 1.2.6 Transportation Access and Transmission Line Corridors

Transportation and transmission line corridors are characterized by mixed coniferous forests dominated by either western hemlock or Pacific silver fir, depending on elevation and aspect. Clear-cuts of varying age, tree dominance, and seral status occur along the routes. Maturing Douglas fir forests resulting from planting or seeding following timbering, red alder uplands in previously timbered areas, and narrow, linear riparian communities along streams and their tributaries with poorly vegetated talus slopes are also present.

## 1.3 SOIL RESOURCES

Study area soils were formed from parent materials derived from weathering of andesite and basalt bedrock, as influenced by additions of volcanic ash. Redistribution and subsequent weathering of these primary parent materials has been modified through the Pleistocene glacial epoch. Parent materials in the study area range from glacial till to recent alluvium, and include colluvial and volcanic ash deposits.

The post-glaciation climate has been characteristically cool and moist. An average annual precipitation of 87 inches has extensively leached basic cations from the soils, and produced very strongly to extremely acidic soil pH conditions. The copious precipitation has also favored the accumulation and addition of organic matter to the soil system. Some soils have thickened organic horizons overlying organic-rich mineral soil horizons.

However, logging activities in the early 1950's in the Bornite project area accelerated erosion rates and exposure of B horizons (subsoil) at the surface. Much top soil was probably lost during this period of deforestation. As a result, a horizon topsoil exists on the project area and a very thin organic layer of material has been regenerated since the logging.

Soils of almost all of the study area were disturbed in the early 1950's when the timber was removed and the waste wood piled and burned. During the 1991 growing season, a soil survey was conducted on the tailings and mine facilities study area (Western Resource Development, 1991a). An Order I survey was completed on potential disturbance areas and an Order III for areas not to be disturbed. Willamette National Forest Soil Resource Inventory (SRI) land type mapping and data (Legrand, et al., 1973) were used to characterize the transportation and electric transmission corridors.

Several soil map units were identified and mapped. Table 2 provides data on the physical and chemical characteristics of the four map units: 10, 12, 13, and 20, in the areas of planned disturbance. The transportation and electric transmission corridors are characterized by 11 SRI land types and their complexes. Figure 3 is a map of soil type locations.

**Table 2. Map Units and Classification of Soils**

| Map Unit | Map Unit Name |
|---|---|
| 10 | Loamy-skeletal, mixed Typic Haplocryands/rock outcrop complex, 40-65% slopes |
| 12 | Fine-loamy, mixed Aeric Cryaquands, 25-35% slopes |
| 13 | Loamy-skeletal, mixed Andic Cryochrepts, 40-65% slopes |
| 20 | Loamy-skeletal, mixed Typic Cryochrepts/loamy-skeletal, mixed Typic Haplocryands Association, 3-20% slopes |
| 21 | Rock outcrop/Lithic Cryorthents, 4-30% slopes |
| 30 | Sandy or sandy-skeletal, mixed Typic Cryofluvents, 1-9% slopes |
| 31 | Loamy, mixed Terric Cryohemists, 0-2% slopes |

Soil texture class was either sandy loam or loam across all soil horizons. Clay content ranged from 8 to 22 percent and gravel greater than 2 mm ranged from 39 to 69 percent in laboratory samples. Accurate assessment of coarse fragment volumes can usually be obtained from soil pedon field descriptions. Based on geotechnical backhoe sampling of soils, the range of cobble content has been developed. The upper foot of soil contains some large, coarse material, but the majority of coarse material is located below

OREGON DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES
1534 QUEEN AVENUE SE, ALBANY, OREGON 97321
TELEPHONE: (503) 967-2039

IDENTIFICATION # ________

## APPLICATION FOR RECLAMATION PERMIT OR GRANT OF EXEMPTION UNDER ORS 517.750-990

1. RESPONSIBLE PARTIES

A. Permittee

Name Plexus, Inc.

Address 185 South State St. Ste. 400

City Salt Lake City State Utah

Phone (801)-363-9152 Zip 84111

B. Landowner (if other than permittee)

Name Willamette National Forest

Address HC 73 P.O. Box 320

City Mill City State Oregon

Phone 503-854-3366 Zip 97360

2. TYPE OF SITE (CHECK ALL THAT APPLY)

- [ ] Pit
- [x] Stockpile
- [x] Plant
- [ ] Quarry
- [ ] Prospect
- [ ] Refuse disposal
- [x] Other Underground Mine

3. MINERAL DEPOSIT CHARACTERISTICS

A. Description

Type of overburden N/A

Approx depth of overburden N/A

Approx depth of mine 900 feet

Primary mineral to be removed Bornite

B. Size

Size in acres of any areas presently affected by surface mining None

How much of the above was affected

before 7/1/72 None

before 7/1/75 None

Has any of the above been reclaimed? N/A

If yes, how much and when? N/A

Approximate acreage to be affected by surface mining during the ensuing 12 months 40

C. Status

- [ ] Active
- [ ] Inactive
- [x] New

Date mining began ______

Date mining will begin 5-1-93

4. IDENTIFICATION OF SITE Tax Lot # ______

| 1/4 Sec. | Section | Township | Range | County |
|---|---|---|---|---|
| S1/2 | 31 | 8S | 5E | Marion |

| Distance in miles | Direction from | Nearest Community |
|---|---|---|
| Six | west | Elkhorn |

5. APPLICATION IS HEREBY MADE FOR:
(see general directions)

A. RECLAMATION PERMIT ( no exemptions)

I apply for a Reclamation Permit under ORS 517.790

Allen S. Ford
signature

Date Nov 24 1992 Title Vice President-Technical Servic

B. GRANT OF LIMITED EXEMPTION based on prior mined (ORS 517.770(1)(a))

I apply for a Grant of Limited Exemption from the requirement for a reclamation plan and bond, but not the fees

signature

Date ______ Title ______

C. GRANT OF TOTAL EXEMPTION

I apply for a Grant of Total Exemption from the requirements of a reclamation plan, bond, and the fees under ORS 517.750(12) and 517.770(2) because:

- [ ] 1. Access road's borrow pit or quarry.
- [ ] 2. On-site construction.
- [ ] 3. The site is less than one acre and a total of less than 5,000 cy of mineral have been, or will be removed.
- [ ] 4. The site has qualified for a Grant of Limited Exemption but annual production is less than 5,000 cy.
- [ ] 5. Other.

signature

Date ______ Title ______

D. Even though entitled to exemptions as shown above, a reclamation plan is submitted voluntarily.

yes ______ no ______

NOTE! COMPLETE THE CONFIDENTIAL SECTION ON REVERSE SIDE (ORS 517.900)

CAUTION: CONFIDENTIAL MATERIAL SHALL NOT BE CIRCULATED OUTSIDE DOGAMI.

the one-foot depth. The coarse fragments average fifty percent of the material in the upper three feet of suitable topsoil material. A range of values has been used in evaluating the topsoil volumes for storage and replacement. The results indicate adequate volumes of topsoil are available for reclamation if the maximum percentage of coarse fragments are removed. Topsoil volume calculations are presented in Table 3.

Soil reaction percentages across all pedons ranged from strong to extremely acidic. Formation of acid conditions in these soils is favored by increased organic matter production and excessive leaching, both due to the average precipitation in the project area. The electrical conductivity ($EC_e$), sodium adsorption ratio (SAR), and calcium carbonate ($CaCO_3$) content over all soil pedons are low, and indicate that salts, free exchangeable $Na^+$ ions, and $CaCO_3$ do not greatly influence the pH or the exchange reactions of the study area soils.

**Table 3. Volume of Soil Available for Reclamation**

| Map Unit | Area | Depth of Suitable Soil | Coarse Fragments | Excluding Coarse Fragments | Including Coarse Fragments |
|---|---|---|---|---|---|
| (Number) | (Acres) | (Inches) | (Percentage) | (Volume x 1000 $yd^3$) | |
| 10 | 1.6 | 35 | 35 - 65 | 2.6 - 4.9 | 7.5 |
| 13 | 20.9 | 44 | 35 - 65 | 42.5 - 78.9 | 121.4 |
| 20 | 22.4 | 30 | 35 - 65 | 31.6 - 58.7 | 90.3 |
| 30 | 1.1 | 8 | 15 - 35 | 0.02 - 0.4 | 1.2 |
| **Total** | **46.0** | | | **76.9 - 142.9** | **220.4** |

## 1.4 CLIMATE

The project site is on the western slope of the Cascade Range at an elevation of 2,200 to 2,300 feet. Mean average temperatures are mild, ranging from about 35 to 65 degrees Fahrenheit. Annual precipitation in the site area exceeds evaporation by a factor of roughly three to one.

Annual precipitation in the site area averages about 87 inches, with almost 70 percent of precipitation occurring during the winter months from November through March. Annual pan evaporation averages about 33 inches, with over 95 percent of evaporation occurring from April through October. Lake evaporation (representing evaporation from pond and other constructed water surfaces on site) is estimated to be 70 percent of measured pan evaporation.

Precipitation and evaporation data is from records collected at Detroit Dam, the closest weather recording station in location and elevation to the site. Detroit Dam is south of the Bornite Project.

### 1.4.1 Precipitation Frequency

From a statistical evaluation of the Detroit Dam data, the 100-year recurrence interval wet year consists of 120.3 inches of annual precipitation and 18.0 inches of annual evaporation. The 100-year recurrence interval dry year consists of 45.0 inches of annual precipitation and 45.8 inches of annual pan evaporation. This data indicates that precipitation exceeds lake evaporation (at 70 percent of pan evaporation) even in 100-year recurrence interval dry conditions.

### 1.4.2 Snowfall/Snow Melt

The site is in a transition zone for winter precipitation, where snow accumulation varies over the winter season, depending on temperature. Snow accumulation may occur over several months with sufficiently cold temperatures.

Calculations indicate that snowmelt at a maximum rate of approximately 5.5 inches per 24 hours would occur in late spring. This would produce runoff similar to that between the 25 and 100 year, 24-hour precipitation events.

## 1.5 FISH AND AQUATIC BIOLOGY

Surveys of the biological characteristics of Cedar Creek and Bornite Brook were done as part of the existing environmental conditions. The sampling was done in September 1991, November 1991, and April 1992. It was found the density of aquatic insects in Cedar Creek varied, with lowest densities in winter and higher densities in fall and spring. No fish were present in Bornite Brook or Vanishing Creek. Cedar Creek did have a rainbow trout population.

### 1.5.1 Riparian Habitat

Riparian habitat of all stream sections sampled was healthy. Indicators of potential sediment production were absent. Stream bank soil stability was excellent, with infrequent raw (barren) banks. Over 80 percent of the stream bank surfaces were covered with vegetation in vigorous condition. Although physiographic and riparian habitat conditions associated with Cedar Creek and Bornite Brook were similar, stream flow and stream habitat conditions were quite different. A significant difference in

ecosystems between the upstream and downstream sections of Cedar Creek was noted. Cedar Creek flows in a subsurface channel during dryer seasons of the year.

### 1.5.2 Aquatic Invertebrate Communities

Examination of aquatic invertebrate communities in streams provides information on the entire stream ecosystem. The density and diversity of species indicate the availability of food resources and habitat for biota to grow and reproduce. Mayflies and stoneflies were important components of the macroinvertebrate community of Cedar Creek. These insects, along with caddis flies, are generally intolerant of low dissolved oxygen levels. Their presence in the abundance found indicates good water quality. A stream study for macroinvertebrates was conducted at nearby Opal Creek (a stream draining from an old growth forest). The density of organisms was slightly higher in Opal Creek than at the Bornite site, although the number of taxa was lower. No threatened or endangered species of macroinvertebrates were found in any of the sampling on or around the project site.

### 1.5.3 Fish

Fish population studies were conducted by one pass electrofishing in four sections of Cedar Creek. All fish were identified, measured and returned unharmed to the stream. Rainbow trout were the only fish species taken in the sampling and are believed to have originated from ODFW stocking activities in the 1960s and 1970s (John Haxton, ODFW, Pers Commun). Above the project site, eight trout were taken from a 400-foot section of stream. Below the site, thirty-three fish were taken from a 400-foot section of Cedar Creek. No fish were found in either Bornite Brook or Vanishing Creek. Fish ranged in size from 3.7 to 11.2 inches, with 75 percent in the 4.0 to 5.9 inch size category. No anadramous fish were found.

Previous ODFW studies in the lower reaches of Cedar Creek also found only rainbow trout. The same relative size category was encountered. Higher trout populations were present in the ODFW sampling in the lower sections of Cedar Creek.

## 1.6 WILDLIFE

### 1.6.1 Avian Threatened or Endangered Species

The northern spotted owl is the only State or Federally threatened or endangered species known to occur in the vicinity of the project area. Two spotted owl habitat conservation areas (HCA), as mapped by the Willamette National Forest, occur in

sections near, but not including, Section 31 containing the project area. Three pairs of spotted owls have been located in areas adjacent to, but not crossed by, the proposed power line corridor.

The northern bald eagle, a State and Federally threatened species, occurs on Detroit Reservoir and the Little North Santiam River to the west of the project area. The type and successional stage of habitats on and immediately surrounding the project site are not important to bald eagles.

The American peregrine falcon is a Federal and State endangered species and a Willamette National Forest sensitive species. Peregrines have been documented on the Willamette National Forest and two sightings have been recorded on the Detroit Ranger District (Willamette National Forest, 1988). There have been no records of peregrines nesting on the District. Although more peregrines undoubtedly move through the area than are detected, the low level of use on the District is by spring and fall migrants moving between nesting and wintering areas. As such, local use is quite limited.

Surveys for Townsend's big-eared bat, a Federal C2 candidate species and a State and Forest sensitive species, were conducted on and around the project area. This species was located in the area, including summer roost use of abandoned cabins along the mine access road, however, no Townsend's bats were detected at the project site, which offers only marginal habitat for Townsend's bat and other bat species.

**Raptors**

Red-tailed hawks and ravens, considered here as raptors because of similar nesting requirements, are the most common, or at least conspicuous, raptors in the vicinity of the project area. Other raptor species such as turkey vultures, all three accipiters, golden eagles, and spotted, barred, small screech, pygmy, and saw-whet owls may also be seasonally present in the surrounding area. There are no known raptor nests on the project site, and the early successional stage of vegetation types on site provide virtually no nesting opportunities.

A modest variety of breeding birds are present on the project site, although bird diversity and abundance are limited because of:

- The small size of the project area;
- The number and area of vegetation types (primarily Douglas fir/ red alder); and

- The age/structural heterogeneity (young/low) of vegetation types present.

Some of the more common species observed at the project site include the dark-eyed junco, mountain chickadees, red-breasted nuthatches, and varied thrushes (Thompson WRD 1991, 1992).

**Game Birds**

Ruffed and blue grouse, mountain quail, and band-tailed pigeons are the game birds present in the vicinity of the project site. No detailed surveys have been conducted to quantify their numbers on the project area or in the surrounding forest. Mountain quail were not observed in the drainage during other baseline surveys.

**Waterfowl and Shorebirds**

Aquatic habitat on the project site is limited to the 2 to 3-foot-wide unnamed tributary of Cedar Creek, sometimes referred to as Bornite Brook. It is flanked by a dense red alder stand. As such, the project site is unimportant to waterfowl and shorebirds. Adjacent reaches of Cedar Creek immediately south of the project site may be used by low numbers and diversities of waterfowl and shorebirds. The most commonly observed water bird along Cedar Creek is the American dipper.

### 1.6.2 Terrestrial Threatened and Endangered Species

There is no evidence that the project site or the surrounding forest is inhabited by any threatened or endangered species including the California wolverine, a Federal candidate species. Wolverine inhabit a large (hundreds of square miles) home range, possibly following migrating ungulate herds between seasonal ranges. Wolverine could conceivably use the project area, if elk and/or deer migrated through the area, or because of the site's location in the valley bottom and the funneling effect of valleys as movement corridors. However, habitats on site are not particularly attractive or important to wolverines.

No records exist of any other State or Federally-listed threatened or endangered species from the project area or its immediate vicinity. No indications of threatened or endangered species were found during baseline wildlife surveys.

**Big Game**

Roosevelt elk, black-tailed deer, and black bear are the big game species present in the vicinity of the project area. There are no site-specific or area data available on elk

or deer numbers because forested habitats are difficult to systematically survey. However, elk densities for the general area are low and are considered one of the lowest of any area in the Willamette National Forest (M. Penninger, USFS, 1991, pers. comm.). Seasonal surveys conducted on and around the project site area indicated that elk were present in the Cedar Creek drainage in only token numbers. Deer were common. Elk and deer winter range in the area is classified on an elevation basis. Northern aspects below 2,400 feet and southern aspects below 3,200 feet are classified as winter range. The project area falls into the winter range classification. In addition, the majority of the project site (the portion below 3,000 feet) is designated a High Emphasis Area for deer and elk winter range. The Cedar Creek drainage is also contained within the Cedar Elk Emphasis Area (a management unit). This area was evaluated using an elk habitat model (Wisdom et al., 1986). Model results indicated that the area represented viable habitat, but could be significantly improved if forage quality could be increased. No calving areas have been identified in the project area and it is unlikely, based on habitats present, that the project area is used for calving.

No seasonal data are available on bear numbers or habitat use. It is likely that habitats on and surrounding the project site are occasionally used by bear during spring and summer. There are no seasonal food concentrations on the project area and the site offers little potential as denning habitat.

**Small Mammals**

Small mammals are ecologically important because they represent the prey base for terrestrial and avian predators. The project site and the surrounding forest supports a variety of small mammals, including shrews, ground and tree squirrels, voles, mice, pocket gophers, etc., although numbers and diversities have not been quantified.

**Predators and Furbearers**

Representatives of this diverse wildlife group include coyotes, bobcat, mountain lion, and weasels, all of which are thought to be at least seasonally present in the Cedar Creek drainage. These species may be occasionally present on site, using the area as part of a larger home range. Mountain lions probably migrate in and out of the area following the migratory movements of deer and elk. Coyotes are probably the most common of all these species on the project area.

**Herpetofauna**

A relatively wide variety of herpetofauna (reptiles and amphibians) inhabit the surrounding forest, although habitat potential on the project area is limited, because:

- Most of the site is a young, mixed conifer stand;
- aquatic resources are limited to Bornite Brook; and
- much of the site has been disturbed by recent mineral activities and past logging activities, and there is little coarse woody debris present.

Nevertheless, several species of snakes and amphibians probably inhabit the site. Pacific giant salamander have been located in Bornite Brook on the project area and adjacent Cedar Creek.

## 1.7 SURFACE WATER HYDROLOGY

### 1.7.1 Quality

All of the surface water samples met EPA primary and secondary drinking water standards, and were within existing DEQ aquatic standards for the Santiam River Basin.

General parameters and major cations and anions were similar to the results shown in WWL (1991), with neutral pH and very low concentrations of species. A small seasonal variation in these parameters is seen. The only metals that were detected (on a total basis) were aluminum, barium, iron, and manganese. These were detected at limited locations.

### 1.7.2 Quantity

The project site is within the Santiam River basin, one of the major Willamette River watershed drainages on the western slope of the Cascades Range. Three streams occur on or adjacent to the project site - Cedar Creek, and the two unnamed streams referred to as Bornite Brook, and Vanishing Creek. The Bornite project site is within the Cedar Creek Valley, which discharges into the westward flowing Little North Santiam River. Bornite Brook is a tributary to Cedar Creek after it flows across the project site. Vanishing Creek flows onto the project site, but infiltrates into the colluvial material before the surface flow reaches Cedar Creek. Flows in the surface streams are variable and dependant on snowmelt and precipitation runoff.

The catchment area of Cedar Creek above its outlet to the Little North Santiam River is approximately 5800 acres (9 square miles). The catchment area of Cedar Creek above the Bornite site is approximately 2600 acres (4 square miles). Flow rates in Cedar creek immediately downstream of the site in 1991 have ranged from less than one to

several hundred cubic feet per second. Flow rates from the 100-year storm at this location were calculated to be 4,440 cubic feet per second. Cedar Creek is a typical Cascade stream with numerous small waterfalls, plunge pools, quiet side channels, and fast flowing riffles. Physical habitat characteristics in Cedar Creek below the project site include an average gradient of 5.2 percent, average flow of 3.16 cubic feet per second, an average width of 20.8 feet and an average depth of 0.33 feet. The substrate is comprised of 51 percent boulders, 42 percent rubble, and 7 percent gravel. The boulder and rubble particles generally have their surface covered by fine sediments and are embedded in the stream channel. Pools constitute 86.6 percent of the stream channel. Woody debris is moderately abundant in the stream channel, covering less than 10 percent of the active channel area.

Just above the project site Cedar Creek flows in a subsurface condition in low flow conditions and is not visible in the creek channel. Cedar Creek then reappears in the stream channel at a bedrock colluvium interface adjacent to the project site.

Bornite Brook discharges into Cedar Creek after it crosses the project site. Bornite Brook is a fast flowing, perennial stream with low flows. Bornite Brook flows are greatly affected by seasonal conditions. Primary influences are precipitation, snowmelt, and groundwater inflow. The average characteristic values of Bornite Brook are depth: 0.17 feet, width: 7.0 feet. Gradient is variable with 27.6 percent and 11.2 percent measured in study areas. The substrate composition is 50 to 54 percent rubble and 25 to 36 percent boulders. Woody debris constitutes 30 percent of the active channel area.

Vanishing Creek flows nearly parallel Bornite Brook. The flow gradually diminishes as it flows across the project area. The infiltration area varies by seasonal flow. Flows in Vanishing Creek were measured at 0.01 cubic feet per second in September 1991.

## 1.8 GROUNDWATER HYDROLOGY

### 1.8.1 Summary of Geohydrologic Evaluation

Surface water sampling was begun during the first quarter of 1991, and has been conducted on a quarterly basis. Flows at the sampling sites have been gauged or estimated with the quarterly sampling. The results indicate that although there is a significant variation in flow rate, surface water quality shows neutral pH and very low solids concentrations, with very little temporal variation. Cedar Creek shows slightly lower solids concentrations than its tributaries.

Groundwater sampling was begun with one of the exploration drill holes in the first quarter of 1991 by sampling an artesian flow from a preexisting unplugged exploration drill hole. Drilling and installation of six new monitoring wells (for site characterization and operational monitoring) was started in the fourth quarter of 1991 and completed in January, 1992. Geohydrology data from the monitoring wells was supplemented with exploration hole logs and hydraulic testing of selected exploration holes.

Two hydrogeologic units have been defined, bedrock and an overlying colluvium. Results indicate bedrock beneath the site is generally of very low porosity and permeability. Hydraulic conductivity depends on the fracture spacing and continuity in the bedrock. Bedrock groundwater quality shows some variability, and contains the highest solids concentrations of water on site. The overlying colluvial terrace materials on site are of moderately high porosity and permeability. Colluvial groundwater has solids concentrations similar to those of surface water and lower than fractured bedrock water. Water levels indicate a general downward gradient from the colluvial terrace materials to bedrock, and a gradient within each hydrologic unit that drains toward Cedar Creek and the lower western end of the site. Water levels in the colluvium respond quickly to significant precipitation.

Water level and water quality data show a similarity between surface water flow and groundwater in the colluvium, and indicate that the primary source of recharge to the colluvial aquifer is from surface water flow. Water level and water quality data between bedrock and other waters do not show this similarity. This indicates a very limited hydraulic connection between bedrock and the overlying colluvium.

### 1.8.2 Hydrologic Units

The colluvium contains groundwater, and comprises the uppermost aquifer in the immediate site area. Due to the limited lateral and downgradient extent of the colluvium, the extent of this aquifer also is limited. Upgradient contributions to the colluvial aquifer are surface flow in Cedar Creek, groundwater flow in the colluvium beneath Cedar Creek, surface flow in Bornite Brook, and surface flow in Vanishing Creek. Groundwater in the colluvial aquifer must exit as surface water, since the colluvium pinches out at the downgradient or northwest end of the site.

The andesitic bedrock contains and yields small amounts of groundwater from fractures and joints. It comprises the lower groundwater system at the site in areas where the colluvium is present and overlies the bedrock. Where the colluvium is not present, the bedrock comprises the only groundwater system. Due to its low yield, the bedrock system is more of an aquitard than an aquifer by most typical definitions (Strachan,

WWL, 1992). Figure 4 is a cross section through the project area of the hydrologic units.

### 1.8.3 Monitoring Wells

Six monitoring wells were completed to provide groundwater hydraulics and groundwater quality data for site characterization and permitting of the Bornite Project. The wells were located in downgradient areas of the site for monitoring changes in water levels and water quality during and after project operation. Wells were constructed according to WRD and DEQ design specifications. WRD personnel visited the site during the well installation.

Three of the wells were completed in bedrock (bedrock wells), and three were completed in the overlying terrace materials (shallow wells). The wells were located in pairs, with one well in rock, and an adjacent well in terrace materials.

At each site of paired wells, the bedrock well was drilled and completed first. The well was drilled into rock a sufficient depth to intercept water-bearing fractures. After the bedrock well drilling was completed, the shallow well was drilled. The depth of completion for the shallow well was chosen from the depth of water encountered in the colluvial materials in the deeper bedrock well.

Differences in water quality between the shallow and bedrock wells can be seen. Shallow wells M4 and M5 show TDS concentrations below 30 mg/l, with cadmium and iron being the only detected metals. Rock wells show TDS concentrations over 100 mg/l, and detected barium, boron, cadmium, iron, manganese, and molybdenum. The rock wells show a similarity in water quality to samples obtained from exploration hole CC18, which penetrates the ore body to a total depth of 618 feet.

Shallow well M6 has a very high TSS value, and generally different water quality from the other shallow wells. Cloudy water was observed during development and sampling of M6. This is most likely due to bentonite in the well from M3 or the upper part of M6.

### 1.8.4 Water Levels

Fluctuations in monitoring well water levels overtime indicate a significantly different response between colluvium wells and bedrock wells. This indicates that there is little hydraulic connection between the colluvium and bedrock.

Power lines and poles will be removed from the mine site and adjacent corridors with any disturbance being regraded and revegetated. Wells and water lines established to provide project water will be removed with the wells backfilled and closed in accordance with State of Oregon requirements.

### 4.4.1 Mine

Mined-out stopes will be backfilled during course of mining operations. This will serve to prevent any subsidence potential. Once backfilling is completed, mine entry and ventilation raise will be permanently closed, either by blasting and recontouring the entry ways or by sealing them with concrete plugs. The mine and ventilation will be closed in a manner to permanently prevent entry.

All equipment will be removed from the mine, with the exception of structural steel concrete or other nonsalvageable items. Any equipment left underground will be approved by DOGAMI, DEQ, and the Forest Service.

### 4.4.2 Mill Facility Ancillary Structures

All buildings and equipment will be removed. Building foundations will be removed or buried.

### 4.4.3 Tailings Impoundment Facility

Process water will be used in the last stages of backfilling. Any excess water will be treated and discharged. The tailings facility impoundment will be reclaimed by removing the capability to store water when the dam is graded. No water storage impoundments will remain on the mine site. When the surface of the tailings material has gained sufficient strength to support equipment, topsoil will be applied, followed by seeding and planting.

### 4.4.4. Ponds

Analysis of pond sediments will be done to determine if on site burial is an allowable disposal method. Ponds will be backfilled with native material. If analysis indicates sediments cannot be buried on site they will be moved to an appropriate disposal site.

Table 13. Topsoil Stockpile Seed Mixture

| Scientific Name | Common Name | Application Rate |
|---|---|---|
| Bromus marginatus | Mountain Brome | 3 lb/acre |
| Dactylis glomerata | Orchardgrass | 3 lb/acre |
| Festuca ardundinacea | Tall fescue | 3 lb/acre |
| Lolium multiflorum | Annual rye | 3 lb/acre |
| Lolium perenne | Perennial ryegrass | 3 lb/acre |
| **Total** | | **15 lbs/acre** |

### Soil Volume

The two stockpiles will have a capacity of 142,900 cubic yards. Adequate area exists to enlarge the stockpile volume area if the course fragment portion is included in the storage. Table 3 illustrates the volume of soil available for reclamation for each mapping unit affected by mining activities. Estimated stripping depths range from 8 to 44 inches, depending on soil type. The total volume of soils available is 220,400 $yd^3$. However, if the estimated percent of coarse fragments are removed, the volume of material ranges from 77,100 to 142,900 $yd^3$, depending on the estimate of percent coarse fragments. Placing the material, coarse fragments included, uniformly over 46 acres would create a soil depth of about 36 inches. Excluding the coarse fragments, the soil depth would range from about 12 to 23 inches, depending on the actual percent of coarse fragments.

## 4.4 DECOMMISSIONING OF FACILITIES

Upon closure, all process buildings and related facilities will be removed and salvaged. Concrete foundations will be broken up and placed either in mine workings or in the process water pond and buried. Then the site will be graded to reestablish a natural drainage. The sediment control pond, which is unlined, will be incorporated into the final grading. The synthetic liners in the process water and mine water ponds will be freed from their anchors, folded in on themselves, and covered with fill material prior to covering by topsoil and revegetation.

Unless designated by the U.S. Forest Service for land management or recreation purposes, all roads will be closed and reclaimed following mine closure. The compacted roads will be ripped, graded, and water-barred to permit natural drainage and revegetation. Fencing will be removed to reestablish access to the site.

Power lines and poles will be removed from the mine site and adjacent corridors with any disturbance being regraded and revegetated. Wells and water lines established to provide project water will be removed with the wells backfilled and closed in accordance with State of Oregon requirements.

### 4.4.1 Mine

Mined-out stopes will be backfilled during course of mining operations. This will serve to prevent any subsidence potential. Once backfilling is completed, mine entry and ventilation raise will be permanently closed, either by blasting and recontouring the entry ways or by sealing them with concrete plugs. The mine and ventilation will be closed in a manner to permanently prevent entry.

All equipment will be removed from the mine, with the exception of structural steel concrete or other nonsalvageable items. Any equipment left underground will be approved by DOGAMI, DEQ, and the Forest Service.

### 4.4.2 Mill Facility Ancillary Structures

All buildings and equipment will be removed. Building foundations will be removed or buried.

### 4.4.3 Tailings Impoundment Facility

Process water will be used in the last stages of backfilling. Any excess water will be treated and discharged. The tailings facility impoundment will be reclaimed by removing the capability to store water when the dam is graded. No water storage impoundments will remain on the mine site. When the surface of the tailings material has gained sufficient strength to support equipment, topsoil will be applied, followed by seeding and planting.

### 4.4.4. Ponds

Analysis of pond sediments will be done to determine if on site burial is an allowable disposal method. Ponds will be backfilled with native material. If analysis indicates sediments cannot be buried on site they will be moved to an appropriate disposal site.

### 4.4.5 Crown Pillar

The crown pillar area will be reclaimed by backfilling the excavated portion of the orebody with cemented backfill tailings. The area will then be recontoured into the surrounding terrain. Topsoil will be replaced, with revegetation following.

### 4.4.6 Power Line

Overhead line will be removed from the poles and salvaged. Wooden pole structures will be cut at ground level and removed. Underground line will be cut off below ground level and left in place.

After removal of the surface structures, disturbed areas will be scarified and revegetated with a seed mixture suggested by the Forest Service. No grading or topsoil application is anticipated for the powerline areas.

### 4.4.7 Removal and Disposal of Equipment and Ancillary Facilities

All equipment, buildings, and ancillary facilities will be removed. Wood, concrete, or structural steel may be disposed of by placing it in the cemented backfill. All other materials will be salvaged or placed in appropriate disposal sites.

### 4.4.8 Removal of Process Chemicals

All process chemicals, gasoline, and oils will be salvaged or hauled off site to appropriate recycling or disposal sites. Unused stock may be returned to suppliers if appropriate.

## 4.5 RECLAMATION

### 4.5.1 Grading and Recontouring

No water impounding areas will remain following grading. Only stream courses will remain after the grading is complete. Plate 5 indicates the general post-mining contours.

When facilities have been removed from the site, grading will be initiated. Equipment will be similar to construction equipment, i.e.: bulldozers, trucks, front end loaders, and motor graders.

### Facilities Area

Facilities will be decommissioned and removed. The only remaining material may be cement building foundations. Material will then be replaced into excavated areas. Excess soil material stockpiled or stacked will be graded to match surrounding terrain.

### Mine Portal

The mine portal area will have all facilities removed from the entrance area and permanently sealed. Following sealing of the portal, material will be graded up to the closed entrance. This will prevent a sharp precipice from existing and help to deter any efforts to reenter mine workings.

### Ponds

Pond will be backfilled with fill material following proper closure of the ponds. The material will be transported to the pond sites from other areas where fill material is located.

### Tailings Impoundment

The dam of the tailings impoundment will be graded, to allow precipitation water to run off. The general slope of the impoundment surface will be from northeast to southwest. Deposition of tailings material near the end of the mine life will be in the eastern end of the tailings impoundment. This deposition will elevate the eastern end of the pond.

### Tailings Impoundment Dam

The tailings impoundment (dam) will be graded to a 2:1 slope or less. Grading will occur when the tailings material have been drained and have become stable. A bulldozer will grade material from the top portions of the dam to reduce the overall outslope angle. The interior slope of the dam will be graded to a 2:1 slope angle or less. The goal of the grading is to eliminate the storage capacity of the structure. Precipitation runoff cannot be stored; thus hazards associated with water storage are nonexistent.

### Crown Pillar Area

The excavation of the 65,000 cubic yards of material from above the crown pillar to be accessed for mining. The stopes will be backfilled with cemented tailings material waste rock material to the original bedrock elevation of 2200 foot level. A cap of seeding. Seedbed preparation will occur just prior to seeding to minimize the time the seedbed is subjected to wind and water erosion.

### Fertilizer and Soil Amendments

Stockpiled soils will be managed to maintain their biological activity and productivity. Reducing the time that soils are stockpiled or promoting growth on the soils immediately after they are stripped will reduce the loss of soil productivity. Stockpiling results in a reduction of viable biological components such as seeds and microorganisms. In the tailings area, the soil will be removed in three stages over the life of the mine. Soils from Stage 1 will be stockpiled for later use.

Topsoils receive organic matter from the vegetation they support and have a high fertility due to the high cation exchange capacity. When soils are stripped, the organic matter recycling is terminated and the fertility declines with time. Stockpiling topsoils produces a "compost heap" effect and, over time, the organic content and soil nitrogen decreases without additional organic matter from vegetation. The fertility of the topsoil stockpiles will be maintained and replenished by establishing a dense cover of grasses and deep-rooted legumes on the topsoil stockpiles. The vegetation will provide organic matter to maintain the nutrient cycling and result in some nitrogen fixation in the soil due to the legumes in the seed mix.

Productivity of soils on the redressed areas may initially have a lower fertility until vegetation results in the re-establishment of an organic horizon (surface litter layer) and development of an organic A horizon (topsoil). Fertilizers will be used to augment soil productivity during the initial stages of reclamation. In the long term, revegetation will result in re-established nutrient cycling biological activity. These activities will enhance soil productivity.

If the tailings have a good internal drainage to encourage root development, it will be possible to establish a plant community with a high productivity due to the larger rooting volume provided by the inert silty sands. That portion of the tailings embankment lined with rocks will have a low biomass productivity because of the lack of topsoil, a fertile media, and the limited space between the rocks for rooting.

The soil will be tested for nutrient levels. After replacement, amendments will be added to condition the soil if needed. Soil samples will be taken on quarter acre grids. The soil will be tested for Sodium Adsorption Ratio (SAR), Nitrogen, Phosphorous, and Potassium.

cemented tailings will cover the top of the crown pillar area. The excavated colluvial material will then be used to restore the area to a premining slope angle. Figure 19 is a cross section of the crown pillar mining technique, and Figure 20 is a plan view of the crown pillar mining area.

### 4.5.2 Surface Preparation

Following grading of an area, topsoil will be reapplied. The surface will be left in a rough condition to receive capping of topsoil. Any areas compacted during the mining operation will be ripped to relieve compaction. Maximum ripping depth will be three feet. The tailings impoundment will not be ripped unless there are areas of extreme compaction.

Soil compaction reduces water and root infiltration and plant productivity. Therefore, areas to be reclaimed will be thoroughly tilled prior to topsoil application to eliminate compaction. Once the topsoil has been added to the surface to be reclaimed, no machines with soil compacting potential will be used on the soils.

### 4.5.3 Topsoil Replacement

Topsoil will be reapplied to areas of the project that have been graded to meet final contour slopes. Scrapers or front end loaders and trucks will remove topsoil from the stockpile and distribute it. The topsoil will be spread in single lifts and will receive minimal traffic (compaction) upon placement. The topsoil will be ripped in a final step prior to seeding. Depending on availability of topsoil, it will be replaced in an even depth over the property.

### 4.5.4 Revegetation

#### Seedbed Preparation

Seedbed preparation will be done with implements such as harrows, disks, and cultipackers. Topsoil materials will be conditioned to a depth of six inches with these implements when the topsoil is sufficiently dry to minimize clogging and compaction. All tilling operations will be done on contour lines to minimize soil erosion.

The final finished seedbed will result in a furrow-like configuration with the height between furrow ridges and bottoms of between two and six inches. The furrows will be constructed along contours where possible. This will minimize erosion, optimize available soil moisture, and produce a soil surface appropriate for broadcast or drill

## Seed Mixtures

The following seed mixture is proposed for final revegetation at Bornite. Based on vegetative test plots, the proposed seed mix may be modified. Approval from the Forest Service will be obtained before modifications. Grass seeding will occur in early fall (September-October), prior to the rainy season. Tree planting will occur in the spring when field conditions permit.

**Table 14. Revegetation Seed Mix**

| Scientific Name | Variety | Common Name | Pounds/Acre |
|---|---|---|---|
| **Shrubs** | | | |
| Acer circinatum | -- | Vine Maple | 1/4 |
| Amelanchier anlifolia | -- | Western serviceberry | 1/4 |
| Ceanothus velutinus | -- | Snowbush | 1/4 |
| Cornus canadensis | -- | Bunchberry | 1/4 |
| Gaultheria shallop | -- | Salal | 1/4 |
| Sambucus racemosa | -- | Red elderberry | 1/4 |
| Symphoricarpos albus | -- | Snowberry | 1/4 |
| **Total Shrubs** | | | **1 3/4** |
| **Grasses** | | | |
| Bromus marginatus | Bromar | Mountain brome | 4 |
| Deschampsia caespitosa | -- | Tufted hairgrass | 1/2 |
| Elymus glaucus | -- | Blue wildrye | 4 |
| Festuca rubra | -- | Red fescue | 1 |
| Lolium multiflorum | -- | Perennial ryegrass | 1/4 |
| Poa ampla | Sherman | Big bluegrass | 1/4 |
| Stipa lettermanii | -- | Letterman needlegrass | 1 |
| **Total grasses** | | | **12 3/4** |
| **Forbs** | | | |
| Achillea millefolium | -- | Western yarrow | 1/4 |

## Tree and Shrub Plantings

Two native forest species will be used in reclamation because they are adapted to the elevation, aspect, rainfall, and expected soil conditions. Douglas fir (*Pseudotsuga menziesii*) and western white pine (*Pinus monticola*) will be planted at a density of about 540 trees per acre. This is equivalent to a 9-foot spacing grid. The ratio of Douglas fir to western white pine will be 60:40. Two year old bare root stock trees will be used.

### Seeding and Planting Methods

Seeding will be accomplished with seed drills or other seeders appropriate for the seed species. Inaccessible or steep areas may be seeded with broadcast methods. Hydro seeding is another method that may be used in steep or inaccessible areas.

### Temporary Seeding and Mulching

After seeding, straw mulch free of weeds or other undesirable species will be applied to the seeded area at the rate of 3,000 pounds per acre and crimped into the soil with a disk or other suitable machine. In areas of steep terrain, crimping may not be feasible. Areas with seed application by hydroseeding methods would contain soil tackifiers to minimize erosion.

### 4.5.5 Wetlands Restoration

To simulate the stream and wetland conditions, a new channel with a similar cross section will be created. New channel construction will be developed by digging a new channel from the downstream end point to a intersection with the current stream channel. The new stream course would be constructed primarily with a backhoe. The relocated stream channel will receive logs, rocks and debris similar to the existing stream channel. This material will be placed with a backhoe or other appropriate equipment. The new stream route will be constructed within existing forest conditions where possible. Construction of Vanishing Creek can occur within the existing forest conditions. No topsoil stripping or timber harvesting is planned in this area. A major portion of the rerouted Bornite Brook will be constructed in a visual buffer area of trees, adjacent to Forest Service road 2207. If removal is required, the trees in this area will be felled only by hand and left. These efforts will continue to provide maximum shade to the stream channels.

The existing Bornite Brook stream channel will be permanently blocked at the diversion point with impervious material protected by suitable erosion resistant material. The remaining downstream portion of Bornite Brook may still collect surface drainage from the undisturbed hillside above.

The relocation of Vanishing creek will occur in the same method as Bornite Brook. A new channel will be constructed initiating at the downstream confluence. Following relocation of these two watercourses, stream banks will be planted with vegetation similar to the existing riparian vegetation.

### 4.5.6 Protection of Public Health and Safety

Reclamation of the Bornite site to a natural forest condition without hazards, i.e. precipices, open mine workings, and abandoned equipment and facilities will protect the public safety.

### 4.5.7 Erosion control

Mitigation procedures will be implemented to reduce soil erosion loss from water during mine operation and during topsoil stripping, stockpiling, and reapplication procedures during the ten-year life of the project. These procedures will result in soil conservation and reduce soil contamination of water and air.

A runoff diversion system will collect surface water and route it around the 31 acres of mine-related disturbance. All surface water runoff within the affected area will be diverted to numerous sedimentation ponds prior to discharge to surface streams. Surface water from the 31-acre permit area will not flow into Bornite Brook as it passes through the permit area. Additionally, the 100-150 foot wide forested buffer between the permit area and Cedar Creek will not only provide a visual screen, but trap airborne sediments originating from mine disturbances.

Erosion control is provided by the construction of a storm water pond during initial project development. Storm water carrying sediments will be collected by this pond. During the initial construction, straw bale filters and silt fencing will be constructed to contain sediments on-site.

Diversion ditches will collect and direct storm runoff from undisturbed areas around the mine site. This will minimize water on the project site. Soil loss during stripping operations will be reduced by: installing the runoff diversion system prior to topsoil removal; quickly removing the soil during the dry summer months when it is not raining; removal of topsoil in three stages in the tailings area to reduce the area exposed to erosion; and once the topsoil has been removed by quickly paving roads, constructing buildings, graveling surfaces, and seeding vegetation in disturbed areas to eliminate areas of exposed soils.

Soil erosion from the topsoil stockpile will be reduced by stabilizing the stockpile, by a construction design which reduces surface erosion and mass movement potential, and by seeding it and maintaining conditions for plant growth. The stability of the stockpiled soil is directly related to the volume of water in the soil. As soil saturation increases, the liquefaction potential increases. Therefore size, shape, and height of the stockpile will be assessed to produce a stable pile.

The stockpiles will be located in a erosionally stable area away from surface water flows and have slopes adequate to intercept water for plant growth without becoming saturated and yet not so steep as to generate excessive runoff and erosion. The soil stockpile will be seeded with a seed mix of perennial grasses and legumes, not only to reduce soil erosion, but to maintain soil fertility. The stockpile vegetation will be monitored to assure a good cover is maintained. Any weed invasions will be eliminated.

After mining, the topography of the area will be returned close to the erosionally stable original contours. The surface of the tailings pile will be gradually sloped at 1-2 percent to create and augment surface water infiltration, and slow the surface water runoff to non-erosive velocities.

Once disturbed areas are topsoiled and cultivated, they will be promptly seeded. Application of a straw mulch will reduce erosion by shielding the soil from the erosive impact of rain and wind.

### 4.5.8 Stream Relocation Alternatives

Two stream sections will require relocation to allow project development. Portions of Vanishing Creek and Bornite Brook will be relocated because of facility location. Vanishing Creek currently infiltrates into the ground near the center of the proposed tailings impoundment. The creek will be diverted into a new channel that will empty into Bornite Brook above the tailings impoundment area. The created wetland in the diverted stream channels will have functions and characteristics similar to those replaced.

The portion of Bornite Brook currently flowing over the mine area will be rerouted through the facilities area. A water course flowing directly over an underground mine would pose a safety hazard. To prevent this situation, the stream course will be directed into a new channel. The new channel will mimic existing stream channel and wetland conditions. An amount of wetlands will be created equal to the amount deleted when stream channels are rerouted.

The streams will remain in the diverted stream channels and will not be redirected into their original channels. The original diversions will be performed in the initial stages of the mine life. During the eight-year mine life, vegetation and the stream course will have the opportunity to stabilize. Putting these stream courses back to the original course would create additional impacts to the environment.

## 4.6 MONITORING AND MANAGEMENT

Vegetative success will be monitored during and after the mining operation. This will evaluate revegetation success. Monitoring will be on a yearly basis. The monitoring would begin in the 1994 following construction. Evaluation of plant growth will be compared with climatic conditions experienced for the year. Perent ground cover, species diversity and erosion will be monitored.

Annual reports of the condition of the reclaimed site will be submitted to DOGAMI. Any areas requiring remedying will be noted, with solutions proposed. Both surface and groundwater testing will be performed. Details of the monitoring and reporting program are explained in section 4.6.2.

### 4.6.1 Revegetation Test Plots

In addition to monitoring of reclamation efforts at the end of mining, two revegetation test plots will be planted each year. These will be located on the topsoil stockpiles. Various plant species will be used to evaluate growth with emphasis on providing ground cover and preventing erosion. If a plant is identified as effective on site reclamation and is approved as by the USFS, it will be incorporated into the seed mixture. If other areas can be identified on the mine site where long term disturbance will not occur vegetative test plots may be established and monitored. Similarly, the plots will be evaluated to determine revegetation efforts are successful.

The reconstructed stream courses will be evaluated to determine if a wetland ecosystem is forming and if additional efforts to establish wetland vegetation if required. Comparison will be made to nonimpacted upstream areas to determine revegetative success.

Following closure of the mine, water quality will continue to be monitored in accordance with applicable state permits. Vegetation will be monitored on a bi-yearly basis to determine success and to indicate where replanting or remedial measures are warranted. Erosion control will be monitored, and if any areas of excessive erosion are noted, they will get corrective action.

### 4.6.2 Protection of Surface and Ground Water

**Surface Water**

The purpose of a surface water sampling program is to quantify flow and quality. Sampling points would be located upstream or above any disturbance, at discharge points, and downstream.

Two surface water flows (Bornite Brook and Vanishing Creek) cross the project site and Cedar Creek is adjacent to the site. All three of these overland flows will be sampled on a regular basis. Quarterly samples will be taken upstream, downstream, and through the project area since the first quarter of 1991. The downstream sampling sites will remain unchanged. The upstream sampling points may move upstream slightly to prevent any influence of the mine disturbance on the samples.

All discharge points would be monitored for flow volume and chemistry. This would allow an analysis to be made of the discharge water, receiving water, and the impact to surface water. Effort will be made to sample all surface water sites within the same day. This would allow similar field conditions to be experienced at all sites. The following chart of the sampling points indicates the sample locations, parameters sampled, frequency, and the surface waters.

Weather conditions at the site will be monitored to document seasonal variations and trends, in addition to precipitation events.

## Table 15. Surface Water Sampling Sites

| Site | Explanation of Sampling Site | Location |
|---|---|---|
| BBU | Bornite Brook Upstream | Middle of Stream |
| VCU | Vanishing Creek Upstream | Middle of Stream |
| BBM | Bornite Brook Middle | Within Project Area<br>Middle of Stream |
| BBD | Bornite Brook Downstream | Before Exit Project Property<br>Middle of Stream |
| CCU | Cedar Creek Upstream | East Bank |
| CCM | Cedar Creek Middle | East Bank |
| CCD | Cedar Creek Downstream | East Bank |
| CCL | Cedar Creek Lower | West Bank |
| DS | Discharge Site to Bornite Brook | End of Pipe |
| SPD | Sediment Pond Discharge | At Discharge Point |
| TC | Tailings Solution Discharge | At Discharge Point |

## Table 16. Sampling Sites Frequency

| Sample Site | Geochemical Sampling Frequency | Flow Frequency | Field Parameters Frequency |
|---|---|---|---|
| BBU | Monthly | Continuous | Weekly |
| BBM | Monthly | | Weekly |
| BBD | Monthly | Continuous | Weekly |
| VCU | Monthly | | Weekly |
| CCU | Monthly | Continuous | Weekly |
| CCM | Monthly | | Weekly |
| CCD | Monthly | | Weekly |
| CCL | Monthly | Continuous | Weekly |
| DS | Weekly if discharge | Continuous | |
| TL | Biweekly if discharge | | |

## Table 17. Surface Water Sampling Analysis List

Person Obtaining Sample:
Sampling Date:
Sampling Time:
Weather Conditions:

General Parameters

Flow* (cfs):
Temperature (°C):
Field pH*:
Lab pH:
Field conditions* ($\mu$mhos/cm):
Lab conditions ($\mu$mhos/cm):

TDS (mg/l):
TSS (mg/l):
Alkalinity (mg/l):
TOC (mg/l):

Major Ions(mg/l)

Calcium:
Magnesium:
Sodium:
Potassium:
Chloride:
Carbonate:
Bicarbonate:
Hydroxide:
Sulfate:
Fluoride:
Nitrate:

Metals (Total) (mg/l)

Antimony:
Arsenic:
Barium:
Beryllium:
Bismuth:
Boron:
Cadmium:
Chromium:
Copper:
Iron:
Lead:
Mercury:
Manganese:
Molybdenum:
Nickel:
Selenium:
Silver:
Zinc:

* Measurement taken in field at time of sampling.

Sample detection limits and methods will be analyzed to DEQ standards for the Santiam River Basin where applicable. EPA drinking water quality standards will be used where ODEQ standards have not been established.

A laboratory accredited and licensed by the State of Oregon will be used for all analyses except for field parameters. Chain of custody forms will be completed for all samples.

Samples will be taken in new decontaminated containers. A preservative will be added required by the test method to stabilize the sample. Samples will be field filtered and analyzed for dissolved chemical constituents. Also, non-filtered samples will be taken and analyzed for total chemical constituents.

**Groundwater Sampling**

The focus of the sampling/monitoring program is to identify and quantify impacts to the groundwater regimes (colluvial and bedrock) in the area. Sampling of groundwater will be conducted upgradient, downgradient, and within the project site. Groundwater will be sampled by obtaining representative specimens of groundwater from monitoring wells at strategic sites. Several wells exist and will be sampled quarterly.

Monitoring wells would be constructed during the development stage of the project, before any process facilities begin operations. After construction and initial sampling, monthly samples will be taken.

Eight groundwater monitoring sites are proposed. Three locations currently have monitoring wells in place and samples have been taken. Four sampling sites will be located at the base of the tailings impoundment dam. In addition to being sampling sites, these wells will be capable of pumping colluvial water into the mill process.

Groundwater samples have been taken from the existing wells each quarter since the first quarter of 1992. Quarterly samples will continue to be taken from these sites throughout the project life. The sites would be monitored to record water levels and to sample the groundwater for chemical makeup. Water levels will indicate seasonal fluctuations in addition to project impacts.

Wells will be constructed according to DEQ and DWR standards. Well design will be submitted to DEQ and DWR before construction to assure acceptable construction design exists. Weather conditions will be monitored at the site to document seasonal variations and trends in addition to precipitation events.

Table 18. Groundwater Monitoring Locations

| Site | Number of Wells | Completion Zone |
|---|---|---|
| M1, M4 | 2 | Colluvial aquifer, bedrock |
| M2, M5 | 2 | Colluvial aquifer, bedrock |
| M3, M6 | 2 | Colluvial aquifer, bedrock |
| M7 | 1 | Bedrock |
| M8 | 1 | Colluvial aquifer |
| M9 | 1 | Colluvial aquifer |
| M10 | 1 | Colluvial aquifer |
| M11 | 2 | Colluvial aquifer, bedrock |
| **Total** | **12** | |
| **Existing** | **6** | |
| **Additional** | **6** | |

### 4.6.3 Facilities Containment

Secondary containment is provided for process facilities and storage of reagents, fuel, and explosives in their immediate areas. In addition to this containment, a storm water - sediment pond will provide a tertiary containment measure. The various facility containment (devices, structures) are described in the following plan. Detailed engineering of the systems will go to ODEQ before construction.

In addition to containment of materials in case of spills or leaks, an emergency spill response trailer will be maintained on site. This will provide emergency response crews with materials for containing spills or releases. A spill prevention, control, and countermeasure (SPCC) plan is being developed to provide a basis for prevention of spills and an action plan in case of an occurrence.

#### Explosives

The primary blasting agent used will be an ammonium nitrate and diesel fuel mix, commonly referred to as ANFO. Ammonium nitrate prills will be delivered and stored in prill (small grain) form. Storage will be above ground. The base of the site will be contained by a low curb that will contain any prill spilled while loading or unloading. Any other blasting agents will be stored in contained areas.

Other high explosives (class A) such as primers or boosters, detonation cord, nonels, blasting caps will be stored in bullet proof explosive magazines. The explosives are in solid commercial form. No secondary containment is required.

Surface drainage from the explosive storage areas will be directed to the stormwater pond.

**Fuel and Oil Storage**

A covered, contained area is proposed for a fuel and oil storage area. All primary storage containers are located above ground, no subsurface storage is anticipated. Secondary containment is provided for the storage area with a curb and liner design. The liner will be concrete or a synthetic material. A roofed covering will prevent precipitation from falling directly onto the storage area.

The secondary containment will be constructed to retain 110 percent capacity of the largest tank (7500 gallon diesel) plus a 25-year, 24-hour storm event. A sump will be located within the secondary containment area, so any escaped material can be sent to recovery vessels. A concrete fueling apron will be constructed adjacent to the fuel storage area. Any spills occurring during refueling or unloading can be contained.

An alarm system will monitor liquid levels within the secondary containment area to alert mine personnel of a spill or leak. The alarm system will also alert mine personnel in case of a fire.

Fire fighting equipment and chemical absorbent material will be kept near the fuel storage area in case of fire or to contain spills.

Hydraulic oil, rock drill oil, and other lubricating oils and greases will be stored within the area. These items will be stored in metal drums (55 gallon capacity). These lubricants will be moved to the maintenance buildings or underground as required by operations or maintenance. A tank is also provided for used oil storage. Used oils will be stored until shipment off site to a recycling-recovery process site.

**Reagent Storage**

Reagent storage will be within the mill building. The mill building containment is designed to retain 110 percent of the process solution within the mill building circuit. This would include the stored reagents. Approximate quantities of reagent stored within the mill building are listed in the table below.

Table 19. Reagent Quantities

| Reagent | Quantity | Container |
|---|---|---|
| Collector | 3 month supply | 5-55 gallon drums |
| Frother | 3 month supply | 20-55 gallon drums |
| Flocculent | 3 month supply | 20-55 gallon drums |

### Cement Storage

Cement required for mine backfilling will be stored in a silo near the mine portal to allow for efficient addition to backfill tailings material. Cement will be stored in silos. The cement will be augured into a mixing box before being added to the backfill tailings material, which is then pumped underground.

An earthen berm will be constructed around the silo area to contain cement spilled during delivery or maintenance efforts. Spilled cement would be added to the mixing box if possible, or hauled underground and deposited in backfilled stopes.

### Stockpiles

The ore stockpile area will be lined to prevent precipitation or drainage from being released to the environment. The lined system will collect drainage and direct the flow into the mill process. A topsoil stockpile will be constructed during the very initial stages of the construction phase. Topsoil will be stripped from the mine site and tailings disposal areas and stored until required for reapplication during the reclamation process.

Upon completion of topsoil salvage, the stockpile will be seeded with an approved Forest Service species to prevent erosion. Drainage from this area will be directed to the storm water pond. Suspended solids will settle out of the water before discharge or utilization in the mill process circuit. As subsequent topsoil is placed on the stockpile, it will be seeded to prevent erosion and loss of material.

### Development Rock Stockpile

Development rock will be sampled and tested for potential to generate acid rock drainage. Development rock that has not exhibited acid generating potential will be incorporated into surface facilities. The majority of the material is proposed to be used in the tailings embankment. Additional uses may be for erosion protection and road aggregate.

If a portion of the development rock is found to be potentially acid generating, it will be segregated in the lined ore stockpile storage area. Final disposal would be in cemented backfilled stope areas utilizing the cement as a neutralizing agent. alternative final surface disposal may consist of segregation to inhibit the flow of air and water through the material.

**Mill Building**

The mill building will contain 100 percent of the process solution. The containment will be provided by a concrete floor-foundation and stub walls of concrete. Curbs or raceways within the building will direct solution to sumps where it will be returned to the proper portion of the milling circuit.

**Backfill Tanks**

A site near the mine portal has been designated as the site where backfill and water storage tanks will be located. All tanks will be located within an area contained by an armored earthen berm. This will prevent the escape of water or backfill tailings material if a storage tank failure occurred. The bermed area would be of sufficient size to contain 110 percent of the solution from the largest tank and a 25 year, 24 hour storm event. Tertiary containment is provided by the storm water-sediment pond.

DEPARTMENT OF ENVIRONMENTAL QUALITY
311 SW Sixth Avenue
Portland, Oregon 97204

# LAND USE COMPATIBILITY STATEMENT
(read page 1 before completing)

## TO BE COMPLETED BY APPLICANT

1. Name: Plexus, Inc. Address: 185 S. State St., Salt Lake City, UT 84111
City State Zip

Phone: (801) 363-9152 Type of permit/approval: ACDP, WPCF, NPDES, WASTE DISPOSAL

2. Application to DEQ will be for: X New Permit/Plan Approval ___ Permit Renewal
___ Permit Modification ___ Authorization Letter

3. Name and address of business: Bornite Mine Section 31 T8S, R5E W.M. Marion County

4. Describe the type of business and product or service the business provides:
Underground metal (copper) mine and processing facility

5. If not a new source, explain the change in circumstances that require a permit/approval:
N/A

6. Describe the specific source/facility that requires a permit/approval:
The underground mine and associated mineral process facility require various permits from the State of Oregon in the areas of air and water quality

7. For permit modification/renewal only: Does the criteria in section II, page 1 apply to the proposed permit modification or renewal? ___ Yes X No
Explain basis for determination:
N/A

If yes, describe how the changes may impact land uses, i.e. increased lot coverage; increase air emissions, water discharges or noise levels; impacts to transportation system, etc.:
N/A

## TO BE COMPLETED BY LOCAL GOVERNMENT PLANNING DEPARTMENT
(The jurisdiction in which the business is located)

8. Business/facility location: ___ Inside city limits ___ Inside UGB X Outside UGB

What local government(s) has planning jurisdiction over this use? Marion County

Is the local plan currently acknowledged? X Yes ___ No If no, is this use affected by any portion of the plan which is not acknowledged? ___ Yes ___ No

9. The business/facility:
A. X *Is an ~~allowed outright~~ exempt use.
B. ___ Is allowed subject to siting, design, constructon or operational standards.
C. ___ Is allowed subject to conditional use or review requirements which require public notice.
D. ___ Is prohibited by the plan.
E. ___ Is not addressed by the plan.

* This means the use may exist without any further local planning conditions or authorizations.

If A. applies, identify or provide duplicate copy of applicable zone/provisions and state specific name of the designated allowed use applied to this business/facility.

See attachment

If applicable, have the additional requirements under B. or C. been met? ____ Yes ____ No

Date of decision or expected decision: N/A

Written findings are required for determinations checked under section 9. B, C, D and E. Findings may include plan policies, criteria, conditions, standards or related regulations. (State findings below or attach separately to statement.) If the activity is not addressed in the plan, under 9. E., compatibility findings must be based on the statewide goals.

N/A

10. Is public notice and opportunity for public hearing required? ____ Yes X No

If yes, date of notice: ____________ Date of public hearing: ____________

If a public hearing was held, attach a summary or hearing report.

11. Would the city/county like to receive a copy of DEQ's public notice regarding this source?
X Yes ____ No

REQUIRED SIGNATURES

City land use jurisdiction: ____________ Phone: ____________

Signature: ____________ Title: ____________ Date: ____________

County land use jurisdiction: Marion County Phone: (503) 588-5038

Signature: Craig A. Luedeman Title: Director for Community Development Date: July 21, 1992

Please direct questions to the Management Services Division at 800-452-4011 or 229-6408, or contact the Division responsible for processing the application (Air, Water, Solid Waste) through the above toll free number.

DEPARTMENT OF ENVIRONMENTAL QUALITY
811 SW Sixth Avenue
Portland, Oregon 97204

# LAND USE COMPATIBILITY STATEMENT
(read page 1 before completing)

## TO BE COMPLETED BY APPLICANT

1. Name: Plexus, Inc. Address: 185 S. State St., Salt Lake City, UT 84111
City State Zip

Phone: (801) 363-9152 Type of permit/approval: ACDP, WPCF, NPDES, WASTE DISPOSAL

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4. Describe the type of business and product or service the business provides:
Underground metal (copper) mine and processing facility

5. If not a new source, explain the change in circumstances that require a permit/approval:
N/A

6. Describe the specific source/facility that requires a permit/approval:
The underground mine and associated mineral process facility require various permits from the State of Oregon in the areas of air and water quality

7. For permit modification/renewal only: Does the criteria in section II, page 1 apply to the proposed permit modification or renewal? ___ Yes X No
Explain basis for determination:
N/A

If yes, describe how the changes may impact land uses, i.e. increased lot coverage; increase air emissions, water discharges or noise levels; impacts to transportation system, etc.:
N/A

## TO BE COMPLETED BY LOCAL GOVERNMENT PLANNING DEPARTMENT
(The jurisdiction in which the business is located)

8. Business/facility location: ___ Inside city limits ___ Inside UGB X Outside UGB

What local government(s) has planning jurisdiction over this use? Marion County

Is the local plan currently acknowledged? X Yes ___ No If no, is this use affected by any portion of the plan which is not acknowledged? ___ Yes ___ No

9. The business/facility:

A. X *Is an ~~allowed outright~~ exempt use.
B. ___ Is allowed subject to siting, design, constructon or operational standards.
C. ___ Is allowed subject to conditional use or review requirements which require public notice.
D. ___ Is prohibited by the plan.
E. ___ Is not addressed by the plan.

* This means the use may exist without any further local planning conditions or authorizations.

If A. applies, identify or provide duplicate copy of applicable zone/provisions and state specific name of the designated allowed use applied to this business/facility.

See attachment

If applicable, have the additional requirements under B. or C. been met? ____ Yes ____ No

Date of decision or expected decision: N/A

Written findings are required for determinations checked under section 9. B, C, D and E. Findings may include plan policies, criteria, conditions, standards or related regulations. (State findings below or attach separately to statement.) If the activity is not addressed in the plan, under 9. E., compatibility findings must be based on the statewide goals.

N/A

10. Is public notice and opportunity for public hearing required? ____ Yes X No

If yes, date of notice: ____________ Date of public hearing: ____________

If a public hearing was held, attach a summary or hearing report.

11. Would the city/county like to receive a copy of DEQ's public notice regarding this source?
X Yes ____ No

REQUIRED SIGNATURES

City land use jurisdiction: ____________ Phone: ____________

Signature: ____________ Title: ____________ Date: ____________

County land use jurisdiction: Marion County Phone: (503) 588-5038

Signature: Craig Q Huedeman Title: Director for Community Development Date: July 21, 1992

Please direct questions to the Management Services Division at 800-452-4011 or 229-6408, or contact the Division responsible for processing the application (Air, Water, Solid Waste) through the above toll free number.

110.810 APPLICATION OF ZONING REGULATIONS. The regulations set by this ordinance within each zone shall be minimum regulations and shall apply uniformly to each class or kind of structure or land.

110.815 NEWLY SUBDIVIDED AREAS IN RA, AR, AND SR ZONES. Any area or premises, within an area now or hereafter classified or zoned as an RA, AR, or SR zone, which is subdivided and a plat thereof is duly recorded as provided by law, shall be automatically classified as an RS Single Family Residential Zone on the date said plat of said subdivision is recorded, except, however, the Planning Commission or Hearings Officer may reclassify said subdivision from an RA zone to an AR or SR zone, or from an AR zone to an SR zone, or it may direct that subdivision should retain its existing classification. The Planning Commission or Hearings Officer in its review of the subdivision will determine the zoning classification best suited for the subject property which will not be in conflict with the development pattern for the area.

110.820 CONFORMANCE AND PERMITS REQUIRED. No building structure, or premises shall hereafter be used or occupied, and no building or structure or part thereof shall hereafter be erected, constructed, moved, structurally altered, or enlarged unless in conformity with all the regulations herein specified for the zone in which it is located, and then only after applying for and securing all permits and licenses required by all laws and ordinances, except as provided in subsection (a) and (b) below.

(a) Federally owned lands are exempt from the permit provisions of this Ordinance. However, land use activities on federal lands shall be managed in a manner consistent with the intent of the Marion County Comprehensive Plan, Zoning Ordinance, and the Land Policy and Management Act of 1976;

(b) On public park lands, park maintenance including rehabilitation, replacements minor improvements, repair and similar maintenance activities are not subject to conditional use permit requirements. In addition, development of new facilities identified in County approved State Parks master plans and in County approved County Park plans are not subject to the conditional use procedures.

110.830 WATER RESOURCE PROTECTION. The impact of proposed land uses on water resources shall be evaluated and potential adverse impacts on the water resource shall be minimized. Where evidence indicates groundwater limitations and the development will use groundwater as a water supply, the developer shall demonstrate that adequate water can be provided without adversely affecting the ground water resource.

110.831 MINERAL AND AGGREGATE EXTRACTION SITES. Proposed land uses within 500 feet of a County designated or approved mineral or

ATTACHMENT TO LAND USE
COMPATIBILITY STATEMENT

The land that is the subject of this land use compatibility statement information form is all federal land located in the Detroit Ranger District of the Willamette National Forest. The land is zoned for forest use. The Applicant intends to use the land for an underground copper mine and associated facilities.

Marion County's Zoning Ordinance (Rural) ("Ordinance"), as a general rule, requires a conditional use permit for a mining operation on forest lands. However Section 110.820(a) of the Ordinance (attached) states: "Federally owned lands are exempt from the permit provision of this Ordinance. ***"

Because the lands in question are all federal lands managed by the U.S. Forest Service, our Ordinance exempts the Applicant from all County land use permit requirements.

Accordingly, the use is allowed outright.

**PAY DIRT**

**July 1991**

WILL IT STIR UP THE TROOPS IN ENVIRONMENTALLY-SENSITIVE OREGON? Bracing itself for what may turn into a tough fight in a state where opposition to mining has been increasing, Plexus Resources of Salt Lake City has begun the formal process to acquire the first of a series of permits to develop an underground copper mine at its Bornite project in the old Santiam Mining District in the Cedar Creek Valley about 50 miles east of Salem. The company has submitted its plan of operations to the Forest Service. In due time it will also have to acquire permits and approvals from the Oregon Department of Geology and Mineral Industries and the Department of Environmental Quality. There will also be local public meetings for review and comment. Plexus said the project is expected to produce 137 million pounds of copper, along with "substantial" amounts of gold and silver, from the high-grade bornite copper in the breccia pipe deposit. The project is expected to last at least eight years and employ between 80 and 100 people.

NEWS COVERAGE AIRED
7/2/91 AT 6:00 P.M.
BY CHANNEL 6
IN PORTLAND, OREGON

DONAHUE: Laid off timber workers in the Willamette National Forest are preparing applications for new jobs... in a copper mine. Eric Mason reports that if approved, this mine could become Oregon's largest.

MASON: The Santiam Canyon is zoned for some of the country's richest forest lands, but that may be changing. Plexus Mining Corporation of Salt Lake City, Utah has struck it rich deep in the heart of one of the most productive forests in Oregon. But it's not gold. Several hundred feet below the surface, Plexus drills have struck a rich vein of silver and copper. Experts say core samples show a rich deposit... enough to keep 80 employees working for as long as a decade. The claim sits at the bottom of this canyon not far from Mount Jefferson in an area cut by loggers 50 years ago. So far there's no opposition to the mine. With little old growth in the area, environmentalists who have toured the site and have seen the plans are not opposed to the mine. George Atiyeh, who's fought to keep timber companies from cutting in nearby Opal Creek, says so far Plexus is acting responsibly to insure that the environment is not harmed.

ATIYEH: My concern in this whole project was that I wanted this to be a model mine. To set an example to the mining industry. I don't want to see the mining industry go the way of the timber industry where they stuck their heads in the sand and went into denial and refused to change the way they were doing business. This mine has the opportunity to be a model mine in the middle of a model forest and if they do what they say they're going to do, it's going to be a great project.

MASON: Plexus officials are inviting congressmen and environmentalists to the drill site to see first hand how they plan to lay out the mine. This week they invited Rep. Mike Kopetski.

KOPETSKI: This is a compact site you're seeing here and with a minimal environmental impact and great economic advantage to it, so thus far, I'm increasingly impressed.

MASON: Plexus officials are somewhat surprised by the lack of environmental opposition so far.

DITTO: I'm gratified by the fact that people are interested in getting an honest understanding of what the project's all about and I think those that take the time to do that will see that there really is very little or minimal environmental impact.

MASON: With hundred of timber jobs now in jeopardy in the canyon because of the spotted owl, the prospect of nearly 80 mining jobs is welcome news. Even if Plexus officials jump all the environmental hurdles, it will be two years before the first mining blasts will be heard in this canyon. In the Willamette National Forest, Eric Mason, Newsroom 6.

**Table 2 Mine Production Schedule** (not included in Plan of Operations).

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 | Year 6 | Year 7 | Year 8 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| Ore Tonnage | 90,000 | 359,000 | 359,000 | 359,000 | 359,000 | 360,000 | 359,000 | 298,000 | 2,542,000 |
| Copper (%) | 2.49 | 2.86 | 3.16 | 2.17 | 2.03 | 1.84 | 2.26 | 1.92 | 2.33 |
| Silver (opt) | 0.33 | 0.52 | 0.77 | 0.60 | 0.57 | 0.48 | 0.64 | 0.29 | 0.55 |
| Gold (opt) | 0.010 | 0.019 | 0.028 | 0.014 | 0.013 | 0.013 | 0.017 | 0.008 | 0.016 |
| Copper (lbs x 1000) | 4,485 | 20,499 | 22,660 | 15,622 | 14,530 | 13,247 | 16,209 | 11,143 | 118,695 |
| Silver (troy ounces) | 29,000 | 185,000 | 275,000 | 215,000 | 203,000 | 172,000 | 230,000 | 85,000 | 1,396,000 |
| Gold (troy ounces) | 1,000 | 7,000 | 10,000 | 5,000 | 5,000 | 5,000 | 6,000 | 2,000 | 41,000 |

Note: Metallurgical recovery not applied.

# THE BORNITE PROJECT:

## *Getting Off the Ground Now; Getting Under It Later*

The Bornite Project is in the western Cascades, about 50 miles east of Salem in Cedar Creek Valley in the Willamette National Forest.

Plexus Inc. is now turning the project into a new underground mine.

Bornite, over a minimum eight-year life, is expected to produce 137 million pounds of copper with substantial gold and silver by-product values. Recent drilling results indicate copper mineralization is nearly 3.5 million tons with 2.2 percent copper content.

**HISTORY**

Discoveries were first made in the area around 1877. Most properties were located by 1903. Over the years, the Santiam Copper Mine shipped around 223 tons of ore averaging 10 percent copper. Shiny Rock Mining Company's Ruth Mine is the only mine in the area still active today.

In 1975, Amoco Minerals Co., now Cyprus Minerals, located mining claims over the Bornite Project area based on proximity to known copper-bearing formations as well as other geologic indicators. Amoco began drilling in 1977 and by 1979, the Bornite ore body was identified.

Plexus acquired Bornite from Cyprus Minerals in 1989 and began a limited drill program to test continuity of copper mineralization. In 1990, the Company continued its program to define margins of the ore zone, confirm previous results, test for grade continuity, and provide more metallurgical sampling. Plexus drilled 16 diamond drill core holes totalling 10,074 feet. Every hole hit major ore-grade minerals.

**GEOLOGY**

The Bornite ore body is contained, within a breccia pipe, which is a roughly cylindrical rock formation that extends from the surface for more than 1,000 feet. It is 400 to 450 feet in diameter and narrows toward the surface. The pipe has been dated by scientific methods to be 10.1 million years old.

Copper minerals were deposited as part of the breccia matrix and inside sheeted quartz veins on the pipe's margins. Bornite and chalcopyrite are the principal ore minerals.

Bornite is an iridescent purple or blue color. It is called several other names: Variegated copper, peacock ore, horseflesh ore, and purple copper. Chalcopyrite is a bright brass-yellow mineral and is considered one of the important copper ores.

**MINING**

Plexus' plans for the Bornite Project include a modern, safe underground mine that will yield 1,400 tons of ore daily, five days per week.

The equipment used underground will be rubber-tired, diesel-powered loading and hauling vehicles. They are built somewhat differently than surface vehicles but they accomplish much the same tasks as surface heavy equipment.

Access to the ore body will be a ramp tunnel.

Eventually, the underground operation will be more than 900 feet deep. The surface entrance will give only a small clue as to the size and scope of the activity below.

**METALLURGICAL PROCESS**

Metallurgical testing on Bornite ores shows high recovery of copper in a premium concentrate. Plexus proposes to process 1,000 tons of ore a day in a concentrator, incorporating a crushing unit that would reduce 24-inch, run-of-mine ore to one-half inch size.

The crushed ore will then be coarsely ground in a rotating mill, and the coarsely ground minerals will then be concentrated in a froth flotation process using safe, non-toxic reagents.

After dewatering, the concentrates will be shipped out of state to a smelter to produce refined metal.

**PERMITTING**

Plexus is now involved in the permitting process set by Oregon's Department of Geology and Mineral Industries and the U.S. Forest Service. Following a meeting last November among Plexus and several state, city, county and U.S. Forest Service representatives, Plexus began a rigorous effort to characterize the proposed operation. The Company is gathering baseline data to be used in the ongoing analysis. A Plan of Operations was submitted to the Forest Service on June 7, 1991.

Plexus recognizes the need for a comprehensive permitting process receiving informed public scrutiny. In talks with the U.S. Forest Service, the Company has pledged to develop all proper information to address specific concerns relating to the Bornite Project. There will be significant opportunity for citizen review during this process.

Plexus intends the Bornite Project to be a showcase of mining's ability to coexist with the area's other important resources.

plexus

# QUESTIONS AND ANSWERS

## THE BORNITE PROJECT

Plexus Inc., based in Salt Lake City, Utah, is in the formal process of acquiring permits to develop the Bornite Project underground copper mine 50 miles east of Salem in the Cedar Creek Valley.

Here are some commonly asked questions about the project and the answers.

***Question:*** ***How big is the site?***
**Answer:** The Bornite Project will disturb 32 acres of second growth forest.

***Question:*** ***What will be left behind when Plexus is done mining?***
**Answer:** The project includes a detailed reclamation plan that calls for over half of the tailings (the leftovers after the copper concentrate is milled from the ore) to be put back into the underground workings. The remainder will be spread over existing contours of the site. It will then be covered with the top soil that has been saved and then replanted with native plant species which may include alder and douglas fir.

***Question:*** ***How many jobs will this create and who will get them?***
**Answer:** Throughout the life of the project, including initial construction activity, there will be about 100 people employed by Plexus. During most of the mining period of at least eight years, the project will employ 80 workers. Most of the employees will be hired locally and are expected to come from among timber industry workers who already have many of the skills needed for both mining and milling. Some of the more technical jobs involving special skills in geology and engineering may come from out of the area but these employees will be asked to live in the Santiam Canyon community. The project is expected to generate about a $2.5 million payroll and spend $1.3 million for materials needed by the project and its crew each year.

***Question:*** ***Where did the name bornite come from?***
**Answer:** Bornite is the name of the copper-rich ore discovered at the site. It is an ore body contained in a so-called "breccia pipe", a rock formation that is cylindrical and extends down from the surface about 1,000 feet. The formation to be mined has been dated to be 10.1 million years old.

B:Q&A

**PLEXUS, INC.** • 185 South State Street • Suite 400 • Salt Lake City, Utah. 84111
(801) 363-9152 • FAX (801) 363-8747

## *COMMENT SHEET*

This form is to give you an opportunity to comment either pro or con on the Bornite Project to Plexus and to ask questions you may want answered in writing. It will also put you on our mailing list for further information on the project as it develops.

**NAME:** ______________________________

**ADDRESS:** ______________________________

______________________________

**TELEPHONE:** ____________________

**I would like more information sent to me on the Bornite Project as it progresses: YES __ NO __**

**QUESTION:** ______________________________

______________________________

______________________________

**COMMENTS:** ______________________________

______________________________

______________________________

B:Q&A

# QUESTIONS AND ANSWERS

## THE BORNITE PROJECT

**Question:** ***Will this hurt the old growth forests nearby?***
**Answer:** No old growth timber will be disturbed and access to the site is along existing Forest Service roads.

**Question:** ***Will this affect water quality in the Santiam Canyon or in Salem?***
**Answer:** No. Water management plans for the project include recycling water used in milling. At the same time tests show that no toxic chemicals will be released into the water during the process and that water ultimately returned to the environment will be of drinking water quality. This is an unusually good project from a water quality and water quality protection standpoint.

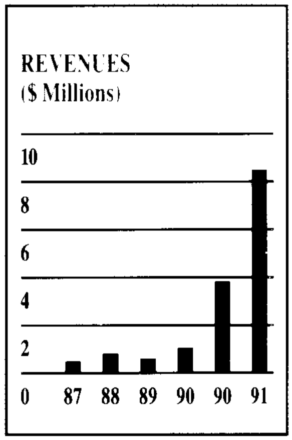
**Question:** ***Is cyanide or any other dangerous chemical used in the milling process like the ones we have read about in heap leach mining in Eastern Oregon and other states?***
**Answers:** No. The process used by Plexus at the Bornite site is called "flotation" and extracts concentrates from the ore much like you remove dirt from clothes in a washing machine. No minerals are placed in solution so no highly caustic chemicals are used in the process.

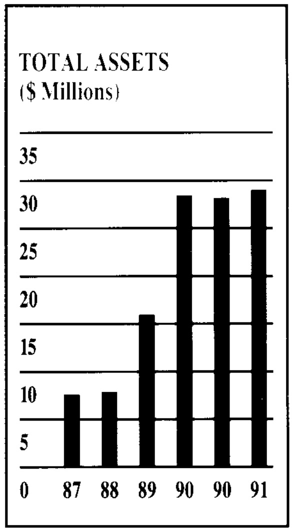
**Question:** ***Will there be a chance for the public to get more direct information from both Plexus and the Forest Service on the project and to comment on the project before it gets the permits?***
**Answers:** Yes. Plexus is planning a series of information meetings on the project in September. These meetings will be followed by a series of "scoping" hearings conducted by the Forest Service to determine public concerns about the project. There also will be a host of other public hearings on other permits required by state and federal government agencies. Interested persons should contact both Plexus and the Forest Service for information on the meetings and to be notified of them. Watch for local newspapers for additional information.

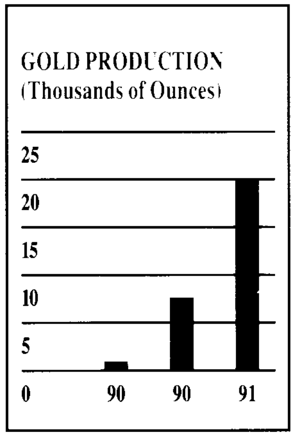
**Question:** ***Will there be any acid mine drainage?***
**Answer:** No. Mineral constituents that contribute to acid drainage are not present in the quantity required to form the acid. Plus, the rock contains other mineral constituents that inhibit the formation of acid in much the same way as antacids are used to control an upset stomach.

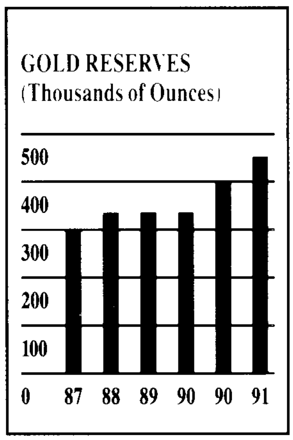
**Annual Meeting**

June 9, 1992 at 11:00 a.m.
Royal York Hotel
100 Front Street West
Toronto, Ontario, Canada M5J 1E3



# HIGHLIGHTS

- Gold production increased 131% to 19,940 ounces in 1991 compared to 1990.
- Direct production costs averaged $221 an ounce of gold.
- Reserves increased 18% at the Denton-Rawhide mine.
- Net income totaled $300,000, $0.03 a share.
- Operations provided $2,240,000 cash flow.
- Bornite project permitting initiated.

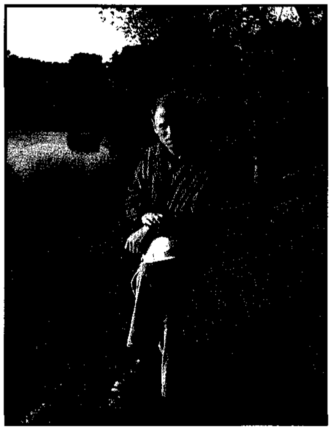
# SELECTED FINANCIAL DATA

| | Year Ended | Six Months Ended Dec. 31, | Year Ended June 30, | | | |
|---|---|---|---|---|---|---|
| | 1991 | 1990 | 1990 | 1989 | 1988 | 1987 |
| **Production** | | | | | | |
| Gold (Ounces) | 19,940 | 7,590 | 1,050 | — | — | — |
| Silver (Ounces) | 134,300 | 29,900 | 6,010 | — | — | — |
| Oil (Barrels) | 4,000 | 2,000 | 4,000 | 4,000 | 6,000 | 10,000 |
| Gas (Mcf) | 83,000 | 42,000 | 105,000 | 119,000 | 137,000 | 91,000 |
| **Financial Results (000's)** | | | | | | |
| Revenues | $ 8,573 | $ 3,834 | $ 963 | $ 543 | $ 670 | $ 438 |
| Net Income (Loss) | 300 | (819) | (567) | (1,234) | (652) | (470) |
| Earnings (Loss) per Share | 0.03 | (0.07) | (0.10) | (0.26) | (0.15) | (0.11) |
| Operating Cash Flow | 2,238 | 424 | (1,859) | (484) | (3) | (113) |
| **Balance Sheet Data (000's)** | | | | | | |
| Total Assets | $29,696 | $28,449 | $28,738 | $16,307 | $ 6,527 | $ 6,004 |
| Shareholders' Equity | 16,252 | 15,933 | 16,752 | 1,893 | 2,671 | 2,707 |
| Debt to Total Capital | 41% | 41% | 39% | 88% | 53% | 52% |

# RESERVES AND MINERAL RESOURCES

| (In thousands except grade) | | Gold | | Silver | | Copper | |
|---|---|---|---|---|---|---|---|
| December 31, 1991 | Tons | Grade (opt) | Contained Ounces | Grade (opt) | Contained Ounces | Grade (%) | Contained Pounds |
| **Proven and Probable Reserves** | | | | | | | |
| Denton-Rawhide | | | | | | | |
| Ore | 7,714 | 0.035 | 272 | 0.53 | 4,126 | — | — |
| Lean Ore | 5,924 | 0.015 | 88 | 0.25 | 1,491 | — | — |
| Western World | 1,091 | 0.033 | 36 | 0.41 | 443 | 2.62 | 57,220 |
| | 14,729 | | 396 | | 6,060 | | 57,220 |
| **Resources** | | | | | | | |
| Bornite | 3,161 | 0.017 | 54 | 0.54 | 1,707 | 2.19 | 138,460 |
| Silver Star | 2,900 | — | — | 0.25 | 725 | 1.62 | 94,000 |
| Total | 20,790 | | 450 | | 8,492 | | 289,680 |

Reserves summarized above include the company's 24% direct interest and 2.45% royalty interest in Denton-Rawhide and 75% of the reserves of Western World.



Arthur H. Ditto
President and Chief Executive Officer

# TO OUR SHAREHOLDERS

We are happy to report that 1991 was a year of solid progress for Plexus. Revenues were at a record. We had a profit. The balance sheet was strengthened. Gold and silver production increased and ore reserves were expanded. We developed new production. We added key people to the organization.

Revenues were up 89 percent to $8,573,000. Earnings increased to $300,000 or $0.03 per share compared with a loss of $864,000 or $0.10 a share the prior year. Operating cash flow increased to $2,240,000 compared to negative cash flow of $950,000 in 1990. These improvements are attributable to a full year of production from the Denton-Rawhide mine, which brought 19,940 ounces of gold and 134,300 ounces of silver to the Company's account in 1991, and to an effective gold price hedging program which enabled Plexus to realize an average $387 an ounce sales price compared with an average London price of $362.

Plexus obtained a new six-year $10,500,000 gold loan in June. It replaced a prior loan, reduced current liabilities, and helped to improve working capital. At year end, debt outstanding was a manageable 41 percent of capitalization.

The Denton-Rawhide mine achieved 94 percent of planned gold production in 1991. Cost of production averaged $218 an ounce. We hope to see gold output increase by 25 percent to 99,000 ounces in 1992. Exploration drilling within and nearby the planned mining area not only replaced all gold mined to date, but increased mineable reserves by 176,000 ounces to 1,426,000 ounces in 53,989,000 tons of ore averaging 0.026 ounces of gold a ton. Prospects for long-term, low-cost production appear excellent.

Work in 1991 at the promising Bornite copper, gold, and silver property 50 miles east of Salem, Oregon put the project in the development stage. Additional diamond drilling to refine ore reserve estimates was completed; an operations plan was filed with the U.S. Forest Service; and the Environmental Impact Statement preparation contract was awarded. The mine, to be an underground operation, is noteworthy in that there will be minimal surface disturbance and very little adverse environmental impact. Every effort is being made in planning and design to assure Bornite's environmental soundness, and to keep all who may be impacted by it fully informed. Expectations are that the operation will have all permits early in 1993.

The top challenge for Plexus is to quickly and efficiently develop its properties and increase profitable metal sales. To achieve this end, the Company invested $3,870,000 in 1991. These funds will cut costs and increase gold and silver output at Denton-Rawhide, and will help to bring the Bornite and Western World projects into production. As part of this effort, our Technical Services and Business Development group was expanded during the year. This group reviewed a large number of possible mineral acquisitions.

Allen S. Gordon, who joined Plexus in January, 1991, fills a new senior management position to oversee engineering, permitting, new projects, and business development.

In June, 1991, David Rovig left as our Executive Vice President to become full-time President of Crown Butte Mines, Ltd., a company founded by Plexus. David, who made substantial contributions to our development, continues as a Plexus director.

We expect to continue positive change at Plexus in 1992. We now have an effective, professional organization to manage and drive that change, and sustain an entrepreneurial outlook for aggressive growth that will benefit shareholders, employees and society.

A. Ditto

**Arthur H. Ditto,**
*President and Chief Executive Officer*
*Salt Lake City, Utah*

# OPERATIONS

## Denton-Rawhide

The Denton-Rawhide gold mine in west central Nevada ranks as one of North America's largest heap-leach mines. Kennecott, Kiewit Mining Group and Plexus are the co-owners.

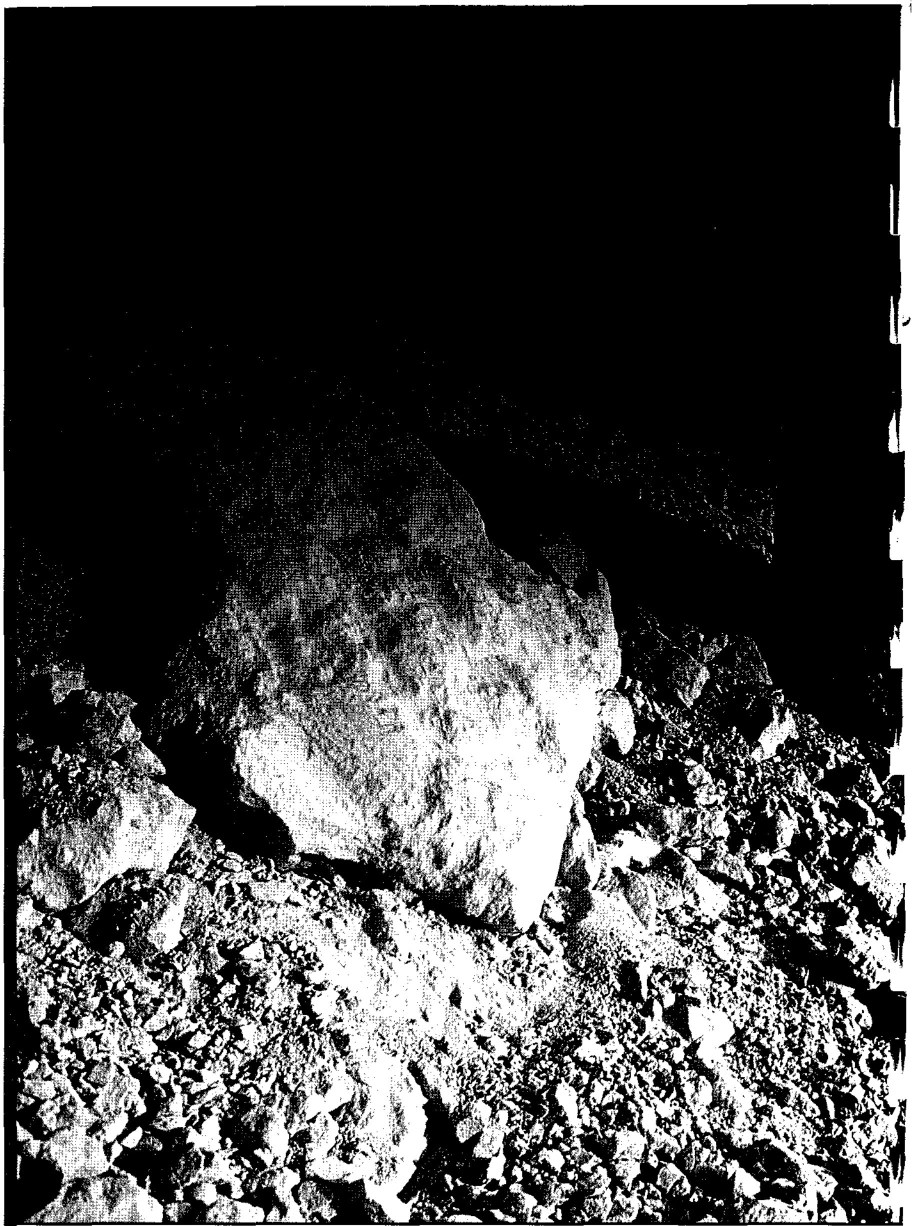
In 1991 the company's 24.01 percent direct and 2.45 percent royalty interests returned 19,940 ounces of gold and 134,300 ounces of silver. Direct operating costs averaged $221 an ounce of gold.

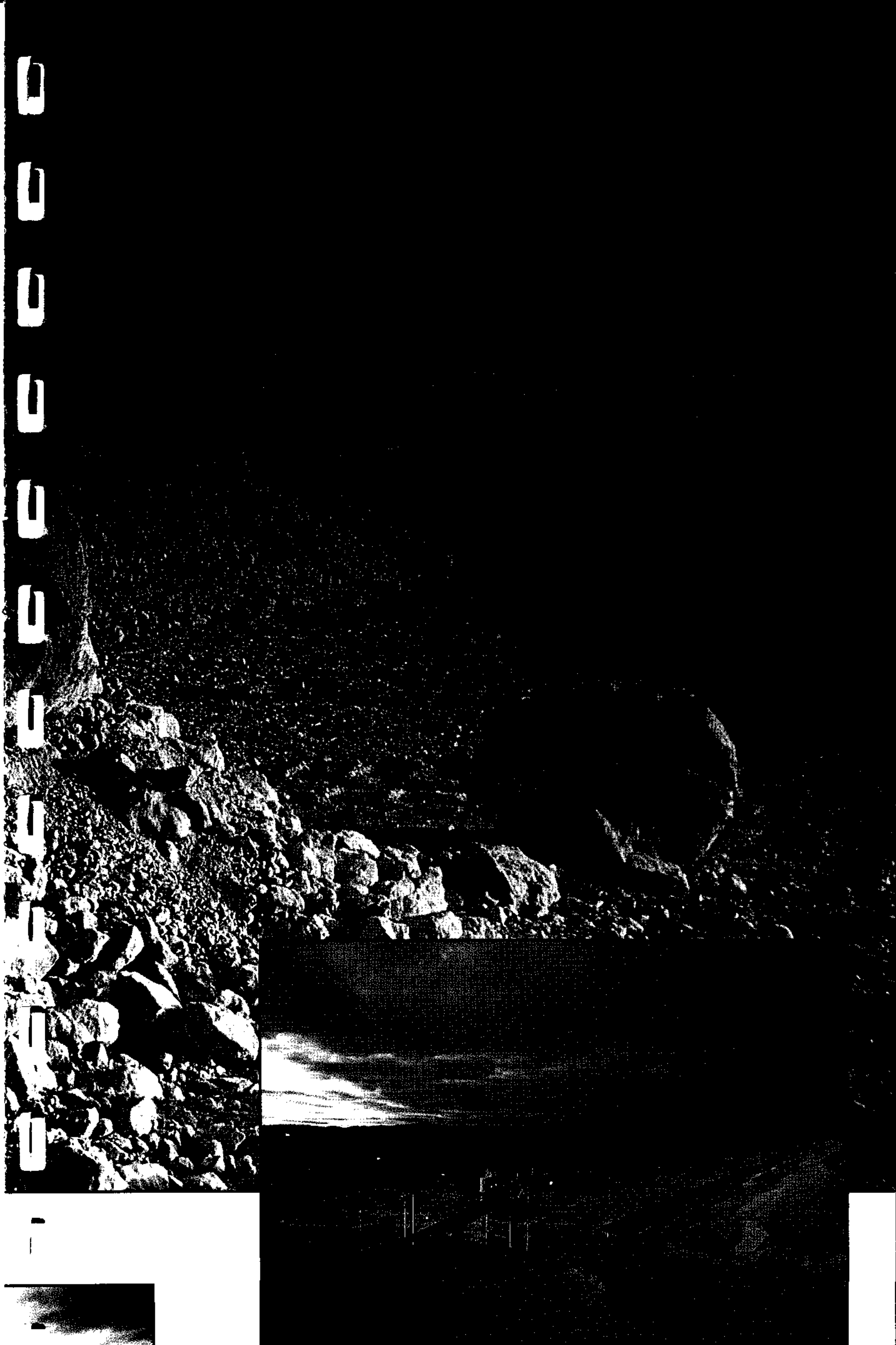
Commissioned in 1990, Denton-Rawhide is a 3.5-million-ton yearly, open-pit operation. Rock is drilled and blasted and then loaded into 85-ton trucks. Ore is crushed to 3/8 inch size in a three stage crushing plant and then placed on permanent heaps by conveyor. A leach solution is circulated through the heaps to dissolve and recover about 79 percent of the gold and 29 percent of the silver. Then, the gold and silver are precipitated from the solution. A 98 percent pure dore bullion is produced on site. The bullion bars are sent to a refinery to produce pure metal which is distributed to each partner.

For 1992 Plexus expects to get 25,000 ounces of gold and 184,000 ounces of silver. Gold recoveries should approach 80 percent and direct operating costs should fall to the $195-205 per ounce level. This is a 25 percent production increase from 1991 and is based on crusher improvements in 1991 and improvement of the heap stacking system in early 1992.

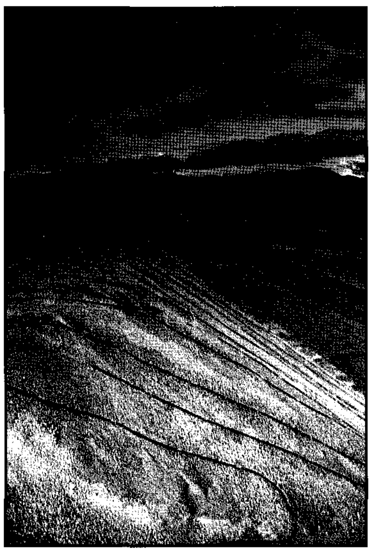
Development and exploration drilling adjacent to current operations continued to expand the reserve base in 1991. Reserves increased by 18% after ore mined was replaced. Plexus considers the potential for future reserve additions to be excellent. Current proven and probable reserves for the entire mine now stand at 53,988,000 tons containing 1,426,000 ounces of gold and 22,240,000 ounces of silver.

Environmental protection is an integral part of the mining at Rawhide. Redundant systems insure wildlife is preserved and protected. Water-conserving drip irrigation systems apply chemical solutions to the ore. Reclamation plans have been developed and are being implemented now rather than waiting until the mine's productive life has ended.





Leach Pad



Crushing Plant

## Oil and Gas

Plexus participates in 75 gas wells and eight oil wells. The company also has an interest in an Oklahoma gas gathering system and gas plant. It is general partner for three limited partnerships formed in 1981, 1983 and 1984. Oil and gas production is in West Virginia, Utah, Colorado, Oklahoma, Wyoming, North Dakota and Montana.

The company limits its oil and gas activities to farmout of existing operations and sale of certain properties when appropriate. Oil and gas related revenues were $289,000 during 1991, about the same as in previous years.

Loading explosives to break the ore

# DEVELOPMENT

## Bornite

Permitting of the 100 percent owned Bornite copper project in the western Cascades, 50 miles east of Salem, Oregon, began during 1991. The mine will be an underground operation. Over its minimum eight-year life, Bornite is expected to produce more than 120 million pounds of copper as well as major gold and silver by-product values. Recently revised reserve calculations, using a .5 percent copper cutoff, indicate the deposit embraces over 3.1 million tons of ore containing 2.2 percent copper.

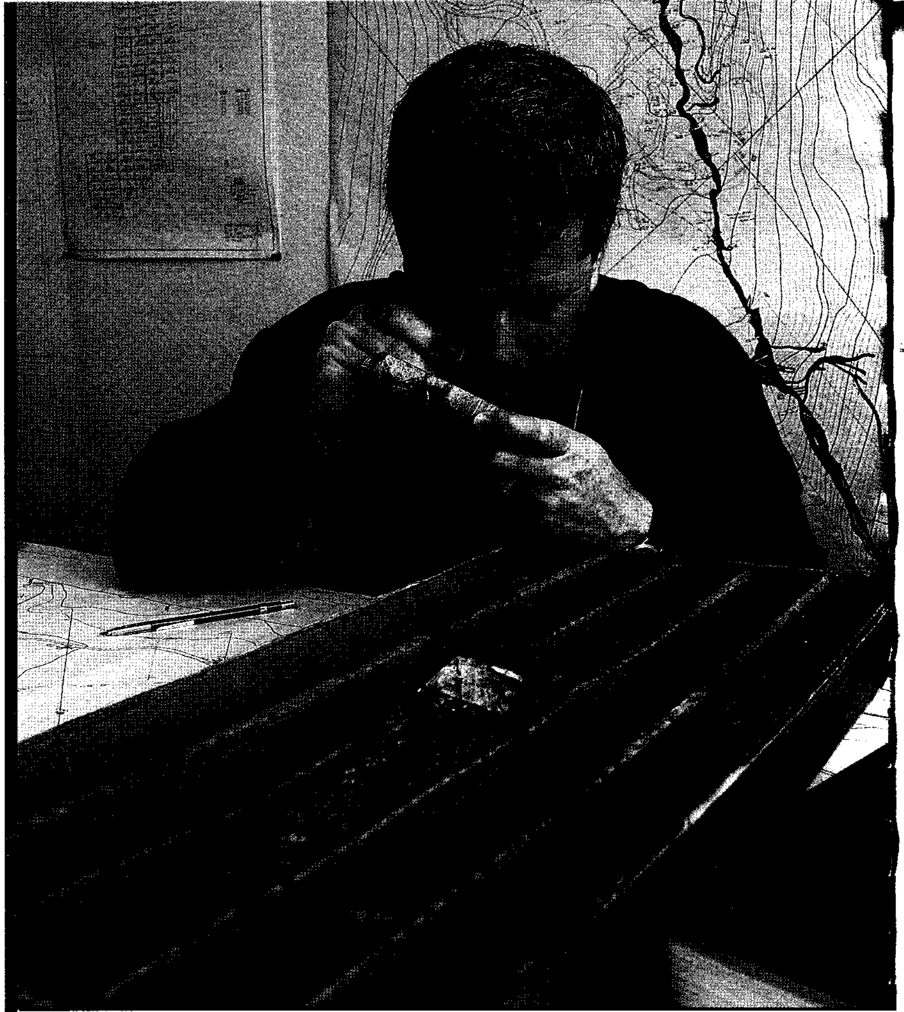
While most of the exploration and metallurgical testing at Bornite has been completed, environmental baseline work is still ongoing. Conceptual designs for the mine, flotation concentrator, tailings management system and eventual site reclamation have been completed.

An Environmental Impact Statement is being developed by the U.S. Forest Service in coordination with various Oregon state agencies and Plexus. Monitoring of critical environmental parameters continues. All permits and approvals are expected in time to allow construction to begin in spring of 1993.

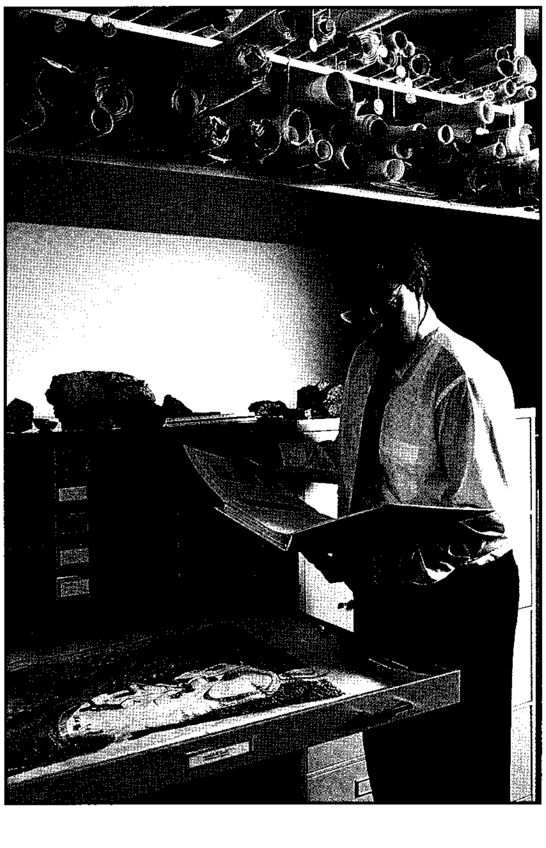
The Bornite ore body is contained within a roughly cylindrical breccia pipe. The formation is 450 feet in diameter and extends from surface down to about 1,000 feet. The ore body has been scientifically dated as 10.1 million years old. Copper minerals were deposited as part of the breccia matrix along the pipe's margins. Bornite and chalcopyrite are the principal ore minerals.

The project anticipates a highly mechanized 1,400 ton per day underground mine, operating five days per week, and a 1,000-ton daily flotation concentrator. The concentrator will yield a premium high-grade copper product containing major amounts of gold and silver. The concentrate will be trucked off site to a railhead or deep-water port for shipment to a smelter. More than half of the mill tailings will go back underground. The balance will be pumped to a tailings impoundment designed for the project.

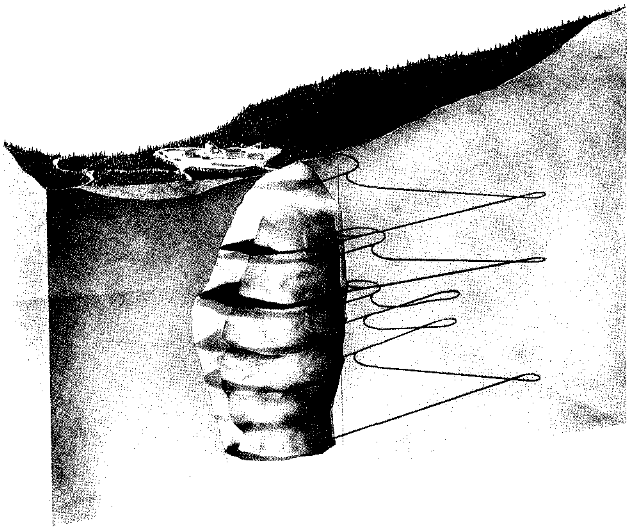
Environmental considerations are an important part of the Bornite mine development process. Planning to avoid and mitigate potential environmental problems is as critical as designing the underground workings and the metallurgical process.



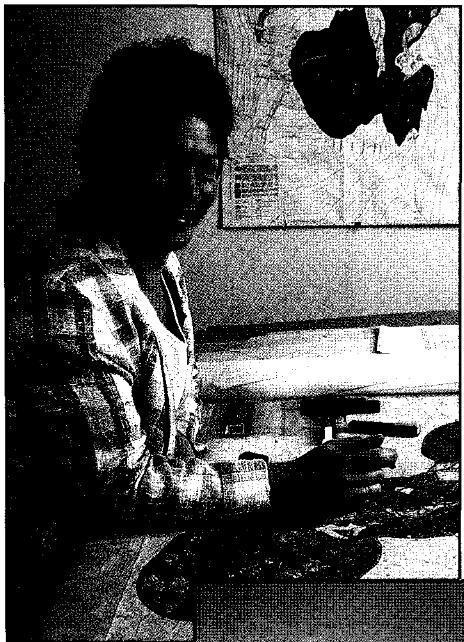
**Barton G. Stone (with core sample**
**Senior Project Geologi**



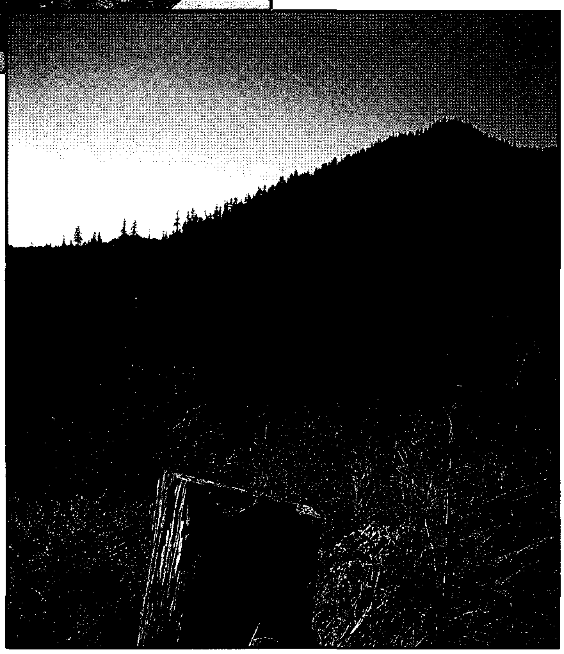
**Douglas E. Barto**
**Manager of Permitting &**
**Environmental Affairs**



An underground mine with limited surface disturbance



Norma Wellsandt
Administrative Assistant



Environmentally, Bornite has been called "earth-friendly," and with good reason. No old growth forest will be affected. No toxic reagents will be used in the flotation process. Less than fifty acres will be disturbed. Process water will be continuously recycled. Any water leaving the site will be of drinking quality. Reclamation will be ongoing at Bornite, not just after the mine is closed.

## Western World

Western World permitting continues. The project includes a surface copper mine and concurrent development of a recreational residential community. When Western World comes on stream in 1993, Plexus will be manager and operator. Plexus has a 75 percent interest in the joint venture ownership.

Western World owns 1,400 acres in the Sierra Foothills 18 miles east of Marysville, California. The project will include an open-pit mine and a mill contained in 160 acres of the company-owned land. Including construction time, mine life is expected to be seven years.

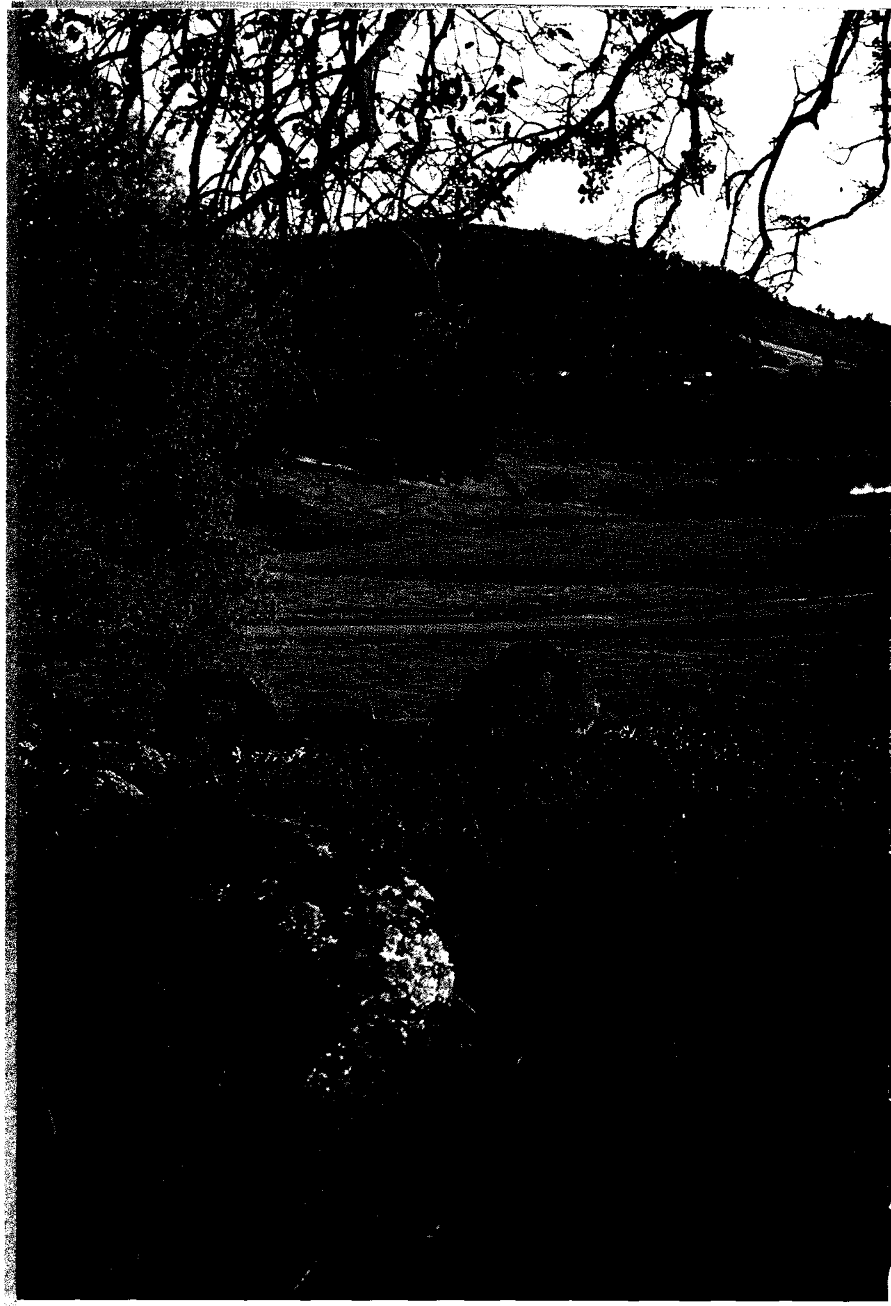
Western World is a massive sulfide deposit. Engineering estimates indicate that the deposit contains 1.4 million tons of 2.62 percent copper ore. The reserves have been qualified by a feasibility study conducted by Wright Engineers, Ltd.

Reclamation of the mining operation will be planned to enhance a residential community development. Sierra Lakes Village is proposed as a planned development with single family housing and an equestrian center around two small lakes. The larger of the lakes will be created during mine reclamation by expanding and landscaping the area previously occupied by the mine and facilities.

Western World is committed to protecting environmental and community values. The required Environmental Impact Report is being prepared and is expected to be done by summer of 1992. Other operating permits are being acquired. Environmental baseline data gathering is complete.

The operation will use conventional surface mining methods. The mine will produce approximately 1,000 tons of ore per day, five days a week. After mining, ore will be crushed and taken by conveyor to the mill for grinding and processing at a rate of 750 tons daily, seven days a week. Concentrate will be shipped to a smelter. Mill tailings will be pumped to a lined tailings impoundment designed for this project. The impoundment will meet stringent environmental and monitoring standards.

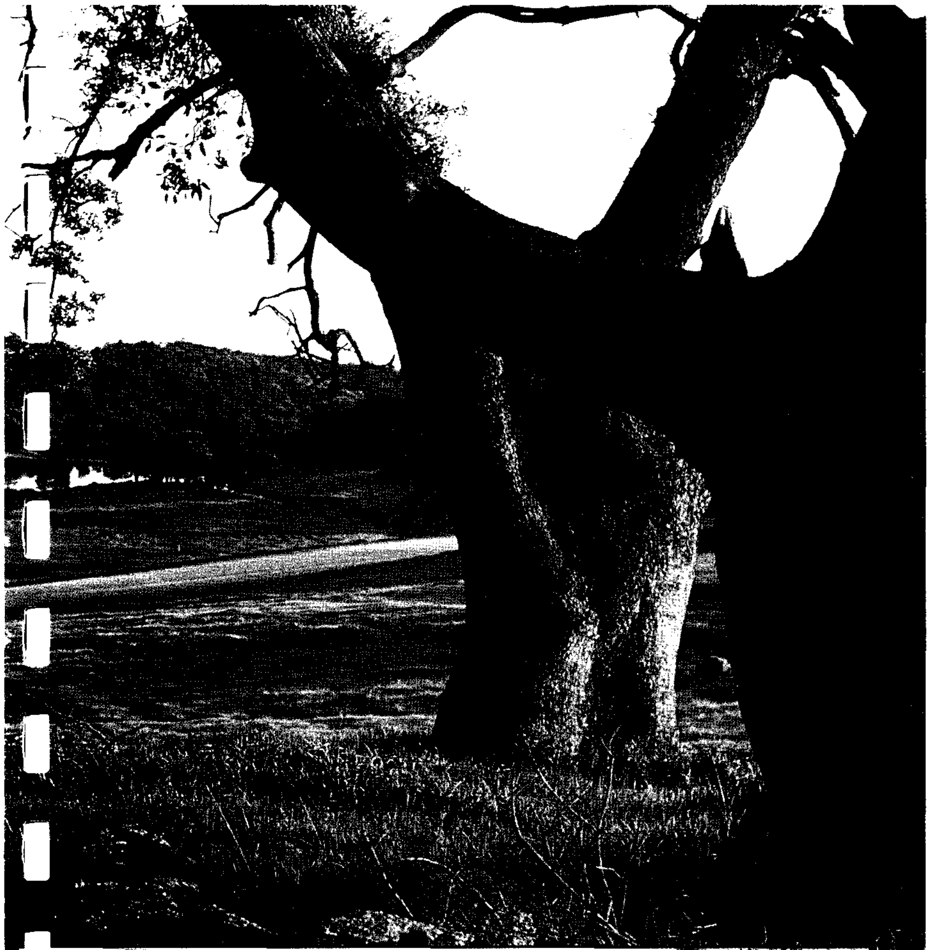
Metallurgical laboratory testing has demonstrated that 84 percent of the copper can be recovered as flotation concentrate. The concentrate will contain 28 percent copper.

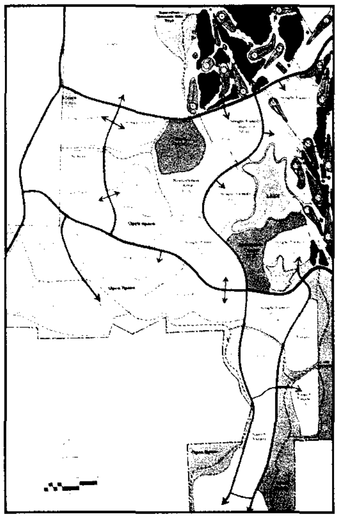


G. Chaun Cadwe
Vice President and
General Manager
Western Wor
Mining Compa

G. Chaun Cadwell
Vice President

Rhonda M. Jones
Administrative Assistant





Reclamation Plan

## BUSINESS DEVELOPMENT

### Silver Star

The Silver Star project, in southwest Washington state, is in the early stage of mine development. Silver Star is very similar to Bornite.

The ore body is contained within a breccia pipe, one of many along the margin of the Silver Star stock. The stock is composed of diorite extending over an area about ten miles long and up to four miles wide.

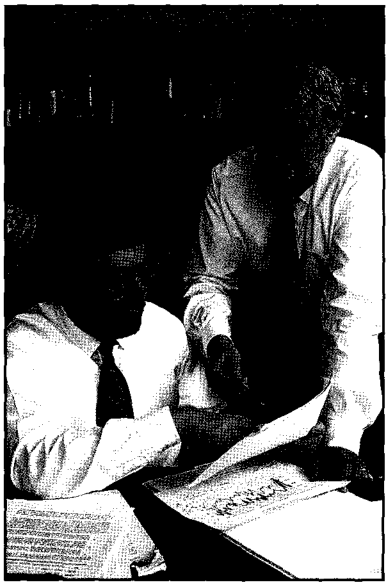
The bell-shaped deposit is about 300 feet in diameter. It extends from surface to a depth of 700 feet. Geologic ore reserves in the pipe are estimated at 2.9 million tons with a copper grade of 1.62 percent. Commercial values of silver and molybdenum also are present.

Because Silver Star is within the boundaries of Gifford Pinchot National Forest, an ecological setting similar to that of Bornite, many of the environmental and permitting issues are the same. Baseline data gathering, including hydrologic monitoring, will be started early in 1992.

Preliminary engineering and metallurgical laboratory work indicates the project is feasible. As the project progresses and operating parameters are better understood, a more precise development schedule will be defined.

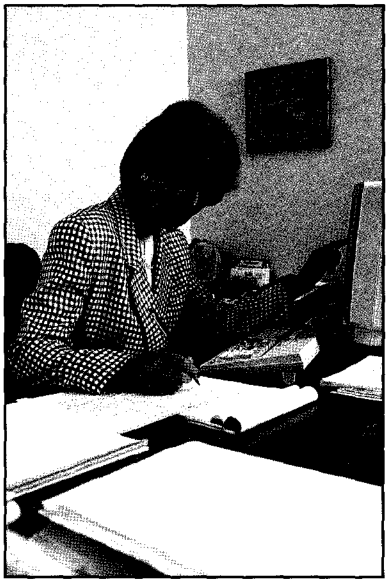
### Crown Butte

During 1991 Noranda Exploration exercised its option to acquire 60 percent of Crown Butte's outstanding shares. During the fourth quarter of 1991 and first quarter of 1992, Plexus sold 307,000 of its 333,000 shares of Crown Butte. We expect the balance will be sold by the end of the year. Proceeds will fund ongoing projects.



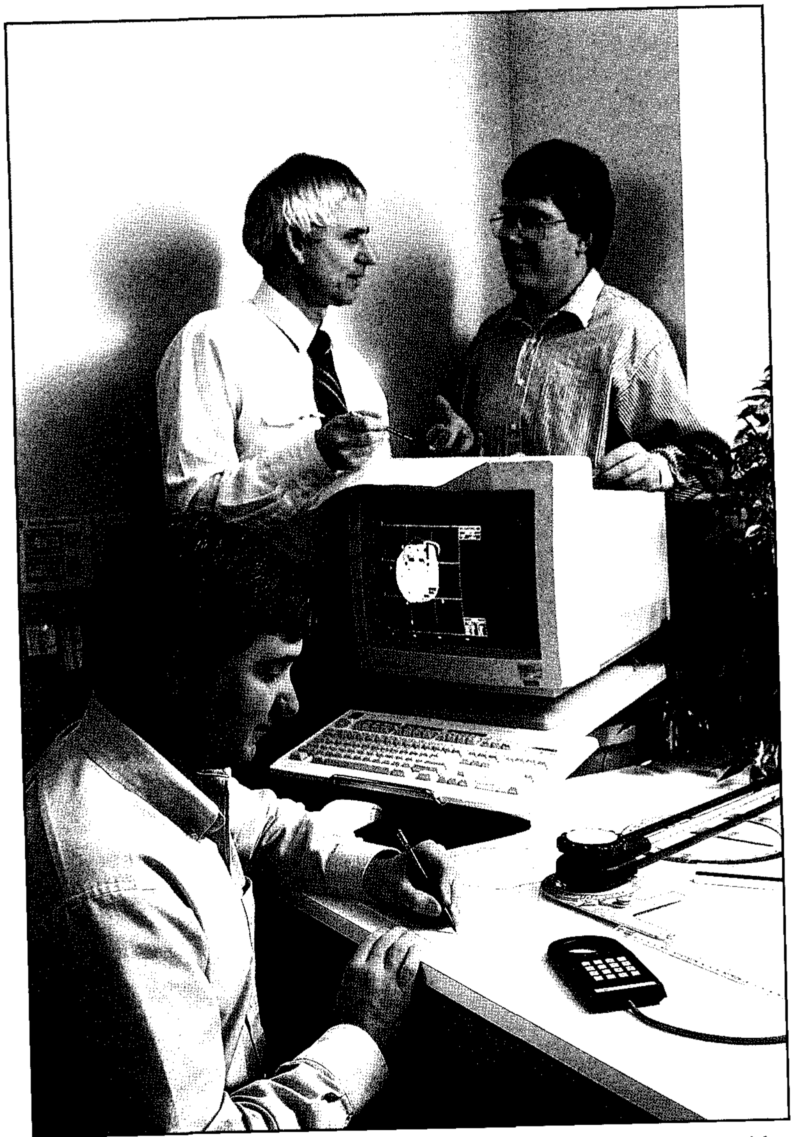
Allen S. Gordon
Vice President Technical Services

J. Michael G. Washington
Vice President and Chief Financial Officer



S. Gitte Coleman, Office Manager

Cindy L. Archibald (left), Laura L. Allison (right), Accounting Staff



Larry G. Snider
Geological Systems Analyst
John D. Taylor
Senior Geological Engineer
David G. Watkinson
Senior Project Engineer

## EXPLORATION

he company's principal long-term objective is acquisition and development of additional mineral reserves. Although Plexus will emphasize exploration near its operating and developing mines, it will keep looking for new and promising precious and base metal business opportunities in the United States and certain Latin American countries. This search will focus on properties with known mineralization that can be defined and expanded. Denton-Rawhide, Bornite, Western World, Silver Star and Crown Butte are all results of this strategy.

Net income of $300,000 and cash provided by operations of $2,240,000 are indications of improved financial performance at Plexus. The Company's net income and cash flow was provided by a complete year of operations at Denton-Rawhide.

The Company's operating and development activities presently emphasize gold and copper mining. It also maintains an interest in oil and gas production. Gold and gas prices continue to demonstrate volatility in the world commodity markets. These markets exhibit substantial price risk but also provide opportunities unavailable in other commodities. Plexus continues to utilize gold financing programs that reduce ongoing interest costs and the impact of gold price changes.

Plexus reports its financial results in U.S. dollars in accordance with Canadian generally accepted accounting principles ("GAAP"). Differences between Canadian and U.S. GAAP are disclosed in the Consolidated Financial Statements Note 11.

The Company changed its year end from June 30 to December 31, effective December 31, 1990. The following discussion compares the results of operations for complete years and does not follow directly the Consolidated Financial Statements presented later.

**1991 compared to 1990**

Net income of $300,000 ($0.03 per share) for the year ended December 31, 1991 compared favorably to a net loss of $860,000 ($0.10 per share) for the same twelve month period in 1990.

| **Analysis of 1991 Net Income to 1990 Net Loss (Dollars in Thousands)** | **Increase/ (Decrease)** |
|---|---|
| 1990 Net Loss | $( 860) |
| Increased gold and silver sales | 5,100 |
| Decreased gold and silver prices | (520) |
| Royalty contract settlement | (300) |
| Operating costs | (2,130) |
| Depreciation, depletion, and amortization | (950) |
| General and administrative | 330 |
| Abandonments and impairments | (190) |
| Gain on investment of Crown Butte common shares | (1,150) |
| Interest and debt expense | 970 |
| 1991 Net Income | $ 300 |

**Revenues** for 1991 increased 89% to $8,570,000 in 1991 compared to $4,530,000 in 1990. Virtually all mining revenues come from the company's interest in the Denton-Rawhide mine which commenced production in May of 1990. Gold production for 1990 was 8,640 ounces increasing 131% to 19,940 ounces in 1991. Silver production went from 29,280 ounces in 1990 to 134,300 in 1991. Production increases were partially offset by a royalty contract settlement and a reduction in the Company's realized gold price from $408 for 1990 to $387 in 1991. The annual average London gold price for those two years was $383 and $362 respectively.

**Operating costs and depreciation, depletion and amortization** increased approximately 65% from 1990 to 1991 resulting from the increase in production.

**General and administrative expense** declined 29% to $810,000 due to an increased percentage of costs being directly related and therefore capitalized to mineral development projects.

**Abandonments and impairments** increased 48% to $580,000 as several mineral exploration properties were written off in 1991 when the Company decided development was unlikely.

**Gains from the sale of the Company's investment in Crown Butte common shares** declined $1,150,000 in 1991 to $650,000 as 100,000 shares were sold compared to 300,000 shares in 1990.

**Interest and debt expense** declined $970,000 due to lower overall interest rates on debt outstanding and $650,000 of deferred debt issuance costs being written off when a significant portion of the 1989 gold loan was retired in 1990.

**1990 compared to 1989**

The Company's net loss for the fiscal year ending June 30, 1990, was $570,000 ($0.10 per share) versus the net loss of $1,230,000 ($0.26 per share) experienced in 1989. The analysis below summarizes the elements of the year-to-year variance.

| **Analysis of Change in Net Loss (Dollars in Thousands)** | **Increase/ (Decrease)** |
|---|---|
| 1989 Net Loss | $(1,230) |
| Gain on sale of Crown Butte shares | 1,800 |
| Increased net operating revenues from mining | 100 |
| Increased interest expense and amortization of debt issuance costs | (930) |
| Increased depreciation, depletion and amortization | (130) |
| Increased pension plan expense | (80) |
| Increased resource property write-downs | (60) |
| Other | (40) |
| 1990 Net Loss | $( 570) |

**Revenues** for 1990 increased 77% to $960,000 from $540,000 as a result of precious metal sales of $400,000 and hedging gains of $50,000. Oil and gas sales declined 6% to $290,000 from $310,000 due to reduced natural gas sales volumes and prices.

**Operating costs** increased 97% from $330,000 to $650,000 due to commencement of precious metal production at Denton-Rawhide.

**Depreciation, depletion and amortization** totaled $240,000, up 110% from the $120,000 recorded for 1989. The increase was almost exclusively related to commercial start-up at the Denton-Rawhide gold mine.

**General and administrative expense** increased 14% or $120,000 to $980,000 primarily because of the initial cost of an employee pension plan.

**Abandonments and impairments** of $270,000 in 1990 increased by $60,000 over 1989 as a result of the sale of a portion of the Company's oil and gas properties at prices below book value.

**Net Interest and debt expense** of $1,180,000 increased $930,000 or 369% from the $250,000 total for 1989. The increase was a result of interest expense associated with the debt incurred to fund Plexus' investment in the Denton-Rawhide project and a write-off of debt issuance costs related to the credit facility consistent with the retirement of a significant portion of the debt. Interest during construction of $1,340,000 was capitalized during 1990 as part of the Company's investment in Denton-Rawhide.

The Company's financial position improved during 1991. Cash flow provided by operations for 1991 totalled $2,240,000 compared to cash requirements of $950,000 during 1990. Improved operating profit margins were obtained and working capital levels stabilized at the Denton-Rawhide mine. This cash flow provides the Company the ability to fund ongoing development projects which will result in the Company's future growth.

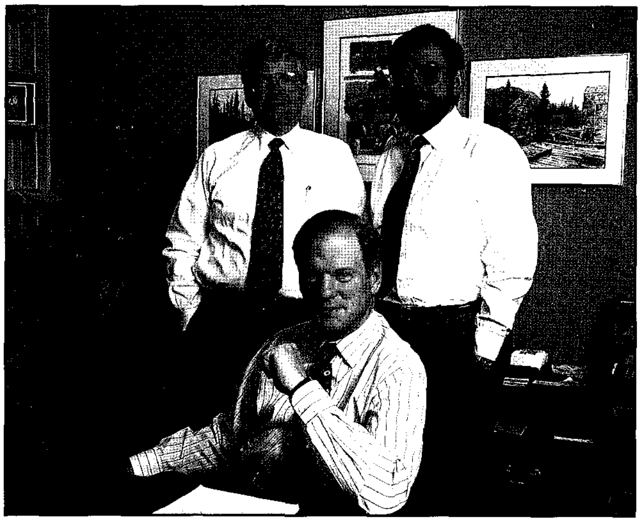
Mining capital projects consumed $3,900,000 in 1991. Denton-Rawhide projects used $2,200,000 for the installation of a tertiary crushing system, construction of a third leach pad and build-up of the lean ore stockpile. The Bornite and Western World projects used a total of $1,600,000 with drilling, permitting, and engineering being the primary activities. This capital spending was partially funded with $700,000 of proceeds from the sale of a portion of the Company's investment in Crown Butte Resources common shares.

In June of 1991 the Company completed a new gold borrowing facility which provided a reduced interest rate and increased working capital. As a result, working capital is more than $2,000,000 stronger at December 31, 1991 than it was a year earlier. The debt to total capital ratio, including current portions, remained constant at 41%.

**Capital project requirements** of $2,300,000 are anticipated for 1992. Denton-Rawhide will use $600,000 primarily for improvements to the ore handling system. Bornite plans include spending of $800,000 to further permitting and engineering while the Western World project will require $400,000 for similar work. Property acquisition activities will consume the balance.

**Liquidity** — Operating cash flow from the Denton-Rawhide mine will be adequate to cover general operating costs and debt service obligations. Capital expenditures will be funded from the remaining operating cash flows and the proceeds from the sale of the Company's investment in Crown Butte common shares. In March of 1992, 203,700 of the 233,334 shares were sold for $1,253,000. Proceeds were used to repay all short-term notes payable.

Completion of the Bornite and Western World development projects will require additional funds in future periods for construction. The Company may finance the cost of further development of these properties by borrowing from banks and others through conventional loans or gold loans, or from the sale of equity securities. There are no assurances that satisfactory financing can be obtained.



Arthur H. Ditto (middle)
J. Michael G. Washington (left)
Allen S. Gordon (right)

# REPORT OF INDEPENDENT AUDITORS

To the Shareholders of
Plexus Resources Corporation

We have audited the consolidated balance sheets of Plexus Resources Corporation as at December 31, 1991 and 1990, respectively and the consolidated statements of operations, shareholders' equity and cash flows for the year ended and the six-month period ended December 31, 1991 and 1990, and for each of the years in the two-year period ended June 30, 1990. These financial statements are the responsibility of the Corporation's management. Our responsibility is to express an opinion on these financial statements based on our audits.

We conducted our audits in accordance with generally accepted auditing standards. Those standards require that we plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In our opinion, these consolidated financial statements present fairly, in all material respects, the financial position of the Corporation as of December 31, 1991 and 1990, and the results of its operations and the changes in its financial position for the year ended and the six-month period ended December 31, 1991 and 1990, respectively and for each of the years in the two-year period ended June 30, 1990 in accordance with accounting principles generally accepted in Canada.

Ernst + Young

Toronto, Canada
March 4, 1992

ERNST & YOUNG
Chartered Accountants

# PLEXUS RESOURCES CORPORATION
## CONSOLIDATED STATEMENTS OF SHAREHOLDERS' EQUITY

Year Ended December 31, 1991; Six Months Ended December 31, 1990;
and Years Ended June 30, 1990 and 1989.

*(U.S. DOLLARS)*

| | Common Stock | | |
|---|---|---|---|
| | **Shares** | **Amount** | **Retained Earnings (Deficit)** |
| Balance, as of June 30, 1988 | 4,647,149 | $ 6,246,021 | $ (3,463,220) |
| Shares issued for private placement ($1.47 per share) | 244,586 | 330,653 | |
| Shares issued under executive incentive plan ($1.44 per share) | 3,500 | 5,026 | |
| Shares issued upon conversion of convertible debentures ($1.79 per share) | 4,712 | 8,438 | |
| Adjustments to unamortized debt issuance costs upon conversion of convertible debentures | | (42) | |
| Net loss | | | (1,233,543) |
| Balance, as of June 30, 1989 | 4,899,947 | $ 6,590,096 | $ (4,696,763) |
| Shares issued for private placement ($2.41 per share) | 6,000,000 | 13,747,071 | |
| Shares issued under executive incentive plan ($3.34, $2.52, and $2.15 per share) | 8,500 | 23,176 | |
| Shares issued to directors upon exercise of stock options ($2.78 per share) | 30,000 | 83,328 | |
| Cancellation of officer's note receivable and related stock ($2.26 per share) | (25,000) | | |
| Shares issued upon conversion of convertible debentures ($1.79, $1.72, $1.80, $2.76, and $2.77 per share) | 850,395 | 1,574,528 | |
| Adjustments to unamortized debt issuance costs upon conversion of convertible debentures | | (2,761) | |
| Net loss | | | (566,976) |
| Balance, as of June 30, 1990 | 11,763,842 | $22,015,438 | $ (5,263,739) |
| Net loss | | | (818,835) |
| Balance, as of December 31, 1990 | 11,763,842 | $22,015,438 | $ (6,082,574) |
| **Shares issued under executive incentive plan ($1.12 and $1.18 per share)** | **17,500** | **19,667** | |
| **Elimination of December 31, 1990 deficit to capital stock** | | **(6,082,574)** | **6,082,574** |
| **Net income** | | | **299,597** |
| **Balance, as of December 31, 1991** | **11,781,342** | **$15,952,531** | **$ 299,597** |

*See accompanying notes.*

**Table 3 Underground Development and Production Equipment Requirements.**

| | |
|---|---|
| Load-haul-dump (6 cy capacity) | 3 units |
| Drill Jumbo | 1 unit |
| Haulage Trucks (40 ton & 26 ton capacity) | 3 units |
| Service Trucks | 4 units |
| Road Grader | 1 unit |
| Explosives Truck | 1 unit |
| ITH Drill | 1 unit |
| Supervisors/Transportation Vehicles | 2 units |

Underground equipment will also include hand tools, small pneumatic rock drills, a variety of pumps, compressors, and auxiliary ventilation fans. The ventilation raise will also be equipped with a small man hoist for emergency access and escape. As the mine deepens and the equipment ages, additional LHD's and haulage trucks will be added to replace or supplement existing units.

## METALLURGICAL PROCESS DESCRIPTION

The Bornite mill will be designed to treat 1,000 tons per day of ore from underground mining operations to produce a flotation concentrate for sale and further treatment.

## FLOTATION

The Bornite flotation process will consist of several sequential steps (Figure 4). Run-of-mine ore is crushed in two stages at a rate of 120 tons per hour to a size of less than 5/8 inch. The crushed ore is conveyed to a fine ore storage bin with a capacity of 3,000 tons. Ore withdrawn from the storage bin is further reduced in a ball mill at a rate of 44 tons per hour. Water is added in the grinding process to produce a slurry of coarsely-ground ore.

The slurry is conditioned to prepare it for flotation, which separates the copper minerals as a concentrate. After thickening, the copper concentrate is filtered to produce a dewatered product suitable for shipping. The tailing is thickened and pumped to the tailings impoundment or backfilled underground.

Geochemical testing of the flotation products for Bornite ores confirms the success of the flotation process to remove metal-bearing minerals. The flotation process tailings are classified as non-toxic, do not generate acid, and do not leach toxic metals. These samples indicate that the tailings meet Oregon DEQ draft requirements for tailings-solids treatment criteria.

# PLEXUS RESOURCES CORPORATION
# CONSOLIDATED STATEMENTS OF CASH FLOWS
*(U.S. DOLLARS)*

| | Year Ended December 31, 1991 | Six Months Ended December 31, 1990 | Year Ended June 30, 1990 | Year Ended June 30, 1989 |
|---|---|---|---|---|
| Operating activities: | | | | |
| Net income (loss) | **$ 299,597** | $ (818,835) | $ (566,976) | $(1,233,543) |
| Adjustments to reconcile net income (loss) to net cash provided by (used in) operating activities: | | | | |
| Depreciation, depletion and amortization | **1,840,196** | 940,537 | 242,360 | 115,606 |
| Abandonments and impairments | **584,141** | 122,353 | 272,689 | 216,679 |
| Foreign exchange loss | **10,584** | 21,817 | 106,219 | 67,379 |
| Amortization of debt issuance costs | **91,517** | 84,073 | 100,030 | 30,535 |
| Write-off of deferred debt issuance costs | **—** | — | 643,884 | 17,894 |
| Gain on sale of investment | **(646,940)** | — | (1,796,695) | — |
| Reserve for reclamation | **90,943** | 25,945 | 3,171 | — |
| Other | **18,109** | (88,728) | 30,378 | 5,026 |
| Changes in operating assets and liabilities: | | | | |
| (Increase) decrease in accounts receivable | **(41,579)** | (270,253) | (129,491) | 177,769 |
| Decrease (increase) in inventories | **153,543** | 54,671 | (1,059,925) | — |
| Decrease (increase) in prepaid expenses | **132,616** | (206,648) | 2,293 | (2,979) |
| (Decrease) increase in accounts payable and accrued expenses | **(295,077)** | 559,486 | 293,196 | 121,832 |
| Net cash provided by (used in) operating activities | **2,237,650** | 424,418 | (1,858,867) | (483,802) |
| Investing activities: | | | | |
| Additions to property and equipment | **(3,869,924)** | (2,911,457) | (12,415,188) | (7,056,273) |
| Proceeds from sale of investment | **696,055** | — | 1,944,042 | — |
| Proceeds from sale of assets | **17,625** | — | — | — |
| Net cash used in investing activities | **(3,156,244)** | (2,911,457) | (10,471,146) | (7,056,273) |
| Financing activities: | | | | |
| Proceeds from issuance of debt | **10,812,388** | 2,500,000 | 10,700,000 | 9,217,823 |
| Proceeds from issuance of common stock | **—** | — | 14,752,977 | 180,702 |
| Principal payments on debt | **(9,544,705)** | (1,965,898) | (10,718,212) | (69,433) |
| Deferred debt and equity costs incurred | **(355,441)** | — | (1,189,152) | (909,114) |
| Effect of exchange rate changes on cash | **(3,409)** | 12,988 | 2,570 | 1,263 |
| Net cash provided by financing activities | **908,833** | 547,090 | 13,548,183 | 8,421,241 |
| (Decrease) increase in cash and cash equivalents | **(9,761)** | (1,939,949) | 1,218,170 | 881,166 |
| Cash and cash equivalents at beginning of period | **313,488** | 2,253,437 | 1,035,267 | 154,101 |
| Cash and cash equivalents at end of period | **$ 303,727** | $ 313,488 | $ 2,253,437 | $ 1,035,267 |
| Supplemental disclosures: | | | | |
| Cash paid during the period for interest (net of amount capitalized) | **$ 448,804** | $ 128,470 | $ 594,869 | $ 150,849 |
| Principal payments on debt from issuance of common stock | **$ —** | $ — | $ 1,574,528 | $ 149,951 |

Other noncash changes (see Consolidated Statements of Shareholders' Equity)

*See accompanying notes.*

## 1. *Significant Accounting Policies*

**General —** Plexus Resources Corporation ("the Company") is a Canadian company operating under the Canada Business Corporations Act. It conducts operations in the United States. The principal business of the Company is to acquire and develop interests in natural resource properties.

**Consolidation and Translation of Foreign Currencies —** The Consolidated Financial Statements include the accounts of Plexus Resources Corporation, Plexus, Inc. and Plexus Rawhide Mining Company (PRMC) (see Note 4). All significant intercompany transactions and balances have been eliminated.

The consolidated financial statements of the Company are prepared in accordance with Canadian generally accepted accounting principles. Accounting under Canadian and United States generally accepted accounting principles as applied by the Company is substantially the same. Differences are described in Note 11. The Company changed its year end from June 30 to December 31, effective December 31, 1990.

The accounts of Plexus, Inc. and Plexus Rawhide Mining Company are maintained in U.S. dollars. Because the functional currency of both of these companies and the reporting currency of the Company is the U.S. dollar, the accounts of Plexus Resources Corporation have been converted into U.S. dollars and all gains and losses resulting from this remeasurement are recognized currently in income except as mentioned in Note 11. No foreign currency gain or loss has been recognized on intercompany transactions.

**Cash Equivalents —** For purposes of the Statement of Cash Flows, the Company considers all highly liquid debt instruments purchased with a maturity of three months or less to be cash equivalents.

**Inventories —** Finished gold inventories at the refinery are valued at net realizable value. Denton-Rawhide gold in process, composed of ore on the leach pad or in process and materials and supplies inventories are valued at the lower of cost or market. Inventory costs are determined on the first-in, first-out (FIFO) method. Market is estimated at replacement cost.

**Mineral Properties —** The Company capitalizes all costs, including interest, relating to the acquisition and development of mineral properties. Mineral properties are assessed at least annually and any material impairment in value is recognized currently.

The Company proportionally consolidates its ownership interest in the Denton-Rawhide mine. Depletion and depreciation of producing properties and buildings are computed on the unit-of-production method based on estimated recoverable proven and probable reserves. The Denton-Rawhide royalty interest is amortized using the unit-of-production method based on estimated recoverable, proven and probable reserves.

**Oil and Gas Properties —** The successful efforts method of accounting is followed for costs incurred in oil and gas exploration and development operations. Property acquisition costs are initially capitalized. All unproved properties are assessed at least annually on a field by field basis and any impairment in value is recognized currently. Costs of abandoned properties are included in current operations. Depreciation, depletion and amortization of proved oil and gas properties are computed for each oil and/or gas field using the unit-of-production method based on estimated proven developed reserves.

**Other Property and Equipment —** Other property and equipment is stated at cost and is depreciated or amortized using the straight-line method over estimated useful lives of three to eight years.

**Deferred Debt Issuance Costs —** Debt issuance costs incurred in issuing convertible debentures or obtaining project debt are amortized using the interest method.

**Gold Loan —** Commencing in 1991, gold loans are remeasured to reflect the market price of gold at each balance sheet date. The difference between the original proceeds and market value is included in deferred revenue. This difference is recognized in revenue when the reserves hedged are produced. For prior periods, the gold loans are recorded at the original proceeds received. Gains or losses on early repayment of gold loans are deferred and recorded in revenue as the original reserves hedged are produced.

**Reserve for Reclamation —** Reclamation costs are accrued on the unit-of-production method using estimates of total costs for reclamation of the mine site as required by state and federal regulations.

**Earnings per Share —** Primary earnings per share is calculated based upon the weighted average number of common shares outstanding during the year. Fully diluted earnings per share is not presented because the result is antidilutive.

**Reclassification —** Certain amounts relating to prior periods in the Consolidated Financial Statements and Notes to the Consolidated Financial Statements have been reclassified to conform to current period presentation.

## 2. *Inventories*

| | December 31, 1991 | December 31, 1990 |
|---|---|---|
| Gold in process | $ 638,235 | $ 876,021 |
| Materials and supplies | 213,476 | 129,233 |
| | $ 851,711 | $ 1,005,254 |

Inventories are solely related to the Company's share of the Denton-Rawhide inventories.

## 3. *Investment*

The Company has an investment in the common stock of Crown Butte Resources Ltd. with a cost of $114,603 and $163,719 at December 31, 1991 and 1990 respectively.

During April 1990, Plexus, Inc. sold 300,000 common shares of its 633,334 share holding of Crown Butte for $1,944,042. In November 1991 it sold an additional 100,000 shares for $696,066. Crown Butte controls a significant gold-copper-silver property which is in the development stage. As of February 25, 1992, the quoted market value of the Company's interest in Crown Butte was approximately US$1,574,000 (CDN$1,867,000).

## 4. *Property and Equipment*

Costs incurred by the Company through December 31, 1991 for acquisition and development of mineral properties are shown below, including $228,329 of interest costs that were capitalized in 1991 and $1,339,761 for the year ended June 30, 1990. The Denton-Rawhide Mine was operating at December 31, 1991. All other properties were under development.

| MINERAL PROPERTIES | December 31, 1991 | December 31, 1990 |
|---|---|---|
| Denton-Rawhide | $22,498,566 | $20,231,875 |
| Western World | 2,524,150 | 2,210,721 |
| Bornite | 2,269,319 | 948,574 |
| Silver Star | 770,174 | 634,051 |
| Other | — | 455,264 |
| | $28,062,209 | $24,480,485 |

Major components of the Denton-Rawhide mine costs are as follows:

| | December 31, 1991 | December 31, 1990 |
|---|---|---|
| Land and royalty interest | $16,175,624 | $15,478,136 |
| Buildings & Machinery | 5,403,070 | 4,071,958 |
| Mine development | 890,252 | 411,589 |
| Construction in progress | 29,620 | 270,192 |
| | $22,498,566 | $20,231,875 |
| Accumulated depreciation, depletion and amortization | (2,710,011) | (994,061) |
| Net Book Value | $19,788,555 | $19,237,814 |

The Company holds a 24.01% direct interest and a 2.45% royalty interest in Denton-Rawhide. These interests were acquired through agreements entered into in June of 1989.

The Company participates in all revenues and expenses in its proportionate 24.01% interest. Substantially all of the Company's mining revenue and operating costs, are attributable to its interest in Denton-Rawhide. The 2.45% royalty is received on gross proceeds from all products shipped from the project. All proceeds are taken in-kind.

| OIL AND GAS PROPERTIES | 1991 | 1990 |
|---|---|---|
| Oil and Gas Properties at Cost | $ 3,589,793 | $ 3,586,468 |
| Accumulated depreciation, depletion, and amortization | (1,829,992) | (1,687,769) |
| Net Book Value | $ 1,759,801 | $ 1,898,699 |

## 5. *Notes payable and long-term debt*

Notes payable of $800,000 and $2,699,874 were outstanding at December 31, 1991 and 1990 respectively. The notes payable of $2,699,874 outstanding at December 31, 1990 were paid off with proceeds of a gold loan issued in May of 1991 described below under 1991 Gold Loan. The $800,000 note, with an interest rate of 6.5% at December 31, 1991 is secured by the Company's investment in Crown Butte common shares. The Company anticipates selling the shares during the year and will repay the note from the proceeds of the sale.

Long-term debt consists of the following:

| | December 31, 1991 | December 31, 1990 |
|---|---|---|
| Gold Loan: | | |
| 1991 | $ 9,306,789 | $ — |
| 1989 | — | 7,200,000 |
| Callable Convertible Canadian Dollar Debentures | 1,207,270 | 1,202,630 |
| | 10,514,059 | 8,402,630 |
| Less current portion | 1,100,841 | 1,600,000 |
| | $ 9,413,218 | $ 6,802,630 |

Total interest expense for debt that had original life of more than one year was $369,281 for the year ended December 31, 1991, $238,155 for the six months ended December 31, 1990 and $1,757,796 and $84,679 for the years ended June 30, 1990 and 1989 respectively.

**Debt Maturities —** Maturities of long-term debt at December 31, 1991 are as follows:

| | |
|---|---|
| 1992 | $ 1,100,841 |
| 1993 | 1,487,814 |
| 1994 | 2,903,590 |
| 1995 | 1,897,758 |
| 1996 | 1,731,660 |
| Thereafter | 1,392,396 |
| | $10,514,059 |

**1991 Gold Loan —** On May 20, 1991 the Company entered into a loan with a major bullion bank. The loan is secured by the Company's 24.01% operating interest and its 2.45% royalty interest in the Denton-Rawhide Mine.

The agreement provides for two facilities. The first is a 27,450 ounce gold loan that was valued at $10,012,388, based on a $364.75 per ounce gold price at the time of closing. The outstanding balance of the 1989 Gold Loan was repaid with 17,592 ounces from this facility. The remaining 9,858 ounces were sold to provide working capital. This facility carries a variable interest rate that was 2.44% at December 31, 1991. A repayment schedule in ounces has been prepared based on projected production. The schedule consists of 24 quarterly payments of which four may be deferred. The facility cannot be extended past June 30, 1998.

There were 26,335 ounces with a market value of $9,306,789 outstanding at December 31, 1991. The loan was revalued at a market gold price of $353.40 per ounce. The difference between the original book value of $364.75 and market is carried in deferred revenue.

As required by the 1991 gold loan, the Company entered into a long-term forward sales hedge agreement. Under the terms of the agreement, the Company must deliver 74,500 ounces of gold to the bullion bank as follows:

| Year | Ounces |
|---|---|
| 1992 | 12,000 |
| 1993 | 11,800 |
| 1994 | 13,000 |
| 1995 | 13,200 |
| 1996 | 12,500 |
| 1997 | 12,000 |
| | 74,500 |

Upon delivery the Company will receive a payment based on the gold borrowing rate, LIBOR and the price of gold since the date of the agreement. The average estimated price to be received over the life of the arrangement, as determined on December 31, 1991, was $418 per ounce.

The second facility provides up to $500,000 of revolving credit for capital expenditure requirements at Denton-Rawhide. A .25% commitment fee is charged on the balance not drawn. No funds have been drawn as of December 31, 1991. This facility must be paid off on or before the final payment of the first facility.

**1989 Gold Loan —** During 1989, the Company obtained a credit facility used to fund the Company's costs to (1) construct the Denton-Rawhide project, (2) purchase a 2.45% royalty interest in gross proceeds from the sales of precious metals or minerals produced from the Denton-Rawhide property, (3) secure a gold marketing program, including related margin exposures, and (4) pay agent fees for the credit facility and debt service costs prior to start of production. All of the assets of the Company were pledged as collateral under the credit facility.

A net gain of $724,400 realized when the gold loan was repaid has been deferred. The deferred revenue will be recognized as the original reserves hedged are produced.

**Callable Convertible Canadian Dollar Debentures, due February 28, 1992 —** In March 1989, the Company sold by private placement in Canada CDN $1,395,000 (US$1,207,270 at December 31, 1991) 10.5% Callable Convertible Debentures and 162,750 Common Share Purchase Warrants. The warrants expired during 1991 without conversion. The debentures are convertible into common shares until February 28, 1992 at the option of the holder at a conversion price of CDN$2.12 per share.

In February 1992, the Company negotiated an extension of the due date for the Callable Convertible Canadian Dollar Debentures. The maturity was extended for two years to February 28, 1994. In addition the interest rate was reduced from 10.5% to 10.0% and the conversion price was reduced from CDN$2.12 to CDN$1.50.

## *6. Income Taxes*

Provision for income taxes in 1991 of $132,000 is offset by a recovery of the same amount through the utilization of net operating loss carryforwards from previous years. The difference between the provision of $132,000 and the provision calculated using the U.S. statutory income tax rate of 34%, $102,000, is that Canadian losses are not deductible for U.S. income tax purposes.

At December 31, 1991, the Company has U.S. net operating loss carryforwards of approximately $3,600,000 for financial reporting purposes and $10,600,000 for U.S. tax purposes which will begin expiring in 1995. Under Section 382 of the Internal Revenue Code, the use of the net operating loss carryforwards will be limited in any given year because of significant changes in ownership of the Company. For United States financial and income tax purposes, the Company also has available investment tax credit carry-forwards of approximately $37,000, which will begin expiring in 1995 and, for tax purposes, percentage depletion carryforwards of approximately $400,000 which do not expire and will be utilized when the Company generates U.S. taxable income.

No provision for Canadian income taxes has been recorded due to the operating losses of the Company. At December 31, 1991, the Company has Canadian net operating loss carryforwards for Canadian financial and income tax purposes of approximately US$730,000 (CDN$846,000), of which US$41,000 (CDN$47,000) begin expiring in 1992.

The loss carryforwards for U.S. tax purposes differ from the financial statement carryforwards principally because of oil and gas development and exploration and mineral properties development activities which are capitalized for book purposes and expensed for tax purposes.

## *7. Related Party Transactions*

An officer has a contract providing for his employment by the Company for a term through 1995. The contract provides that the officer will automatically participate in Company benefit plans, awards, options and bonuses currently provided or to be initiated in the future by the Company. The contract also contains a provision for termination by the Company under certain circumstances.

The Company has a current liability of approximately $252,000 to an affiliated company that is due upon demand.

## *8. Common Stock*

On June 26, 1991 the shareholders of the Company approved elimination of the deficit of $6,082,574 at December 31, 1990 by a corresponding reduction of capital stock.

At the June 22, 1990 Special General Meeting of Shareholders, the Company's shareholders approved the terms of a private placement agreement with TOTAL Energold Corporation of Vancouver, British Columbia, which included the issuance of 6,000,000 common shares of the Company and 2,150,000 common share purchase warrants. 513,692 of these warrants expired during 1991. Under the terms of the private placement agreement, TOTAL Energold

Corporation paid $14,007,000 (CDN$16,500,000) in cash plus all of the issued and outstanding common shares of its wholly-owned, U.S. mining exploration subsidiary, Sovereign Explorations, Inc. (subsequently merged into Plexus, Inc.), as consideration for the 6,000,000 common shares of the Company. Related equity issuance costs were $846,000. The net assets of Sovereign were recorded using the purchase method at cost in the amount of $586,000. The exercise price of the 1,636,308 remaining related common share purchase warrants is CDN$3.00 per share, and they expire on various dates from March 1, 1992 to June 22, 1995.

On November 7, 1984, the shareholders of the Company approved an Incentive Stock Option Plan and an Executive Incentive Plan. The plans provide that no more than 10% of the Company's outstanding common stock be reserved for issuance under the two plans. Awards under these plans are issued at the discretion of the Board of Directors to directors, officers and key employees, with an exercise price equivalent to the price per share of the last sale of the Company's shares on The Toronto Stock Exchange on the date on which the option is granted. The stock option plan also provides for loans to the option holders for purchase of such shares, at the discretion of the Board.

Outstanding options as of December 31, 1991:

| Options Held by | Date of Grant | Expiry Date | Number of Common Shares Under Option | Exercise Price Per Share (CDN $) |
|---|---|---|---|---|
| Directors | Nov 03, 1989 | Nov 03, 1994 | 180,000 | 3.05 |
| | Dec 03, 1990 | Dec 03, 1995 | 110,000 | 1.20 |
| Executive Officers | Nov 03, 1989 | Nov 03, 1994 | 100,000 | 3.05 |
| | Dec 03, 1990 | Dec 03, 1995 | 100,000 | 1.20 |
| | Dec 12, 1990 | Dec 12, 1995 | 25,000 | 1.35 |
| | Jan 03, 1991 | Jan 03, 1996 | 40,000 | 1.12 |
| | Nov 25, 1991 | Nov 25, 1996 | 110,000 | 1.10 |
| Employees & Others | Nov 03, 1989 | Nov 03, 1994 | 30,000 | 3.05 |
| | Dec 30, 1991 | May 10, 1995 | 25,000 | 1.08 |

## *9. Employee Savings and Pension Plan*

The Company has an employee savings plan qualifying under section 401(k) of the U.S. Internal Revenue Code. Substantially all employees are eligible to participate in the plan. The Company, at the discretion of the Board of Directors, on an annual basis sets the employer contribution amounts to the plan. Employees may elect to contribute up to six percent of their base salary, and the Company may elect a matching contribution equal to 50 percent of the employee's contribution. For the year ended December 31, 1991, six months ended December 31, 1990 and the year ended June 30, 1990, the Company's contribution to the plan was $12,000, $3,000 and $27,000, respectively.

Plexus provides a target benefit pension plan in which substantially all employees participate. For the six months ended December 31, 1990 and the year ended June 30, 1990, the Company's contribution to the plan was $26,000 and $35,000, respectively. There was a $37,000 contribution accrued to the pension plan during the year ended December 31, 1991. The Company has also established a non-qualified deferred compensation plan for the benefit of an officer and contributed $45,000 to that plan during 1990. The Company, at the discretion of the Board of Directors, sets an annual contribution to the plans such that no unfunded pension benefit obligation exists.

## *10. Segment Information*

The Company is primarily engaged in the business of acquiring and developing mineral properties. All properties are located in the United States. Gold and copper properties comprise the mining segment. The oil and gas segment includes all activities related to exploration, development and production of oil and gas. The Company does not operate any of the producing properties. The Company is operator of two mining properties that are in the development stage.

Identifiable assets by segment are those assets that are used in the Company's operations within that industry including deferred financing costs. General corporate assets consist principally of cash, cash equivalents, certain receivables, certain property and equipment, and unamortized debt issuance cost.

The oil and gas segment is less than 10% of combined operating revenues, income and identifiable assets for the year ended December 31, 1991 and the six month period ended December 31, 1990 and management believes that it will be less than 10% in the future. Segmented information for these periods is not presented.

| | Oil and Gas | Mining | General and Corporate | Consolidated |
|---|---|---|---|---|
| **Year ended June 30, 1990** | | | | |
| Operating revenue | $ 292,986 | $ 669,983 | $ — | $ 962,969 |
| Net income (loss) | (276,265) | 1,563,483 | (1,854,194) | (566,976) |
| Identifiable assets | 1,950,786 | 23,423,644 | 3,364,014 | 28,738,444 |
| Capital expenditures | 19,130 | 10,970,426 | 148,487 | 11,138,043 |
| Depreciation, depletion, amortization and impairments | 386,053 | 115,408 | 13,588 | 515,049 |
| **Year ended June 30, 1989** | | | | |
| Operating revenue | $ 311,838 | $ 230,871 | $ — | $ 542,709 |
| Net income (loss) | 34,003 | (344,519) | (923,027) | (1,233,543) |
| Identifiable assets | 2,372,342 | 11,756,448 | 2,178,844 | 16,307,634 |
| Capital expenditures | 10,764 | 8,648,767 | 26,480 | 8,686,011 |
| Depreciation, depletion, amortization and impairments | 102,164 | 218,307 | 11,814 | 332,285 |

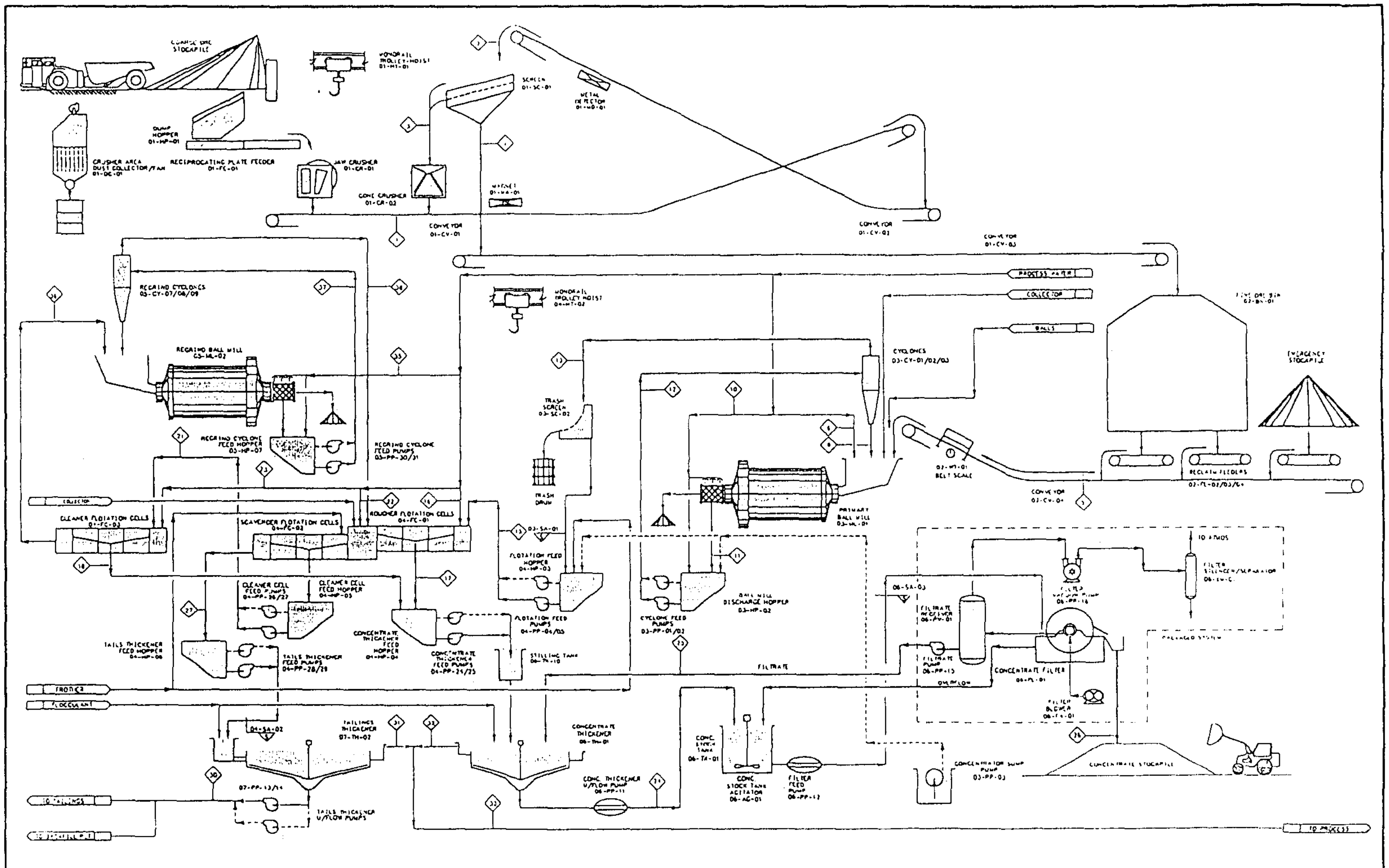
## *11. Difference between Canadian and United States Generally Accepted Accounting Principles*

Accounting under Canadian and United States generally accepted accounting principles as applied by the Company is substantially the same. Differences affecting the accompanying financial statements are as follows: Under generally accepted accounting principles in Canada, exchange gains or losses relating to non-current monetary assets and liabilities are deferred and amortized over the remaining life of the asset or liability. Under United States principles such amounts are included in the determination of net income (loss).

Canadian GAAP allows for elimination of operating deficits by the reduction of stated capital of outstanding common shares with a corresponding offset to the accumulated deficit. This reclassification, which the Company made in 1991, is not permitted by United States GAAP and would require an increase in capital stock and deficit of $6,082,574 at December 31, 1991.

The effects of these differences between Canadian and United States generally accepted accounting principles on retained earnings (deficit), net income (loss) and net income (loss) per share are as follows:

| | Year Ended December 31, 1991 | Six Months Ended December 31, 1990 | Year Ended June 30, 1990 | Year Ended June 30, 1989 |
|---|---|---|---|---|
| **United States Generally Accepted Accounting Principles** | | | | |
| Retained earnings (deficit) | $( 5,798,484) | $( 6,100,634) | $( 5,310,800) | $( 4,774,379) |
| Net income (loss) | 302,150 | (789,834) | (536,421) | (1,199,134) |
| Primary earnings (loss) per share | 0.03 | (0.07) | (0.09) | (0.25) |
| **Canadian Generally Accepted Accounting Principles** | | | | |
| Retained earnings (deficit) | $ 299,597 | $(6,082,574) | $(5,263,739) | $(4,696,763) |
| Net income (loss) | 299,597 | (818,835) | (566,976) | (1,233,543) |
| Primary earnings (loss) per share | 0.03 | (0.07) | (0.10) | (0.26) |




PLEXUS, INC.

BORNITE PROJECT
MARION COUNTY, OREGON

1000 TPD COPPER CONC. PLANT
PROCESS FLOW SHEET

PREPARED BY MINPROC ENGINEERS, INC.

Figure 4

MAY, 1991

## PROCESS FACILITIES DESCRIPTION

The process facilities will consist of three major structures with interconnecting belt conveyors (Figure 5). The first, the crushing and screening building, will be located adjacent to the mine portal. The elevation of the mine portal bench will be approximately 25 feet above the process plant bench to facilitate direct dumping of the loaded mine trucks into the primary crusher feed hopper. The second structure, the fine ore storage bin and reclaim tunnel, will be located 150 feet to the northwest of the crushing and screening building. This facility will have a minimum storage capacity of 3,000 tons of crushed ore to provide an uninterrupted flow of material to the concentrator. The third and largest of the structures will be the concentrator/mill building. This facility, located 100 feet to the southwest, will contain the grinding, flotation, concentration, tailings thickener, and reagent sections.

## TAILINGS MANAGEMENT

Flotation tailings will be thickened at the mill to a solids content averaging 55 to 60 percent. During the majority of mill operation, the tailings will be pumped to the backfill plant (adjacent to the mine portal) for cement addition, when required, and placement to designated areas underground for mine backfill. During the project life, all underground areas, except for those required for post-closure access, will be backfilled.

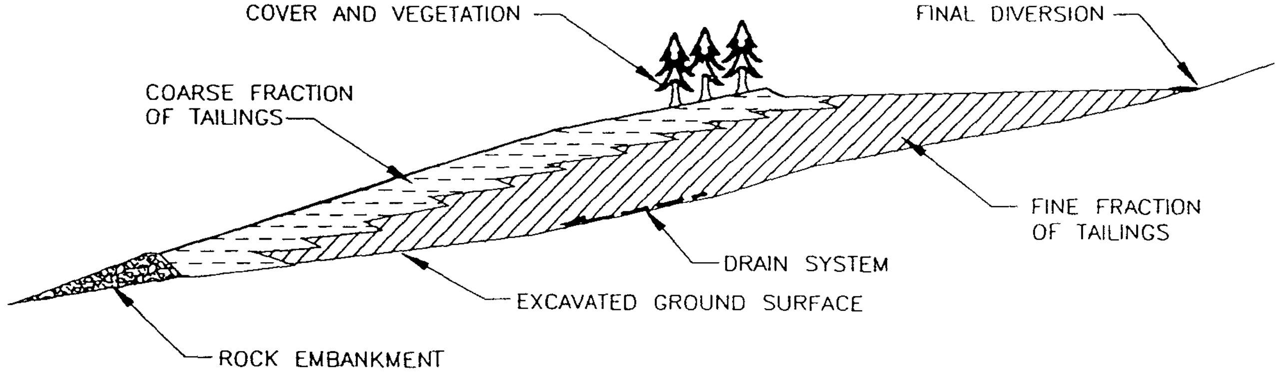
The density of the backfilled tailings will be optimized to get as much tailings back into the mine as possible. The milled and backfilled tailings will not be as dense as the rock that was mined. Therefore, surface disposal of approximately 990,000 tons of tailings not backfilled is required. When underground areas are ready for backfill, tailings will be routed to the backfill plant. When no underground areas are ready for backfill, tailings will be routed to the surface facility.

Tailings will be conveyed to either location by pipeline as a thickened slurry. It will be laid above ground in a shallow channel or buried beneath access roads. The tailings will be of relatively coarse grind, consisting of primarily fine-grained sand particles. The tailings will be free-draining.

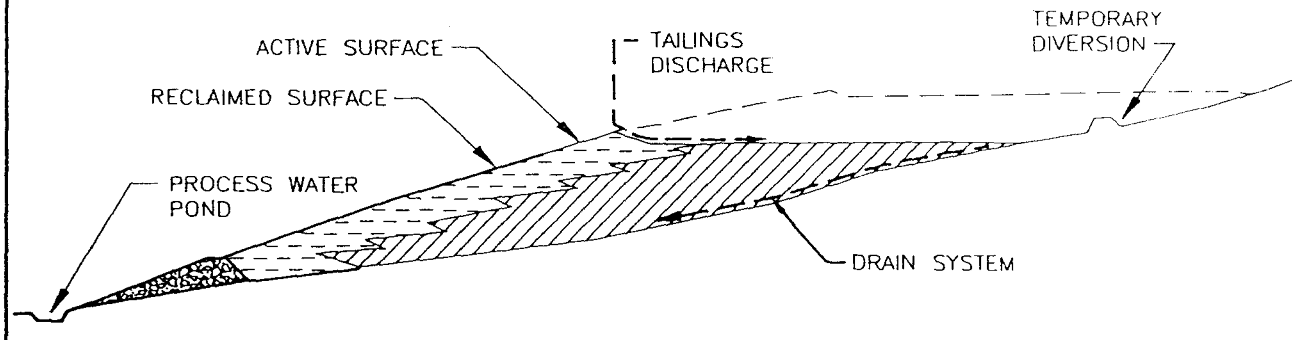
The surface tailings impoundment facility (Figure 6) will be constructed in an upstream manner, such that the tailings embankment crest moves upstream with time during the life of the project. The construction method makes the best use of available space and will allow reclamation of the facility's outside slopes during operation.

## ELECTRIC POWER

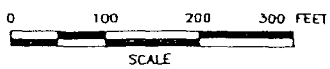
Electrical power for the project will be provided by Consumer's Power Tumble Creek Substation near Detroit. An overhead 24.9 kV line will be routed along existing U.S. Forest Service roads approximately 14 miles. The line will terminate in a main substation at the west side of the plant perimeter.




FINAL CONFIGURATION




OPERATING CONFIGURATION




PLEXUS, INC.

BORNITE PROJECT
MARION COUNTY, OREGON

TYPICAL TAILINGS FACILITY
CROSS-SECTION

PREPARED BY WATER WASTE & LAND, INC.

Figure 6 | MAY, 1991

The metering point for electric service will be at the Tumble Creek substation. The total annual energy usage is estimated to be 15,034,000 kWhr.

A primary transformer will reduce the line voltage to 4160 V. The 4160 V power will be distributed to the underground mine, the ball mine, the crushing and screening plant and the concentrator/mill motor control center. There will be motors with an estimated 600 kW maximum load in the mine, 630 kW maximum load in the crushing plant, 508 kW in the concentrator, 537 kW in the primary ball mill and approximately 100 kW elsewhere in various applications.

## SUMMARY OF GEOCHEMICAL TESTING

Several geochemical tests were run on tailings, development rock, and tailings fluids. The objective of the testing was to characterize acid-generating potential, leachability, and other parameters that may prove undesirable or detrimental to the environment.

Samples of tailings were obtained during metallurgical testwork and evaluated in April, 1991. Development rock testing utilized five samples representing various degrees of alteration and mineralization from exploration drill core. Development rock samples were taken from areas where planned underground openings will be constructed. Tailings fluids analysis was done on solution taken from metallurgical testing done in Salt Lake City, Utah. The results of this test on solutions should be considered only as a frame of reference for a worst case due to the poor quality of the water used in the metallurgical testing (Salt Lake City drinking water is much poorer quality than surface groundwater from the Bornite Project area). Using water from the project site is expected to dramatically improve analytical values in the tailings fluid analysis.

A summary of findings are presented in Table 4 - Table 7.

## Table 4 Summary of Geochemical Testing.

ACID GENERATION/ACID NEUTRALIZATION

| Parameter | Tailings | Development Rock | DEQ Criteria |
|---|---|---|---|
| Total sulfur (%) | 0.03 - 0.25 | 0.04 - 0.20 | -- |
| Pyritic sulfur (%) | 0.03 - 0.07 | 0.03 - 0.18 | 0.1[b] |
| Acid Generation Potential (AGP)[a] (tons $CaCO_3$/1000 tons) | 0.9 - 7.8 | 1.3 - 7.2 | -- |
| Acid Neutralizing Potential (ANP) (tons $CaCO_3$)/1000 tons | 22.6 - 28.9 | 18.4 - 50.7 | -- |
| ANP/AGP[a] | 3.7 - 25.1 | 3.2 - 26.1 | >3 |

[a]Values based on total sulfur.
[b]Values based on sulfide sulfur.

## Table 5 Summary of Geochemical Testing.

TCLP BATCH LEACH TESTING (EPA METHOD 1311)[c]

| Parameter | Tailings | Development Rock | DEQ Criteria |
|---|---|---|---|
| Arsenic | <0.03 | <0.02 - 0.03 | 5 |
| Barium | <0.02 | <0.14 - 0.39 | 100 |
| Cadium | <0.02 | <0.02 - 0.05 | 1 |
| Chromium | <0.02 - 1.70 | 0.03 - 0.27 | 5 |
| Copper | <0.02 - 0.05 | <0.0 - 0.28 | 1 |
| Lead | <0.10 | <0.10 | 5 |
| Mercury | 0.0018-0.0025 | <0.00002 | 0.2 |
| Selenium | <0.03 | <0.02 - 0.06 | 1 |
| Silver | <0.02 | <0.02 | 5 |
| Zinc | <0.01 - 0.01 | 0.10 - 0.15 | 1 |

[c]All values in mg/l.

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# THE BORNITE PROJECT

*October 1992*

**PLEXUS, INC.** • 185 South State Street • Suite 400 • Salt Lake City, Utah, 84111
(801) 363-9152 • FAX (801) 363-8747

## Table 6 Summary of Geochemical Testing.

BATCH LEACH TESTING (EPA Method 1312)[d]

| Parameter | Tailings | EPA Drinking Water Standard (DWS) |
|---|---|---|
| Arsenic | <0.05 | 0.05 |
| Barium | 0.42 - 0.51 | 1.0 |
| Cadmium | <0.005 | 0.01 |
| Chromium | <0.01 | 0.05 |
| Copper | 0.01 - 0.05 | 1.0 |
| Lead | <0.05 | 0.05 |
| Mercury | <0.0003 | 0.002 |
| Selenium | <0.1 | 0.01 |
| Silver | <0.01 | --- |
| Zinc | <0.01 - 0.02 | 5.0 |

[d]All Values in mg/l.

## Table 7 Summary of Geochemical Testing.

TAILINGS FLUID ANALYSIS[*]

| Parameter | Tailings Fluid[†] | Primary DWS | Secondary DWS | Oregon DEQ STD. |
|---|---|---|---|---|
| Lab pH | 7.9 | --- | 6.5-8.5 | --- |
| TDS | 940 | --- | 500 | 100 |
| Calcium | 29 | --- | --- | --- |
| Magnesium | 7 | --- | --- | --- |
| Sodium | 257 | --- | --- | --- |
| Potassium | 20 | --- | --- | --- |
| Chloride | 330 | --- | 250 | 25 |
| Sulfate | 132 | --- | 250 | --- |
| Nitrate | 1.29 | 10 | --- | --- |
| Fluoride | 0.7 | N/A | --- | 1.0 |
| Arsenic | <0.004 | 0.05 | --- | 0.01 |
| Barium | 0.03 | 1.0 | --- | 1.0 |
| Cadmium | <0.0001 | 0.01 | --- | 0.003 |
| Chromium | <0.01 | 0.05 | --- | 0.02 |
| Copper | 0.05 | --- | 1.0 | .005 |
| Iron | 0.05 | --- | 0.3 | 0.1 |
| Lead | <0.05 | 0.05 | --- | 0.05 |
| Manganese | 0.23 | --- | 0.05 | 0.05 |
| Mercury | 0.0005 | 0.002 | --- | --- |
| Selenium | 0.012 | 0.01 | --- | --- |
| Zinc | 0.02 | --- | 5.0 | 0.01 |

[*]All values (except pH) in mg/l; metals reported on a dissolved basis; cations and anions reported on a total basis.

[†]Testing using Salt Lake City water.

## ENVIRONMENTAL CONSEQUENCES AND MITIGATION

Data was collected describing the existing conditions of various resources in the vicinity of the Bornite Project. The following resource areas were considered:

- Geologic
- Topography and site characteristics
- Air quality
- Noise
- Surface and ground water
- Cultural
- Soils
- Vegetation
- Wildlife and habitat utilization
- Acquatic
- Visual
- Socioeconomics
- Land use, recreation and transportation

The data was compiled from previous studies such as the Detroit Ranger District of the Willamete National Forest, the U.S. Soil Conservation Service, Marion County, State Historic Preservation Office, U.S. Fish and Wildlife Service, and various universities. With the exception of the information on water resources, no detailed field surveys have been conducted on the property. Soils, biological, and geotechnical surveys will be completed as part of the impact assessment process mandated to the U.S. Forest Service under the requirements of the National Environmental Policy Act (NEPA).

The findings of the resource studies indicate that Bornite will have minimal if any adverse impact on existing natural resource values.

Economically, the project will be a very significant contribution to the improvement of the existing conditions in the communities near the project area. A significant cash infusion would bolster the local economy when the project proceeds to development and operation. Jobs would be available to local workers. The average wage rate for jobs at Bornite will be significantly higher than existing averages.

## RECLAMATION

The preliminary reclamation and decommissioning plan has been prepared to comply with the requirements of the Willamette National Forest and the Oregon Division of Geology and Mining Industries (DOGAMI). A detailed site investigation will be completed during the upcoming months, as a precursor to the completion of the environmental impact statement. Using the information generated in these field studies, a definitive plan will be formulated. In general, the goals of the reclamation plan are:

- To stabilize the site to prevent erosion and sedimentation on both a short and long-term basis;

- To re-establish a productive vegetation and wildlife habitat consistent with predevelopment conditions and the accepted landuse objective.

- To achieve a visual compatability with the surrounding landscape.

Bornite is being planned to keep the site disturbance as small as possible and to begin restoration and reclamation activities in a concurrent manner. In this manner, at the end of the active project life, approximately 50 percent of the disturbance will require final reclamation. This will include roads, the final phase of the tailing facility and the plant/mine site.

## WORK FORCE

Bornite is planned to begin construction in the spring of 1993, depending upon receipt of permits and approvals. Construction of the surface facilities will occur over the following nine to eleven months. An average of 85 workers and a peak of 100 will be employed during this period.

Subsequent to completion of construction, the operating manpower requirements will drop to the range of 79 to 85 and continue at that level throughout the productive life of the project (Table 8). Approximately 82 percent will be hired from the local Marion/Linn county labor pool.

Plexus will develop a training program to retrain local workers to work in a mining environment. Skills available from individuals with experience in agriculture, construction, and timer industries will be considered desirable. It is anticipated that hiring locally will allow for a more stable long-term work force.

Table 8 Bornite Project Typical Manpower Requirements.

| Mine | | Processing | | Administration | |
|---|---|---|---|---|---|
| Mine Superintendent | 1 | Mill Superintendent | 1 | General Manager | 1 |
| Mine Engineers | 2 | General Foreman | 1 | Secretary | 1 |
| Mine Geologists | 2 | Metallurgist | 1 | Accounting Clerks | 2 |
| Surveyors | 3 | Lab Technicians | 2 | Safety/Environmental Engineer | 1 |
| Mine Clerk | 1 | Shift Foremen | 4 | | |
| Shift Foremen | 3 | | | | |
| Mechanical Foreman | 1 | | | | |
| Maintenance | 7 | Maintenance | 5 | | |
| Equipment Operators | 7 | Mill Operator | 14 | | |
| Blasters | 3 | | | | |
| Miners | 16 | | | | |
| Subtotal | 46 | | 28 | | 5 |
| TOTAL | 79 employees | | | | |

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PLEXUS RESOURCES CORPORATION • 185 South State Street • Suite 400 • Salt Lake City, Utah 84111 • (801) 363-9152 • FAX (801) 363-8747

July 17, 1992

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

PLEXUS RESOURCES REPORTS SHARPLY IMPROVED 2ND QUARTER RESULTS

Salt Lake City, Utah: Plexus Resources Corporation today reported second quarter net income of $534,000, $0.05 a share, on sales of $2.3 million. This compares to net income of $51,000, $0.00 a share, on sales of $2.4 million in the second quarter of 1991.

Arthur H. Ditto, the company's president and chief executive officer, attributed the improvement to higher grade gold ore produced during the quarter at the company's 24% owned Denton-Rawhide gold mine.

Direct operating costs declined to $132 per ounce from $206 for the comparable period in 1991. Plexus' share of gold production increased to 5,450 ounces for the quarter from 5,260 ounces for the comparable period a year earlier. Operating income increased to $437,000 from $217,000.

Six month results include sales of $4.1 million, operating income of $631,000 and a net income of $1,797,000, $0.15 a share, compared to sales of $3.7 million, an operating loss of $58,000 and a net loss of $455,000, $0.04 per share for the same period in 1991.

Investment securities sales contributed $166,000 and $1,318,000 to 1992 second quarter and six month results.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

(more)

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| Quarter Ended June 30 | 1992 | 1991 |
| --- | --- | --- |
| Revenues | $2,293,000 | $2,354,000 |
| Operating Income | 437,000 | 217,000 |
| Net Income | 534,000 | 51,000 |
| Average Shares | 11,785,000 | 11,780,000 |
| Income per Share | $0.05 | $0.00 |

| Six Months Ended June 30 | | |
| --- | --- | --- |
| Revenues | $4,092,000 | $3,723,000 |
| Operating Income | 631,000 | (58,000) |
| Net Income (Loss) | 1,797,000 | (455,000) |
| Average Shares | 11,786,000 | 11,780,000 |
| Income (Loss) per Share | $0.15 | $(0.04) |

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May 8, 1992

FOR IMMEDIATE RELEASE
Contact: Allen S. Gordon (801) 363-9152
Chuck Bennett (503) 362-6617

MILL CITY - Plexus, Inc. of Salt Lake City announced successful completion of tests confirming the nontoxic nature of the reagents used in the froth flotation system planned for use at its Bornite Project copper mine 50 miles east of Salem.

Two series of tests were conducted using Environmental Protection Agency (EPA) procedures. Algae cells, water fleas, and fathead minnow larvae were exposed to varying concentrations of solutions encountered in the flotation process. The three life forms represent a complete food chain.

The tests are part of the information required by the Oregon Department of Environmental Quality. The testing provides a guide to determine the impact to aquatic life from exposure to milling by-products and reagents planned for use on the site.

In one test, water fleas were exposed for a two-day period to reagent concentrations three times stronger than required for the froth flotation process. The fleas all lived.

The second series of tests, where the algae, fleas and minnows were exposed to full strength solutions for an extended period was also passed conclusively. The tests demonstrated that the solution concentrations far higher than planned operating levels had very little impact on survival rates. This test is a common measure of aquatic toxicity established by the EPA.

Plexus Vice President of Technical Services, Allen Gordon, said he and his team developing the mine were "very pleased by these results. We expect that tests will continue to confirm the Bornite Project is an environmentally safe mining operation."

--more--

Gordon said that these test results were "one of the most important sets of data we will develop during our analysis of the project's effect on the environment. If you ask people what concerns them most about our project, it is how the mine may impact water quality. The tests show that under the most extreme conditions imaginable, the reagents will have virtually no impact. The testing certainly shows that there is absolutely no risk to downstream water users."

The Bornite Project is currently in the permitting phase. An Environmental Impact Statement is being developed by the USDA Forest Service, various Oregon state agencies and Plexus. All permits and approvals are expected in time to allow construction of the mine to begin in the spring of 1993.

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February 28, 1992

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

## PLEXUS RESOURCES EXTENDS MATURITY OF 10.5% CONVERTIBLE DEBENTURES

**Salt Lake City, Utah:** Plexus Resources Corporation announced that maturity of its outstanding CDN $1,395,000 of 10.5% Convertible Debentures has been extended for two years to February 28, 1994.

As amended the debentures are now convertible into common stock at a rate of $1.50 per share, down from $2.124 per share; interest will be paid at the rate of 10.0% per annum, down from 10.5%; and the price at which the Company can require conversion of the debentures into common stock is reduced to $3.00 a common share from $4.00.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

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February 26, 1992

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

## PLEXUS RESOURCES REPORTS IMPROVED 1991 EARNINGS

**Sait Lake City, Utah:** Plexus Resources Corporation announced net income of $300,000, $.03 a share for the year ending December 31, 1991. The Company reported a loss of $864,000, $.10 a share in the comparable period of 1990.

Earnings were favorably impacted by increased gold production at its 24% owned Denton-Rawhide Mine. The Company's share of production totalled 19,460 ounces in 1991 compared to 8,650 in the prior year. The mine operated at design rates for twelve months in 1991, while 1990 included only eight months of production after startup. Direct gold production costs decreased from $289 an ounce to $232 in 1991.

When commenting on results for the year, Arthur H. Ditto, President and Chief Executive Officer, said, "We are pleased with the improvement in our financial and operating performance. We are anticipating further progress in 1992 when production for our account will approach 25,000 ounces."

Revenues for the year increased to $8,573,000 from $4,526,000 during the 12-month period a year earlier. Cash flow from operations totalled $2,050,000.

Plexus realized an average gold price of $387 in 1991, $25 higher than the average London price per ounce.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

- more -

PLEXUS RESOURCES CORPORATION
CONSOLIDATED STATEMENTS OF OPERATIONS
(UNAUDITED)
(000's)

| | Year Ended December 31, 1991 | Year Ended December 31, 1990 (1) |
|---|---|---|
| Revenues | $ 8,573 | $ 4,526 |
| Costs & expenses: | | |
| Operating costs | 5,292 | 3,165 |
| Depreciation, depletion and amortization | 1,840 | 1,127 |
| General and administrative | 810 | 1,138 |
| Abandonments and impairments | 584 | 395 |
| | 8,526 | 5,825 |
| **Operating income(loss)** | **47** | **(1,299)** |
| Gain from sale of investment | 647 | 1,797 |
| Interest and debt expense, net | (394) | (1,362) |
| **Income(loss) before income taxes and extraordinary item** | **300** | **(864)** |
| Provision for income taxes | 132 | – |
| Income(loss) before extraordinary item | 168 | (864) |
| Extraordinay item–utilization of net operating loss carryforward | 132 | – |
| **Net income(loss)** | **$ 300** | **$ (864)** |
| Net income(loss) per share of common stock and common stock equivalents | | |
| Income(loss) before extraordinary item | $ 0.02 | $ (0.10) |
| Extraordinary item | 0.01 | – |
| Net income(loss) | $ 0.03 | $ (0.10) |
| Weighted average number of shares of common stock and common stock equivalents outstanding | 11,781 | 8,918 |

(1) Includes results for 12 months for comparative purposes. The Company previously reported results for the six months ending December 31, 1990 due to a change in fiscal year.

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PLEXUS RESOURCES CORPORATION • 185 South State Street • Suite 400 • Salt Lake City, Utah 84111 • (801) 363-9152 • FAX (801) 363-8747

November 22, 1991

FOR IMMEDIATE RELEASE
Contact: Allen S. Gordon (801) 363-9152
Chuck Bennett (503) 362-6617

MILL CITY--A Memorandum of Understanding has been signed between the U.S. Forest Service and Plexus, Inc. of Salt Lake City outlining the process to complete an Environmental Impact Statement on the Bornite Project copper mine 50 miles east of Salem.

The Memorandum, which is a milestone in developing the project planned for the Cedar Creek Valley near Elkhorn, is an agreement which anticipates that a Draft Environmental Impact Statement on the mining plan will be completed by next June. It also targets completion of a final Environmental Impact Statement and Record of Decision by the end of November, 1992.

Completion of the analysis of the project's impact on both the environment and affected communities are required before the project can proceed. The project will employee between 80 and 100 persons in the North Santiam Canyon.

Data collection work for the Environmental Impact Statement has been under way for several months. It has included public meetings in Elkhorn, Mill City and Salem sponsored by the Company, and public "scoping meetings" on the project in Mill City, Stayton and Salem sponsored by the Forest Service. There has been strong public support for the project.

Public comment on the project is an important part of the Environmental Impact Statement process. Issues raised by the public must be addressed in the Company's Plan of Operation. Concerns addressed so far include water quality protection, full reclamation plans, a transportation plan, local employment opportunities and protection of the environment around the mining site.

Plexus' Technical Services Vice President Allen S. Gordon said the Company continues to conduct meetings with interested groups or individuals. "This past month we met with a representative of the Chemeketans and the president of the Northwest Steelheaders to outline the project and answer their questions about it. We plan next month to meet with the Ancient Forest Alliance in Salem.

--more--

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"Plexus is committed to making this a model project to showcase mining as part of a mix of resource uses in the area. We believe we can work closely with the many interested groups to develop a mine we call can be proud of," Gordon said.

Plexus is continuing to work with the Willamette National Forest and the Detroit Ranger District to demonstrate mining's ability to coexist with the area's other important resources.

The Bornite Project is in the Little North Santiam River basin that has been the site of a number of environmental battles involving nearby old growth forests. The mine site is an area of immature second growth forest and will not affect any old growth areas. It also has been reviewed for impact on spotted owl populations and has been found by environmental scientists to not be an owl habitat or dispersal area.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

(###)

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PLEXUS RESOURCES CORPORATION • 185 South State Street • Suite 400 • Salt Lake City, Utah 84111 • (801) 363-9152 • FAX (801) 363-8747

October 29, 1991

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

## PLEXUS RESOURCES REPORTS IMPROVED 3RD QUARTER RESULTS

Salt Lake City, Utah: Plexus Resources Corporation today reported net income of $135,000, $0.01 a share, on sales of $2.5 million for the third quarter of 1991. This compares to a net loss of $417,000, $0.04 a share, on sales of $1.7 million in the third quarter of 1990. The improved performance was due to increased gold and silver production at the Company's 24% owned Denton-Rawhide gold mine.

Plexus' share of gold production increased to 5,250 ounces for the quarter from 3,850 ounces for the comparable period a year earlier. Direct operating costs declined to $192 per ounce from $280 for the comparable period in 1990.

Nine month results include sales of $6.5 million, operating income of $199,000 and a net loss of $319,000, $0.03 a share, compared to sales of $2.4 million, an operating loss of $1,075,000 and a net loss of $462,000, $0.06 per share for the same period in 1990. A sale of investment securities reduced 1990's loss by $1,797,000.

| Quarter Ended September 30, | 1991 | 1990 |
|---|---|---|
| Revenues | $2,450,000 | $1,721,000 |
| Operating Income | 256,000 | 270,000 |
| Net Income (Loss) | 135,000 | (417,000) |
| Average Shares | 11,781,000 | 11,764,000 |
| Income (Loss) per Share | $0.01 | $(0.04) |
| **Nine Months Ended September 30,** | | |
| Revenues | $6,517,000 | $2,412,000 |
| Operating Income | 199,000 | (1,075,000) |
| Net Income (Loss) | (319,000) | (462,000) |
| Average Shares | 11,781,000 | 7,969,000 |
| Income (Loss) per Share | $(0.03) | $(0.06) |

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

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PLEXUS RESOURCES CORPORATION • 185 South State Street • Suite 400 • Salt Lake City, Utah 84111 • (801) 363-9152 • FAX (801) 363-8747

FOR IMMEDIATE RELEASE
Contact:
Allen Gordon (801) 363-9152 or
Chuck Bennett (503) 362-6617

August 13, 1991

## PLEXUS INC. HOLDS COMMUNITY MEETINGS/OPEN HOUSE

Mill City, Oregon: Plexus Inc. announced it will hold three community meetings to provide information to interested citizens on its Bornite Project underground copper mine 50 miles east of Salem in the Cedar Creek Valley.

Meetings are scheduled to be held in Mill City, Elkhorn and Salem.

The Mill city meeting will be on September 3 in the Santiam High School Auditorium at 7:30 p.m. The meeting will follow an open house at the Company office in the old U.S. Bank Building on Wall Street. The open house will give people an opportunity to see the local Plexus office, talk with Company representatives and mine officials. The event also will include soft drinks, hot dogs and chips and will begin at the office at 5:30 p.m.

The Elkhorn meeting will be on September 4 at 7:30 p.m. in the Elkhorn Fire Substation. The meeting is to give Elkhorn and Little North Fork residents a chance to discuss in detail the mining operation and the impact it will have on the local area and residents.

The Salem meeting will be at the Salem Library Auditorium on September 5 at 7:30 p.m.

Each meeting will include a slide show, video tape and presentation by mine officials on the geology, mining project and reclamation and environmental protection plans. The presentation will be followed by an extended question and answer session to give everyone a chance to review their questions with mining or government officials. Plans are to have representatives of the U.S. Forest Service and Oregon Department of Geology and Mineral Industries present.

- more -

B:news.mtg

Plexus' Vice President for Technical Services, Allen Gordon, said the Bornite Project calls for a modern underground mine with an adjacent mill site that will disturb only about 32 acres of second growth forest near Cedar Creek. He said that no old growth timber will be affected and that access is planned along existing Forest Service roads.

The mine is expected to produce about 137 million pounds of copper with substantial amounts of gold and silver. Over half of the tailings will be returned underground with the remainder being recontoured to blend with the area's natural surroundings and then revegetated. Reclamation will be underway throughout the project's planned eight to ten year life.

About 80 people will be employed full-time throughout the life of the project with an additional 20 employees during initial construction. Most hiring will come among local residents with experience in the timber industry.

Plexus will be required to successfully receive a number of permits before the project can begin, including permits from the Forest Service, Oregon Department of Geology and Mineral Industries and Department of Environmental Quality.

# # #

B:news.wtg

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NEWS RELEASE

July 25, 1991

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

# PLEXUS RESOURCES REPORTS 2ND QUARTER EARNINGS

Salt Lake City, Utah: Plexus Resources Corporation today reported sales of $2,551,000 for the second quarter of 1991. The sales yielded operating income of $216,900 and net income of $52,000. This compared with sales of $556,600, an operating loss of $683,000 and net income of $149,300 ($0.02 per share) in the second quarter of 1990. A sale of investment securities impacted 1990's earnings.

The Company attributes its improved operating income to increased gold and silver production and reduced operating costs at its 24% owned Denton - Rawhide Mine. Plexus' share of gold production increased to 5,260 ounces for the quarter from 1,060 ounces for the comparable period a year earlier. Direct operating costs declined to $206 per ounce from $268.

Six month results include sales of $4,066,600, an operating loss of $57,800 and a net loss of $454,700 ($0.04 per share) compared to sales of $691,600, an operating loss of $804,700 and a net loss of $45,100 ($0.01 per share) for the same period in 1990.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

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# PLEXUS RESOURCES CORPORATION

*(U.S. Dollars in Thousands)*

| CONSOLIDATED STATEMENTS OF OPERATIONS | Unaudited Three Months Ended June 30, 1991 | 1990 | Six Months Ended June 30, 1991 | 1990 |
|---|---|---|---|---|
| Revenues | $ 2,551.7 | $ 556.6 | $ 4,066.6 | $ 691.6 |
| Operating Expenses: | | | | |
| Production Costs | 1,455.4 | 304.5 | 2,774.2 | 381.4 |
| Depreciation, depletion and amortization | 591.1 | 159.2 | 837.5 | 186.0 |
| General & Administrative | 288.3 | 503.2 | 512.7 | 656.2 |
| Impairments and abandonments | 0.0 | 272.7 | 0.0 | 272.7 |
| | 2,334.8 | 1,239.6 | 4,124.4 | 1,496.3 |
| Operating Income | 216.9 | (683.0) | (57.8) | (804.7) |
| Gain from sale of investment | 0.0 | 1,796.7 | 0.0 | 1,796.7 |
| Interest and debt expense, net | (165.9) | (964.4) | (396.9) | (1,037.1) |
| Net Income (Loss) | $ 51.0 | $ 149.3 | $ (454.7) | $ (45.1) |
| Net Income (Loss) per Share | $ 0.00 | $ 0.02 | $ (0.04) | $ (0.01) |
| Weighted Average Shares | 11,780.3 | 6,356.7 | 11,780.3 | 6,071.2 |

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NEWS RELEASE

FOR IMMEDIATE RELEASE
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Chuck Bennett (503) 362-6617

June 24, 1991

PLEXUS INC. SUBMITS BORNITE PLAN OF OPERATIONS

Mill City, Oregon: Plexus Inc., based in Salt Lake City, Utah, announces it has begun the formal process to acquire a permit to develop the Bornite Project underground copper mine 50 miles east of Salem in the Cedar Creek Valley.

Plexus' Vice President for Technical Services, Allen Gordon, said the Company has submitted its Plan of Operations to the U.S. Forest Service. The plan outlines details for the Bornite Project, which is expected to last at least eight years and employ between 80 and 100 people.

The project is expected to produce 137 million pounds of copper with substantial amounts of gold and silver also coming from the 32-acre site.

Mineral discoveries were first made in the area around 1877. During many years of operation, Santiam Copper Mine shipped ore averaging about 10 percent copper. Shiny Rock Mining Co.'s Ruth Mine currently is the only active mine in the Santiam Mining District. Plexus acquired the Bornite site from Amoco's Cyprus Minerals in 1989.

The Bornite ore body is contained within a so-called "breccia pipe", a rock formation that is cylindrical and extends down from the surface about 1,000 feet. "Bornite" is the name given to the copper ore. The formation has been dated to be 10.1 million years old.

Gordon said that Plexus' mining plans call for a modern underground mine with an adjacent mill site. No old growth timber will be disturbed and access to the site will be along existing Forest Service roads.

- more -

B:News.Born

# EXECUTIVE SUMMARY

# OF

# THE BORNITE PLAN OF OPERATIONS

as submitted to
USDA FOREST SERVICE

June 1991

B: BORNITE.SUMM

Surface activity at the site will be held to a minimum, confined to underground support facilities, surface water diversion and control structures and tailings containment facilities. Over half of the tailings will be put back underground as the project progresses. Vegetation will be re-established at the site as soon as possible and at the end of the project the entire area will have been fully reclaimed. Buildings and mine facilities will be removed and remaining tailings will be recontoured to blend with the area's natural surroundings and then revegetated, he said.

"Plexus is very proud of the plan because it shows that a mining project can successfully co-exist with other resource values in the area," Gordon said.

The Bornite Project also offers significant job opportunities in the Santiam Canyon where many timber jobs have been lost. "The mine is expected to put many of those people to work again," Gordon said. "Plexus will develop a training program to retain local workers for the Bornite mine work force. Skills developed in the forest products industry are desirable and local hiring also helps guarantee a stable, long term work force."

Plexus will be required to successfully receive a number of permits before the project can begin, including permits from the Forest Service, Oregon Department of Geology and Mineral Industries and Department of Environmental Quality.

There also will be public meetings locally for review and comment on the plans.

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FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

June 11, 1991

## PLEXUS RESOURCES COMPLETES FINANCING

Salt Lake City, Utah: Plexus Resources Corporation announced today the completion of a US$12.5 million dollar financing with Mase Westpac Limited. The new facility will repay an existing 17,100 ounce gold loan and $2.7 million of short term debt. The balance of the proceeds are for general corporate purposes.

The new facility includes a $10 million, 27,500 ounce, six-year term gold loan, and two revolving loans that provide up to $2.5 million for working capital needs. The gold loan is convertible to a currency loan at the company's option and the term can extend for one year based on cash flow and reserve criteria.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

# # #

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NEWS RELEASE

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

May 9, 1991

PLEXUS RESOURCES REPORTS FIRST QUARTER RESULTS

Salt Lake City, Utah: Plexus Resources Corporation reported a net loss of $506,000 or $0.04 a share on sales of $1,515,000 for the first quarter of 1991. The Company reported a net loss of $194,000 or $0.03 a share on revenues of $135,000 in the same period a year ago.

Gold production for the first quarter totalled 3,686 ounces of gold at a direct cost of $268 per ounce. Gold production commenced in the second quarter of 1990.

Adverse weather conditions and installation of a new conveyor system at the Denton-Rawhide gold mine affected both production and financial results. Planned operating rates have been maintained since late February.

Plexus Resources Corporation is a North American natural resources company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

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B:News.May

Plexus Resources Corporation
Consolidated Statements of Operations
Unaudited
(in thousands except per share amounts)

| | Three Months Ended March 31, | |
|---|---|---|
| | 1991 | 1990 |
| Revenues | $ 1,515 | $ 135 |
| Operating Expenses | | |
| Production Costs | 1,319 | 77 |
| Depreciation, Depletion | 247 | 27 |
| General and Administrative | 224 | 153 |
| Operating Loss | (275) | (122) |
| Interest and Debt Expense, net | 231 | 72 |
| Net Loss | $ (506) | $ (194) |
| Net Loss per Shares | $ (0.04) | $ (0.03) |
| Weighted Average Shares | 11,780 | 5,786 |

8:News.May

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March 12, 1991

FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

## PLEXUS RESOURCES REPORTS 1990 RESULTS

Salt Lake City, Utah: Plexus Resources Corporation announced a net loss of $402,000, $0.03 a share, for the three months ending December 31, 1990. This compares with a loss of $261,000, $0.05 a share, in the same period of 1989. The Company's loss for the six months ending December 31, 1990 is $819,000, $0.07 a share, which compares with a loss of $522,000, $0.10 a share, in the period a year earlier.

The Company has changed its year-end from June 30 to December 31 and future results will be reported on a calendar year basis. The increased losses were due to low sales margins during start-up operations at the Company's 24% owned Denton-Rawhide heap leach gold mine, higher levels of administrative activity and increases in interest charges for project financing.

Revenues for the quarter increased to $2,113,000 from $142,000, while six month revenues totalled $3,834,000 up from $271,000. The change in both instances was due to gold sales from the mine. Gold sales totaled 3,740 ounces for the quarter and 7,585 ounces for the six months.

In commenting on results for the year, Arthur H. Ditto, President and Chief Executive Officer said, "While we are disappointed with the financial results for the six months, we are encouraged by the fact that the mine operated at capacity in December. Operations in 1991 are scheduled to produce over 20,000 ounces of gold for our account."

Plexus Resources Corporation is a North American natural resources company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

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G:NEWS.MAR

PLEXUS RESOURCES CORPORATION
CONSOLIDATED STATEMENTS OF OPERATIONS
(Unaudited)
(000's)

| | Three Months Ended December 31, | | Six Months Ended December 31, | |
|---|---|---|---|---|
| | 1990 | 1989 | 1990 | 1989 |
| Revenues | $ 2,113 | $ 142 | $ 3,834 | $ 271 |
| Costs & expenses: | | | | |
| Operating costs | 1,238 | 93 | 2,569 | 172 |
| Depreciation, depletion and amortization | 592 | 25 | 941 | 56 |
| General and administrative | 385 | 224 | 696 | 424 |
| Abandonments and impairments | 122 | 0 | 122 | 0 |
| | 2,337 | 342 | 4,328 | 652 |
| Operating loss | (224) | (200) | (494) | (381) |
| Interest and debt expense, net | (178) | (61) | (325) | (141) |
| Net loss | $ (402) | $ (261) | $ (819) | $ (522) |
| Net loss per share of common stock and common stock equivalents outstanding | $ (0.03) | $ (0.05) | $ (0.07) | $ (0.10) |
| Weighted average number of shares of common stock and common stock equivalents outstanding | 11,764 | 5,776 | 11,764 | 5,351 |

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February 26, 1991

FOR IMMEDIATE RELEASE

Contact: Mike Washington

SALT LAKE CITY, UTAH -- Plexus Resources Corporation announced today that it now holds a 24% direct participating interest in the Denton-Rawhide gold mine located near Fallon, Nevada. The company also holds a 2.45% royalty interest in all gold and silver produced by the project. The assignment of the direct interest was based on completion of contractual obligations associated with construction and achievement of operational performance standards. Plexus has invested $20 million in the mine and its royalty interest.

The mine, which is operated by Kennecott, is expected to produce 82,000 ounces of gold at an average direct cost of less than $210 per ounce during 1991. Current ore reserves contain 996,000 ounces of gold in 28.9 million tons of ore. The reserves are sufficient to sustain operations for 10 years at current production rates.

Arthur Ditto, President of Plexus, stated, "the assignment of a direct interest in Denton-Rawhide is a significant milestone in the development of our company. Income and cash flow from the mine is expected to provide funds for development of our copper properties in California and Oregon."

Plexus Resources Corporation is a North American natural resources company. Its shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ (PLUSF) system.

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FOR IMMEDIATE RELEASE
Contact: Mike Washington
(801) 363-9152

February 25, 1991

ALLEN S. GORDON NAMED VICE PRESIDENT AT PLEXUS

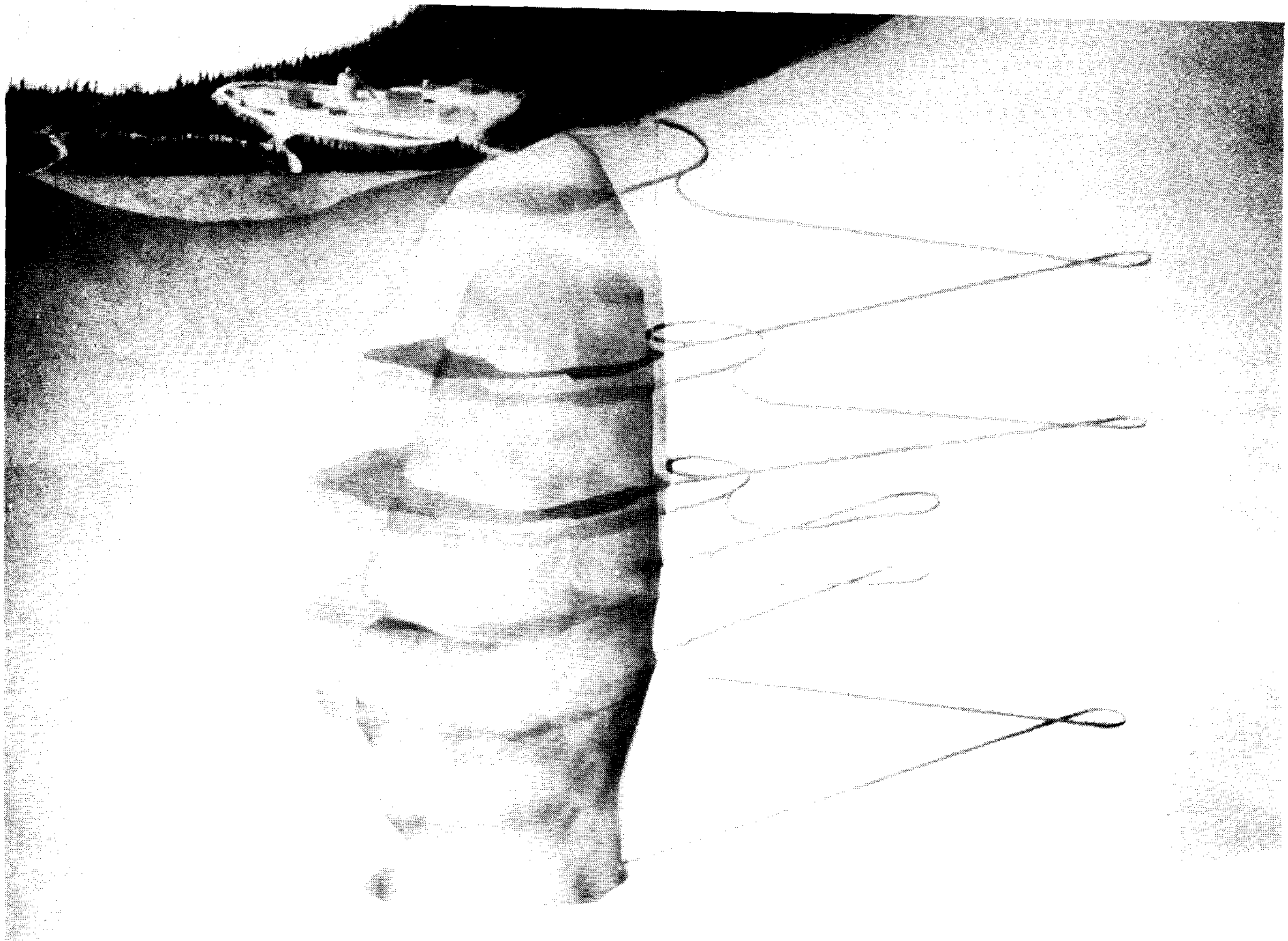
SALT LAKE CITY, UTAH -- Allen S. Gordon has been named Vice President of Technical Services at Plexus Resources Corporation in Salt Lake City, Utah. Mr. Gordon's new responsibilities will include technical support and oversight of the Company's interest in the Denton - Rawhide gold mine located near Fallon, Nevada. He will be responsible for exploration, evaluation, planning, permitting and implementation of work to advance the Company's various projects to the development stage. The position will also be the focus of evaluation of new business prospects.

Prior to joining Plexus, Mr. Gordon was associated with Western States Minerals Corporation where he was responsible for all facets of operations management, mine development and engineering, exploration and environmental planning. Mr. Gordon has 16 years experience in the mining industry. He graduated from the University of Idaho with a Masters Degree in Mining Engineering.

Plexus Resources Corporation is a North American minerals development company. Its common shares trade on the Toronto Stock Exchange (PXS) and the NASDAQ System (PLUSF).

# # #

## BORNITE: AN UNDERGROUND MINE - LIMITED SURFACE DISTURBANCE





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## INTRODUCTION

The Bornite Project will incorporate the development and operation of a highly mechanized 1,400 ton per day underground mine, operating five days per week, with an on-site 1,000 ton per day conventional flotation concentrator.

Bornite has an estimated 10-year life, which includes a minimum of eight years productive mine life plus two years of construction and reclamation. The project site is located in the Detroit District of Willamette National Forest. Approximately 32 acres would be directly affected by the Bornite Project. All project-related facilities will be located in an area of second growth forest. No old growth forest will be directly affected by the project's construction or operation.

During the project's life, approximately 2.5 million tons of ore will be mined and processed. There will be an additional 260,000 tons of non-mineralized development rock mined and either stockpiled on the surface or used in constructing surface facilities.

The product of the flotation concentrator will be a premium high grade copper concentrate containing significant amounts of gold and silver. The copper concentrate will be trucked off-site to a railhead or a deep water port, where it will be shipped to a smelter outside of Oregon.

## PROJECT LOCATION

The Bornite Project is located approximately 50 miles east of Salem, Oregon, in the western Cascades (Figure 1). The project area is contained within a broad valley in the Cedar Creek drainage. Cedar Creek is a tributary of the Little North Santiam River. The property consists of 64 unpatented lode claims, held under a lease from Cyprus Minerals Corporation. The claims are within Sections 30 and 31, T8S, R5E and Sections 6 and 7,T9S, R5E, W.M. The powerline servicing the project will be routed adjacent to F-2207 and F-2233 to a location near Detroit, Oregon. All project facilities will be within Willamette National Forest boundaries. The project area is within the southern portion of the Lester Mining District, also known as the North Santiam Mining District.

The Bornite Breccia Pipe is located in the southwest 1/4 of Section 31, T8S, R5E. Limited exposure of the breccia pipe occurs approximately at the 2250 foot elevation near the bottom of the Cedar Creek drainage.

## PERMITS AND APPROVALS

The project described in the Plan of Operations is based on the results of exploration work on the property conducted by both Plexus and the previous property holder, Cyprus Minerals Corporation. The results of the exploration have lead Plexus to the project evaluation stage in which metallurgical testing and preliminary mine design have been accomplished with favorable results. The project is now at the stage where various permits and regulatory approvals are



B: BORNITE.SUMM

Experience
the WILLAMETTE NATIONAL FOREST

VOLUME 1 ISSUE 4 211 E. 7th Ave., P. O. Box 10607, Eugene, OR 97440-2607 FALL 1991

# Bornite Mining Project Proposed

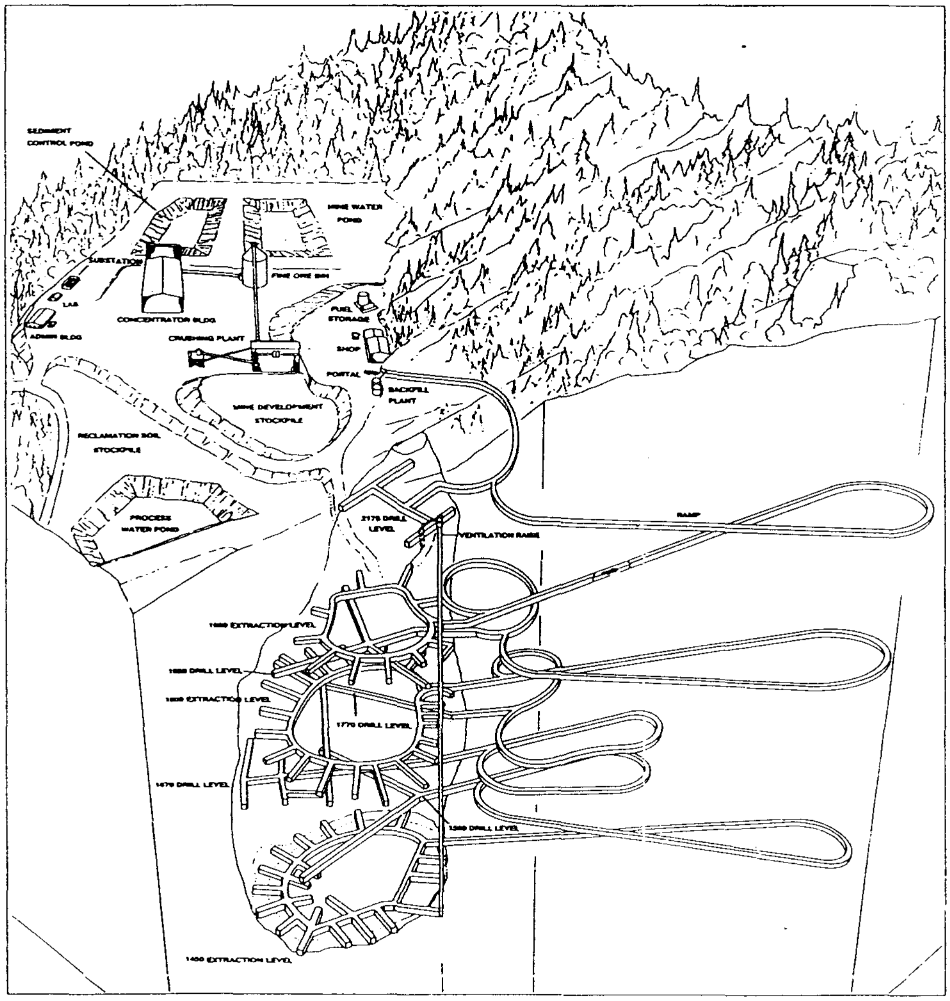
*by Patti Rodgers*

The Willamette National Forest has received a plan of operation for a copper mine on the Detroit Ranger District from Plexus Incorporated of Salt Lake City. The Bornite Project, named for the copper-yielding ore, proposes an underground mine in the Cedar Creek drainage of the Little North Fork of the Santiam. Plexus expects the project to produce 137 million pounds of copper and substantial gold and silver by-products over a minimum 8-year life.

Plexus officials say results from exploratory drilling support an operation with several unique features:

- •No use of cyanide
- •No leaching of ore
- •No acid-generating potential
- •No acid drainage
- •50% of the tailings will be returned underground
- •Minimal surface disturbance
- •Groundwater protection program
- •Complete reclamation will be done

Bornite is an iridescent purple or blue copper iron sulphide, also known as peacock ore. The ore is in a cylindrical rock formation known as a breccia pipe, which is 400-450 feet in diameter and extends more than 1,000 feet below the surface. The deposit near Cedar Creek has been dated at 10.1 millions years.




*Underground mine and plant site perspective--Bornite Project, Plexus, Inc.*

Plexus officials expect the project to employ 80 to 100 workers with base wages from $10 to $15 per hour. Many of the jobs will call for skills that may be available from local populations, and Plexus has made a commitment to worker training and re-training programs.

An Interdisciplinary Team is being formed to oversee the prepartion of

(Cont. on Page 2)

## Message from the FOREST SUPERVISOR

It's my third month as Forest Supervisor and I'm very appreciative of people's hospitality. It's a very challenging time for folks on the Willamette as well as for the communities and all our multiple-use business partners. Three themes I'm talking about as I visit are:

- Understand the changing situation
- Focus on quality and success
- Network broadly and effectively

I've seen excellent project implementation on my field visits. In our National Forest Centennial Year, I'm proud to be associated with my collegues on the Willamette National Forest and their quality efforts on your behalf. Their award winning work is assuring that forests are forever and that we truly "Care for the Land and Serve People."

## Bornite (Cont. from Page 1)

an environmental impact statement, and we invite you to participate. A tentative timeline calls for:

- September 1991 – public scoping meetings.
- November 1991 – award of EIS contract.
- Fall 1992 – draft EIS submitted to Environmental Protection Agency (EPA) and available for public review.
- Spring/summer 1993 – signing of Record of Decision (ROD).

If you would like to participate or receive more information on the Bornite Project, please contact Mike Hernandez, Interim Project Coordinator, at the Detroit Ranger District, 854-3366 or Patti Rodgers, Public Involvement Coordinator, at the Supervisor's Office, 465-6450.

# 1991 Yew Goal Accomplished

*by Jim Simonson*

In April, the Willamette estimated it could provide 180,000 pounds of Pacific Yew bark for taxol production. Collections could reach 200,000 pounds, with Hauser Northwest reporting more than 188,500 pounds collected by the end of July.

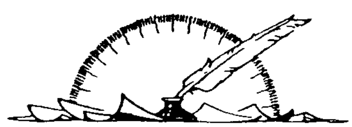
The Willamette made a special effort to salvage all available yew bark from completed timber sales before slash burning. More than 25%, or 50,000 pounds, of the bark was salvaged from these areas, and an estimated 10,000 acres were surveyed in the effort.

On current sales, most timber purchasers cooperated by allowing peelers to gather yew bark before logging. Collectors recovered 50 to 60% more bark by gathering before logging, and most collectors practiced sound utilization, peeling limbs down to 1 or 2 inches.

Bark peeling provided work for an estimated 100 people at the season's peak in June. Loggers and former mill workers were the mainstay of the season's operations.

Yew theft made national headlines with the largest incident being the poaching of bark from 56 trees along Aufderheide Drive on the Oakridge Ranger District. Secretary of Agriculture, Edward Madigan, took a personal interest in yew theft, doubling the reward from $5,000 to $10,000 for information leading to the arrest and conviction of poachers.

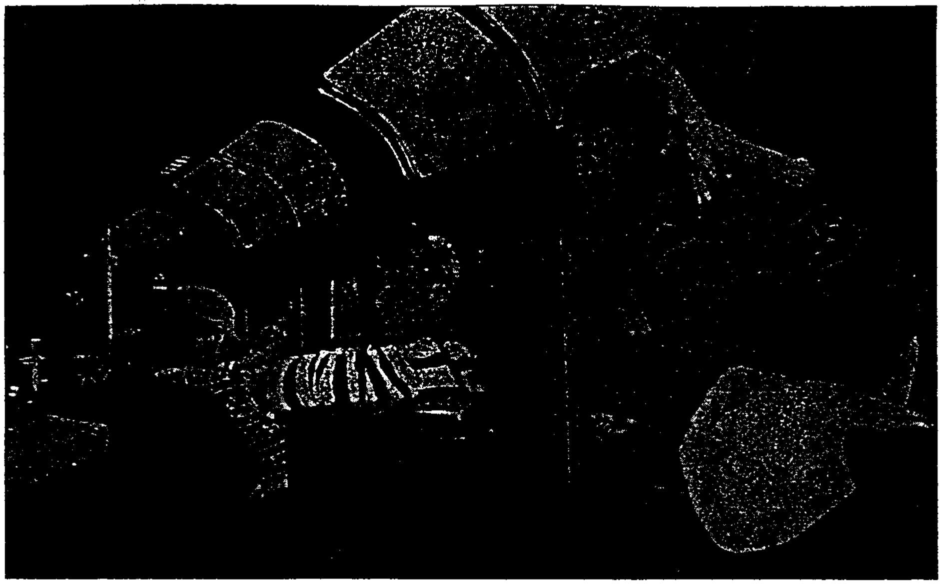
Current Forest Service yew studies include a regional yew inventory, regeneration and reforestation studies, and yew ecology and sustainability studies. The experimental use of taxol has remained a high national priority and taxol produced from this year's yew bark collection on the Willamette will treat as many as 4,500 cancer patients. For more information about yew on the Willamette, please contact Jim Simonson at the Supervisor's Office, 465-6570.



## Editor's Message

We would like to thank you for your questions and responses to "Experience the Willamette." This is our fourth issue and completes our first year of publishing the newsletter.

We look forward to another year. Please continue offering comments and asking questions.



*Forest Service Interpreter, Denise Swanson* REGISTER-GUARD PHOTO

# ALL ABOARD! Amtrak Interpretive Program is a Hit

*by Steve Couche*

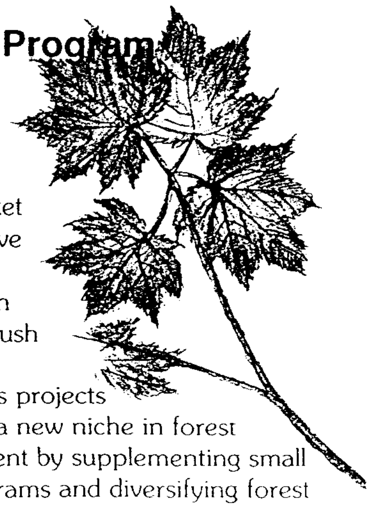
Amtrak passengers found a new reason for riding the train between Eugene and Klamath Falls this summer. The Forest Service launched a new interpretive program has been described as "like seeing the Discovery Channel live."

Passenger response was overwhelmingly in favor of continuing and expanding the Forest Service program, which ran through the Willamette, Deschutes and Winema National Forests on the Amtrak Coast Starlight Train, from July 1 through September 15th. One passenger said, "My trip to Eugene has become far more enjoyable and educational than I ever would have imagined."

The interpreters would like to thank Amtrak employees and enthusiastic passengers for contributing to a wonderful experience.

## Innovative Special Forest Products Program

*by Brad Bernardy*



Vic Baumann, Special Forest Products Coordinator at the Detroit Ranger District, is known as "The Boughman" for establishing a showcase bough sales program at Detroit. Baumann has expanded his established program to include a vegetation stewardship contract. The vegetation contract will cover ten years and will allow the purchaser to harvest a variety of materials with miscellaneous product value from the site.

Currently, a vine maple contract is being prepared that will provide alternative forestry employment, a product to the local floral market and improve plantation tree growth through brush release.

Baumann's projects represent a new niche in forest management by supplementing small sales programs and diversifying forest employment opportunities. For more information please contact Vic Baumann at the Detroit Ranger District, 854-3366.

# Lowell Tops Riparian Challenge

The Willamette's Lowell Ranger District received the 1991 Riparian Challenge Award in the ranger district category from the Western Division of the American Fisheries Society, against a field of more than 140 entries from 13 western states and 3 countries.

Resource Assistant, Don Gray, received a plaque, recognizing the district's "interdisciplinary skills & leadership so capably applied toward protection, enhancement, and overall management of riparian zones."

The Lowell Ranger District entry included 16 separate projects, which directly affected 208 acres of riparian habitat. The projects improved fish access to an additional 46 miles of stream or 1200 acres of habitat. Projects included:

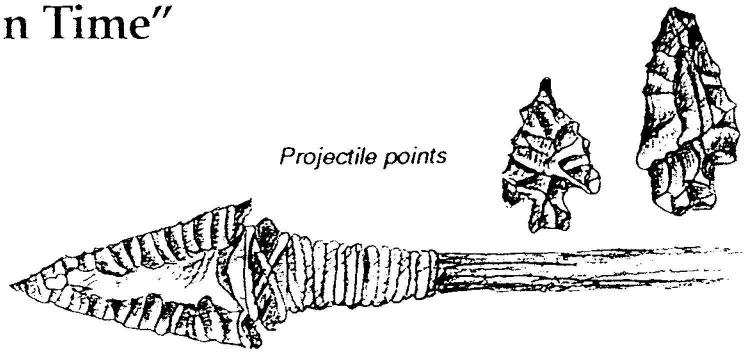
- installation of a fish ladder around a waterfall area
- placement of structures along roadbanks to remedy and control erosion
- water diversion projects to provide rearing or spawning habitat
- hardwood plantings along stream banks to promote rapid shade recovery and bank stability after timber harvests
- placement of over 900 structures in several streams to improve water quality, channel stability and fish habitat
- seeding and fertilizing road cuts and fill slopes to control erosion and improve runoff water quality
- sedge plantings in the draw down zone of Lookout Point Reservoir to reduce wave erosion, provide full pool fish habitat, and to improve aesthetics and wildlife forage at low pool levels.

# Journey with a "Passport in Time"

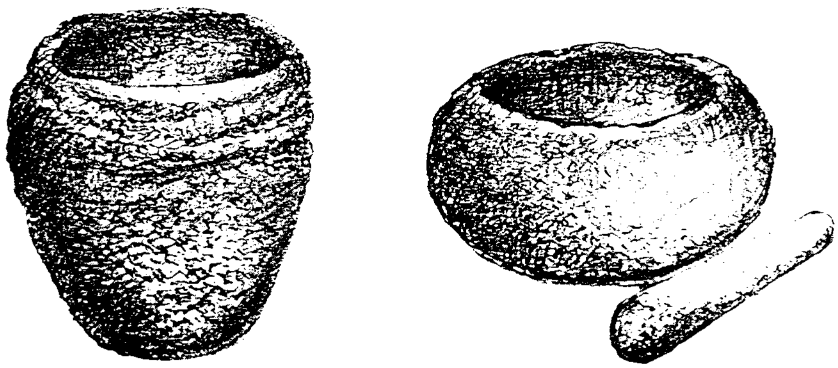
*by Carol Winkler*

Passport in Time (PIT) is a program sponsored by the Forest Service which offers the American public an opportunity for "hands-on" experience with archaeology and historical research on National Forests throughout the United States.

The Willamette's first PIT project was held in September at Bedrock Campground, along Fall Creek on the Lowell Ranger District. Volunteers learned scientific excavation techniques, mapping, and artifact analysis under the direction of Dr. Paul Baxter of Western Oregon State College. For more information about PIT programs, please contact Carol Winkler at the Lowell Ranger District, 937-2114.



*Projectile points*



*Stone bowl, mortar and pestle*

Experience the WILLAMETTE NATIONAL FOREST

Willamette National Forest
211 E. 7th Ave.
P. O. Box 10607
Eugene, OR 97440-2607
Ph. 503-465-6521

***Experience the Willamette*** is a quarterly publication of the Willamette National Forest.

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Steve Couche
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John Bowman

PRINTED ON RECYCLED PAPER

## Kerrick Awarded for Distinguished Service

Former Willamette National Forest Supervisor, Mike Kerrick, received a "distinguished service" award for environmental and natural resource protection. In June, the Department of Agriculture recognized Kerrick for "providing exceptional leadership" in guiding the Willamette into a "new era of natural resource management."

Kerrick served as the Willamette's Forest Supervisor for the last 10 years of his four-decade Forest Service career, before retiring last January. He was among thirty Forest Service employees recognized for distinguished and superior service or heroic action. Distinguished and Superior Service awards are the highest that can be attained within the Department of Agriculture, and are usually given only once in a person's career.

The ceremony culminated a year-long process that began last summer with nominations from all branches of the Forest Service and USDA. A Forest Service committee screened the nominations, and a committee of nongovernment, agricultural officials made the final selections.

being sought. The first step of that endeavor is the submittal of an operating plan to the Willamette National Forest, the land management agency. This will be followed by individual permit applications being submitted to the various local, state and federal regulatory authorities with responsibility for aspects of the development, operation and decommissioning of the Bornite Project.

The successful development of the Bornite Project will require the acquisition of a number of local, state and federal permits, and approvals. Each of the federal permits can only be issued after the completion of the required National Environmental Policy Act provisions. Individual permits required for the project include the following:

**Table 1 Principal Operating Permits Required.**

| AGENCY | PERMIT/APPROVAL |
|---|---|
| **Federal** | |
| Willamette National Forest | Operating Plan<br>Special Permits |
| Corps of Engineers | 404 Dredge and Fill |
| **State** | |
| Department of Geology and Mineral Industries | Operating/Reclamation |
| Department of Environmental Quality | Water Pollution Control<br>National Pollution Discharge Permit<br>Air Contaminant Discharge |
| Water Resources Department | Reservoir Construction<br>Groundwater Appropriation |
| Division of State Lands | Removal and Fill Permit |
| **Local** | |
| Marion County | Building Projects |

In addition to the permits mentioned, several permits will be required from the Mine Safety and Health Administration (MSHA), from other local agencies for the handling and storage of explosives, and from the Oregon State Health Department for construction and operation of the sanitary waste system and for the provision of potable water.

## DESCRIPTION OF UNDERGROUND OPERATIONS

At Bornite, copper ore is concentrated in higher grade sections along the outer margins of the pipe. Ore extends downward from the surface for more than 900 feet. The ore body outcrops in a very small area at about 2,250 feet elevation. From the outcrop to the 2,100 foot elevation, the top of the pipe is solidly mineralized with copper ore. From the outcrop, the ore body slopes to the south under rapidly thickening surface fluvioglacial deposits.

Underground extraction methods will allow for optimum recovery of the Bornite ore body. Minimal surface disturbance will result from the underground mining. Only two small openings will be visible from the surface, the mine portal and the collar of the ventilation raise (Figure 2).

The underground mine will produce ore at a rate of approximately 360,000 tons annually for its eight year productive life (Table 2). There will be sufficient capacity to nominally increase the mining rate in response to prevailing economic conditions. Initially the mine operations will be scheduled for two eight hour shifts daily, five days per week. Eventually, as the mining depth increases, a third shift may be required to sustain production levels.

Access to the ore body will be gained through a declining ramp constructed at a 12.5 percent downward grade. From the ramp, all material, personnel and equipment will enter and exit the mine. All of the ore and development rock will also be transported on this ramp system.

The geometry of the ore body and strength of the surrounding country rock indicate that a sublevel blasthole stoping method with delayed backfill is appropriate for Bornite (Figure 3). Extraction of ore from the stoping areas will be continuous. As now planned, there will be a minimum of 12 stopes in the ore body, with one to three operating at any given point in time. The number may change due to prevailing economic conditions.

Following ore extraction, the stopes will be filled with cemented mill tailings (Figure 3). Backfilling will provide structural support for later pillar extraction. In this way the extraction of the ore body will be maximized.

The Bornite Project underground mine will be developed as a trackless operation, utilizing diesel-powered rubber-tired equipment. The drilling, loading and hauling unit operations will utilize specially designed equipment for underground use. Table 3 summarizes the primary underground mobile development and production requirements.

10/12/92

Rawhide mine, Nevada

24 % of 92,000 opy Au + 2% NSR to Plexus

Plexus, Inc. - 16 employees

Developing open pit Cu in Calif. ~ 40 mi. N. of Sacramento

105 unpatented claims / Willamette N.F.

137 million lbs Cu over 8 yr. production life

32 acres of disturbance

No acid generating potential

Mine site logged in 1964/65

Disc. in 1976

50 ddh to date

Makeup water - 60-70 gpm ≈ 15,000 gpd

May have excess water in winter

Mine isn't expected to make water

Diversion of stream will be required

2,542,000 tons of ore - 60% will go back u.g.
30% " be stored on surface

2.33 % Cu
0.016 Au

DEQ - NPDES applic submitted in 8/92
" /91
WRD water right applic "

Py, if present, will report to Cu cons

Reagents are di-thio- phosphate and MIBC, an organic

Seismic criteria for dam - same as Detroit dam, not using more

# THE BORNITE PROJECT

## OPERATING AND RECLAMATION PERMIT

**Submitted to**
**The Oregon Department of Geology**
**and Mineral Industries**

**November 25, 1992**

g:\bornite.drp

# THE BORNITE PROJECT
# 1.0 EXISTING ENVIRONMENT

## 1.1 HISTORY

Small mining districts throughout the western Cascades of Oregon and Southern Washington and have been mined and explored since the 1890's. The North Santiam District first attracted attention during this time, but most of the production was intermittent between 1915 and 1930. Limited production from the North Santiam District over a 40-year period between 1890 and 1930 accounts for one percent of total production of the seven Cascade districts identified.

The Bornite deposit was discovered by AMOCO Minerals in 1976 during an extensive exploration project to locate porphyry copper deposits in the northwest United States. Although the Bornite deposit is within the North Santiam district and within two miles of deposits known since the 1890's, the Bornite discovery awaited the newer technology involving a combination of soil geochemistry and geophysics. Geologic trends, structures and mineralization at Bornite are similar, and related, to the same intrusives found in adjacent mineral occurrences.

## 1.2 VEGETATION RESOURCES

The Bornite site is in the western hemlock vegetation zone in relatively mild, low elevations just above the Douglas fir zone and below the silver fir zone. Dominant overstory coniferous trees in the western hemlock zone include western hemlock, Douglas fir, and western red cedar.

Plant community types in the study area were identified and quantitatively sampled during the 1991 growing season (Western Resource Development, 1991b). Those in the transportation and transmission line corridors were mapped and qualitatively described. The study area embraces four plant community types: Douglas fir forest, western hemlock/Douglas fir forest, red alder upland, and red alder riparian. Figure 2 is a map of the plant community types of the study area. Each of the plant communities of the mine study area are summarized below from data in the Baseline Vegetation Study (Western Resource Development, 1991b). Table 1 summarizes the occurrence of plant vegetation community types at the Bornite site.

thick in places, and overlies the bedrock. The colluvial aquifer is the dominant aquifer and fluctuates in rapid response to precipitation events. The groundwater aquifer is confined to fissures or openings in the bedrock. The aquifers exhibit different potentiometric levels, water chemistry, and physical aquifer properties. Vanishing Creek infiltrates into the colluvium. Downgradient seeps and springs appear as the colluvial aquifer discharges into Cedar Creek.

Many species of wildlife inhabit the area in and around the mine site. No threatened or endangered species were found at the mine site. The area provides no unique habitat for any threatened or endangered species of animal or aquatic life forms. Fish were found in Cedar Creek adjacent to the project site, but Bornite Brook and Vanishing Creek do not contain any fish. No threatened or endangered macroinvertebrate species were found on the mine site.

The Bornite Project's reclamation goal is to return the site to a forest condition and use. The area is now managed as general forest by the USFS. Reclamation of the site will start during the construction process, with most activity at the end of the project. The topsoil will be salvaged and stored at the beginning of mine development. The area will be revegetated with plants common to the area.

### 1.2.1 Douglas Fir Forest

Most of the study area and a large surrounding area in the Cedar Creek valley was timbered in the early 1950's and later planted with Douglas fir. Western hemlock, western red cedar, and red alder have all invaded the Douglas fir plantings. Douglas fir, the largest trees, have mean heights to about 50 feet and mean diameter-at-breast height (dbh) of about six inches. They provide more cover than any other plant. The shade-tolerant western hemlock have a greater density, but are smaller in height and dbh. Western red cedar and red alder are minor components of the forest canopy.

### 1.2.2 Western Hemlock/Douglas Fir Forest

The 2.8-acre western hemlock/Douglas fir forest is the only portion of the study area undisturbed by the timbering in the early 1950's. This climax western hemlock forest association is characterized by a rather open stand of large trees with a very shrubby understory and little herbaceous development.

### 1.2.3 Red Alder Riparian

The 4.69-acre red alder riparian community occurs as a narrow band along Bornite Brook and Vanishing Creek and in zones of springs and seeps adjacent to Bornite Brook. The red alder riparian community is dominated by red alder and has a dense understory of shrubs with scattered ferns, several dominant perennial forbs, and a mossy cover on rocks, logs, and soil.

### 1.2.4 Red Alder Upland

Red alder also dominates upland areas not moistened by streams and seeps, forming a seral community following timbering. This community consists of one small stand south of Bornite Brook and includes the dry outer fringes of the red alder riparian community in the zone of springs and seeps. This community, covering four acres, is dominated by red alder and has and understory of shrubs, ferns, and numerous perennial forbs.

### 1.2.5 Threatened, Endangered, or Sensitive Plants

There are apparently no federally-listed threatened or endangered plant species documented in the Willamette National Forest, and none was found during field surveys. There are, however, three Category 1 and 2 federally-listed plants and 11 plants listed by the Oregon Natural Heritage as endangered/threatened in the entire range of the Willamette National Forest. Thirteen other plants, one a federal candidate 2 and 12 listed

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No threatened, endangered, or sensitive plant species have been found during vegetation surveys. Small, isolated individuals of Pacific yew (*Taxus brevifolia*) up to ten feet tall occur in the western hemlock/Douglas fir and Douglas fir forest. A Pacific yew management plan will be developed with the Forest Service to provide for harvest procedures.

**Table 1. Plant Vegetation Community Types**

| Plant Community Type | Tailings Area (acres) | Mine Facilities | Permit Area (%) | Total Area |
|---|---|---|---|---|
| Douglas Fir | 35.41 | 9.24 | 97 | 44.65 |
| Red Alder Riparian | 0.29 | 0.60 | 2 | 0.89 |
| Red Alder Upland | 0.37 | 0.09 | 1 | 0.46 |
| **Total** | **35.07** | **9.93** | **100** | **46.00** |

### 1.2.6 Transportation Access and Transmission Line Corridors

Transportation and transmission line corridors are characterized by mixed coniferous forests dominated by either western hemlock or Pacific silver fir, depending on elevation and aspect. Clear-cuts of varying age, tree dominance, and seral status occur along the routes. Maturing Douglas fir forests resulting from planting or seeding following timbering, red alder uplands in previously timbered areas, and narrow, linear riparian communities along streams and their tributaries with poorly vegetated talus slopes are also present.

## 1.3 SOIL RESOURCES

Study area soils were formed from parent materials derived from weathering of andesite and basalt bedrock, as influenced by additions of volcanic ash. Redistribution and subsequent weathering of these primary parent materials has been modified through the Pleistocene glacial epoch. Parent materials in the study area range from glacial till to recent alluvium, and include colluvial and volcanic ash deposits.

The post-glaciation climate has been characteristically cool and moist. An average annual precipitation of 87 inches has extensively leached basic cations from the soils, and produced very strongly to extremely acidic soil pH conditions. The copious precipitation has also favored the accumulation and addition of organic matter to the soil system. Some soils have thickened organic horizons overlying organic-rich mineral soil horizons.

However, logging activities in the early 1950's in the Bornite project area accelerated erosion rates and exposure of B horizons (subsoil) at the surface. Much top soil was probably lost during this period of deforestation. As a result, a horizon topsoil exists on the project area and a very thin organic layer of material has been regenerated since the logging.

Soils of almost all of the study area were disturbed in the early 1950's when the timber was removed and the waste wood piled and burned. During the 1991 growing season, a soil survey was conducted on the tailings and mine facilities study area (Western Resource Development, 1991a). An Order I survey was completed on potential disturbance areas and an Order III for areas not to be disturbed. Willamette National Forest Soil Resource Inventory (SRI) land type mapping and data (Legrand, et al., 1973) were used to characterize the transportation and electric transmission corridors.

Several soil map units were identified and mapped. Table 2 provides data on the physical and chemical characteristics of the four map units: 10, 12, 13, and 20, in the areas of planned disturbance. The transportation and electric transmission corridors are characterized by 11 SRI land types and their complexes. Figure 3 is a map of soil type locations.

**Table 2. Map Units and Classification of Soils**

| Map Unit | Map Unit Name |
|---|---|
| 10 | Loamy-skeletal, mixed Typic Haplocryands/rock outcrop complex, 40-65% slopes |
| 12 | Fine-loamy, mixed Aeric Cryaquands, 25-35% slopes |
| 13 | Loamy-skeletal, mixed Andic Cryochrepts, 40-65% slopes |
| 20 | Loamy-skeletal, mixed Typic Cryochrepts/loamy-skeletal, mixed Typic Haplocryands Association, 3-20% slopes |
| 21 | Rock outcrop/Lithic Cryorthents, 4-30% slopes |
| 30 | Sandy or sandy-skeletal, mixed Typic Cryofluvents, 1-9% slopes |
| 31 | Loamy, mixed Terric Cryohemists, 0-2% slopes |

Soil texture class was either sandy loam or loam across all soil horizons. Clay content ranged from 8 to 22 percent and gravel greater than 2 mm ranged from 39 to 69 percent in laboratory samples. Accurate assessment of coarse fragment volumes can usually be obtained from soil pedon field descriptions. Based on geotechnical backhoe sampling of soils, the range of cobble content has been developed. The upper foot of soil contains some large, coarse material, but the majority of coarse material is located below

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the one-foot depth. The coarse fragments average fifty percent of the material in the upper three feet of suitable topsoil material. A range of values has been used in evaluating the topsoil volumes for storage and replacement. The results indicate adequate volumes of topsoil are available for reclamation if the maximum percentage of coarse fragments are removed. Topsoil volume calculations are presented in Table 3.

Soil reaction percentages across all pedons ranged from strong to extremely acidic. Formation of acid conditions in these soils is favored by increased organic matter production and excessive leaching, both due to the average precipitation in the project area. The electrical conductivity ($EC_e$), sodium adsorption ratio (SAR), and calcium carbonate ($CaCO_3$) content over all soil pedons are low, and indicate that salts, free exchangeable $Na^+$ ions, and $CaCO_3$ do not greatly influence the pH or the exchange reactions of the study area soils.

**Table 3. Volume of Soil Available for Reclamation**

| Map Unit | Area | Depth of Suitable Soil | Coarse Fragments | Excluding Coarse Fragments | Including Coarse Fragments |
|---|---|---|---|---|---|
| (Number) | (Acres) | (Inches) | (Percentage) | (Volume x 1000 $yd^3$) | |
| 10 | 1.6 | 35 | 35 - 65 | 2.6 - 4.9 | 7.5 |
| 13 | 20.9 | 44 | 35 - 65 | 42.5 - 78.9 | 121.4 |
| 20 | 22.4 | 30 | 35 - 65 | 31.6 - 58.7 | 90.3 |
| 30 | 1.1 | 8 | 15 - 35 | 0.02 - 0.4 | 1.2 |
| **Total** | **46.0** | | | **76.9 - 142.9** | **220.4** |

## 1.4 CLIMATE

The project site is on the western slope of the Cascade Range at an elevation of 2,200 to 2,300 feet. Mean average temperatures are mild, ranging from about 35 to 65 degrees Fahrenheit. Annual precipitation in the site area exceeds evaporation by a factor of roughly three to one.

Annual precipitation in the site area averages about 87 inches, with almost 70 percent of precipitation occurring during the winter months from November through March. Annual pan evaporation averages about 33 inches, with over 95 percent of evaporation occurring from April through October. Lake evaporation (representing evaporation from pond and other constructed water surfaces on site) is estimated to be 70 percent of measured pan evaporation.

OREGON DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES
1534 QUEEN AVENUE SE, ALBANY, OREGON 97321
TELEPHONE: (503) 967-2039

IDENTIFICATION # ____________

## APPLICATION FOR RECLAMATION PERMIT OR GRANT OF EXEMPTION UNDER ORS 517.750-990

### 1. RESPONSIBLE PARTIES

A. Permittee

Name Plexus, Inc.

Address 185 South State St. Ste. 400

City Salt Lake City State Utah

Phone (801)-363-9152 Zip 84111

B. Landowner (if other than permittee)

Name Willamette National Forest

Address HC 73 P.O. Box 320

City Mill City State Oregon

Phone 503-854-3366 Zip 97360

### 2. TYPE OF SITE (CHECK ALL THAT APPLY)

- [ ] Pit
- [x] Stockpile
- [x] Plant
- [ ] Quarry
- [ ] Prospect
- [ ] Refuse disposal
- [x] Other Underground Mine

### 3. MINERAL DEPOSIT CHARACTERISTICS

A. Description

Type of overburden N/A

Approx depth of overburden N/A

Approx depth of mine 900 feet

Primary mineral to be removed Bornite

B. Size

Size in acres of any areas presently affected by surface mining None

How much of the above was affected

before 7/1/72 None

before 7/1/75 None

Has any of the above been reclaimed? N/A

If yes, how much and when? N/A

Approximate acreage to be affected by surface mining during the ensuing 12 months 40

C. Status

- [ ] Active
- [ ] Inactive
- [x] New

Date mining began ______

Date mining will begin 5-1-93

### 4. IDENTIFICATION OF SITE

Tax Lot # ______

| ¼Sec. | Section | Township | Range | County |
|---|---|---|---|---|
| S1/2 | 31 | 8S | 5E | Marion |

| Distance in miles | Direction from | Nearest Community |
|---|---|---|
| Six | west | Elkhorn |

### 5. APPLICATION IS HEREBY MADE FOR:
(see general directions)

A. RECLAMATION PERMIT ( no exemptions)

I apply for a Reclamation Permit under ORS 517.790

Allen S Forde
signature

Date Nov 24 1992 Title Vice President-Technical Services

B. GRANT OF LIMITED EXEMPTION based on prior mined (ORS 517.770(1)(a))

I apply for a Grant of Limited Exemption from the requirement for a reclamation plan and bond, but not the fees

____________ signature

Date ________ Title ____________

C. GRANT OF TOTAL EXEMPTION

I apply for a Grant of Total Exemption from the requirements of a reclamation plan, bond, and the fees under ORS 517.750(12) and 517.770(2) because:

- [ ] 1. Access road's borrow pit or quarry.
- [ ] 2. On-site construction.
- [ ] 3. The site is less than one acre and a total of less than 5,000 cy of mineral have been, or will be removed.
- [ ] 4. The site has qualified for a Grant of Limited Exemption but annual production is less than 5,000 cy.
- [ ] 5. Other.

____________ signature

Date ________ Title ____________

D. Even though entitled to exemptions as shown above, a reclamation plan is submitted voluntarily.

yes _____ no _____

**NOTE! COMPLETE THE CONFIDENTIAL SECTION ON REVERSE SIDE (ORS 517.900)**

**CAUTION: CONFIDENTIAL MATERIAL SHALL NOT BE CIRCULATED OUTSIDE DOGAMI.**

OREGON DEPARTMENT OF GEOLOGY & MINERAL INDUSTRIES
1534 QUEEN AVENUE SE, ALBANY, OREGON 97321
TELEPHONE: (503) 967-2039

IDENTIFICATION # ____________

## APPLICATION FOR RECLAMATION PERMIT OR GRANT OF EXEMPTION UNDER ORS 517.750-990

1. RESPONSIBLE PARTIES

A. Permittee

Name Plexus, Inc.

Address 185 South State St. Ste. 400

City Salt Lake City State Utah

Phone (801)-363-9152 Zip 84111

B. Landowner (if other than permittee)

Name Willamette National Forest

Address HC 73 P.O. Box 320

City Mill City State Oregon

Phone 503-854-3366 Zip 97360

2. TYPE OF SITE (CHECK ALL THAT APPLY)

- [ ] Pit
- [x] Stockpile
- [x] Plant
- [ ] Quarry
- [ ] Prospect
- [ ] Refuse disposal
- [x] Other Underground Mine

3. MINERAL DEPOSIT CHARACTERISTICS

A. Description

Type of overburden N/A

Approx depth of overburden N/A

Approx depth of mine 900 feet

Primary mineral to be removed Bornite

B. Size

Size in acres of any areas presently affected by surface mining None

How much of the above was affected

before 7/1/72 None

before 7/1/75 None

Has any of the above been reclaimed? N/A

If yes, how much and when? N/A

Approximate acreage to be affected by surface mining during the ensuing 12 months 40

C. Status

- [ ] Active
- [ ] Inactive
- [x] New

Date mining began ______

Date mining will begin 5-1-93

4. IDENTIFICATION OF SITE Tax Lot # ______

| ¼Sec. | Section | Township | Range | County |
|---|---|---|---|---|
| S1/2 | 31 | 8S | 5E | Marion |

| Distance in miles | Direction from | Nearest Community |
|---|---|---|
| Six | west | Elkhorn |

5. APPLICATION IS HEREBY MADE FOR:
(see general directions)

A. RECLAMATION PERMIT ( no exemptions)

I apply for a Reclamation Permit under ORS 517.790

Allen S Ford
signature

Date Nov 24 1992 Title Vice President-Technical Services

B. GRANT OF LIMITED EXEMPTION based on prior mined (ORS 517.770(1)(a))

I apply for a Grant of Limited Exemption from the requirement for a reclamation plan and bond, but not the fees

______________ signature

Date ______ Title ______

C. GRANT OF TOTAL EXEMPTION

I apply for a Grant of Total Exemption from the requirements of a reclamation plan, bond, and the fees under ORS 517.750(12) and 517.770(2) because:

- [ ] 1. Access road's borrow pit or quarry.
- [ ] 2. On-site construction.
- [ ] 3. The site is less than one acre and a total of less than 5,000 cy of mineral have been, or will be removed.
- [ ] 4. The site has qualified for a Grant of Limited Exemption but annual production is less than 5,000 cy.
- [ ] 5. Other.

______________ signature

Date ______ Title ______

D. Even though entitled to exemptions as shown above, a reclamation plan is submitted voluntarily.

yes ______ no ______

NOTE! COMPLETE THE CONFIDENTIAL SECTION ON REVERSE SIDE (ORS 517.900)

CAUTION: CONFIDENTIAL MATERIAL SHALL NOT BE CIRCULATED OUTSIDE DOGAMI.

SMLR-1 (Rev 3/18/86)

Precipitation and evaporation data is from records collected at Detroit Dam, the closest weather recording station in location and elevation to the site. Detroit Dam is south of the Bornite Project.

### 1.4.1 Precipitation Frequency

From a statistical evaluation of the Detroit Dam data, the 100-year recurrence interval wet year consists of 120.3 inches of annual precipitation and 18.0 inches of annual evaporation. The 100-year recurrence interval dry year consists of 45.0 inches of annual precipitation and 45.8 inches of annual pan evaporation. This data indicates that precipitation exceeds lake evaporation (at 70 percent of pan evaporation) even in 100-year recurrence interval dry conditions.

### 1.4.2 Snowfall/Snow Melt

The site is in a transition zone for winter precipitation, where snow accumulation varies over the winter season, depending on temperature. Snow accumulation may occur over several months with sufficiently cold temperatures.

Calculations indicate that snowmelt at a maximum rate of approximately 5.5 inches per 24 hours would occur in late spring. This would produce runoff similar to that between the 25 and 100 year, 24-hour precipitation events.

## 1.5 FISH AND AQUATIC BIOLOGY

Surveys of the biological characteristics of Cedar Creek and Bornite Brook were done as part of the existing environmental conditions. The sampling was done in September 1991, November 1991, and April 1992. It was found the density of aquatic insects in Cedar Creek varied, with lowest densities in winter and higher densities in fall and spring. No fish were present in Bornite Brook or Vanishing Creek. Cedar Creek did have a rainbow trout population.

### 1.5.1 Riparian Habitat

Riparian habitat of all stream sections sampled was healthy. Indicators of potential sediment production were absent. Stream bank soil stability was excellent, with infrequent raw (barren) banks. Over 80 percent of the stream bank surfaces were covered with vegetation in vigorous condition. Although physiographic and riparian habitat conditions associated with Cedar Creek and Bornite Brook were similar, stream flow and stream habitat conditions were quite different. A significant difference in

the one-foot depth. The coarse fragments average fifty percent of the material in the upper three feet of suitable topsoil material. A range of values has been used in evaluating the topsoil volumes for storage and replacement. The results indicate adequate volumes of topsoil are available for reclamation if the maximum percentage of coarse fragments are removed. Topsoil volume calculations are presented in Table 3.

Soil reaction percentages across all pedons ranged from strong to extremely acidic. Formation of acid conditions in these soils is favored by increased organic matter production and excessive leaching, both due to the average precipitation in the project area. The electrical conductivity ($EC_e$), sodium adsorption ratio (SAR), and calcium carbonate ($CaCO_3$) content over all soil pedons are low, and indicate that salts, free exchangeable $Na^+$ ions, and $CaCO_3$ do not greatly influence the pH or the exchange reactions of the study area soils.

**Table 3. Volume of Soil Available for Reclamation**

| Map Unit | Area | Depth of Suitable Soil | Coarse Fragments | Excluding Coarse Fragments | Including Coarse Fragments |
|---|---|---|---|---|---|
| (Number) | (Acres) | (Inches) | (Percentage) | (Volume x 1000 $yd^3$) | |
| 10 | 1.6 | 35 | 35 - 65 | 2.6 - 4.9 | 7.5 |
| 13 | 20.9 | 44 | 35 - 65 | 42.5 - 78.9 | 121.4 |
| 20 | 22.4 | 30 | 35 - 65 | 31.6 - 58.7 | 90.3 |
| 30 | 1.1 | 8 | 15 - 35 | 0.02 - 0.4 | 1.2 |
| **Total** | **46.0** | | | **76.9 - 142.9** | **220.4** |

## 1.4 CLIMATE

The project site is on the western slope of the Cascade Range at an elevation of 2,200 to 2,300 feet. Mean average temperatures are mild, ranging from about 35 to 65 degrees Fahrenheit. Annual precipitation in the site area exceeds evaporation by a factor of roughly three to one.

Annual precipitation in the site area averages about 87 inches, with almost 70 percent of precipitation occurring during the winter months from November through March. Annual pan evaporation averages about 33 inches, with over 95 percent of evaporation occurring from April through October. Lake evaporation (representing evaporation from pond and other constructed water surfaces on site) is estimated to be 70 percent of measured pan evaporation.

ecosystems between the upstream and downstream sections of Cedar Creek was noted. Cedar Creek flows in a subsurface channel during dryer seasons of the year.

### 1.5.2 Aquatic Invertebrate Communities

Examination of aquatic invertebrate communities in streams provides information on the entire stream ecosystem. The density and diversity of species indicate the availability of food resources and habitat for biota to grow and reproduce. Mayflies and stoneflies were important components of the macroinvertebrate community of Cedar Creek. These insects, along with caddis flies, are generally intolerant of low dissolved oxygen levels. Their presence in the abundance found indicates good water quality. A stream study for macroinvertebrates was conducted at nearby Opal Creek (a stream draining from an old growth forest). The density of organisms was slightly higher in Opal Creek than at the Bornite site, although the number of taxa was lower. No threatened or endangered species of macroinvertebrates were found in any of the sampling on or around the project site.

### 1.5.3 Fish

Fish population studies were conducted by one pass electrofishing in four sections of Cedar Creek. All fish were identified, measured and returned unharmed to the stream. Rainbow trout were the only fish species taken in the sampling and are believed to have originated from ODFW stocking activities in the 1960s and 1970s (John Haxton, ODFW, Pers Commun). Above the project site, eight trout were taken from a 400-foot section of stream. Below the site, thirty-three fish were taken from a 400-foot section of Cedar Creek. No fish were found in either Bornite Brook or Vanishing Creek. Fish ranged in size from 3.7 to 11.2 inches, with 75 percent in the 4.0 to 5.9 inch size category. No anadramous fish were found.

Previous ODFW studies in the lower reaches of Cedar Creek also found only rainbow trout. The same relative size category was encountered. Higher trout populations were present in the ODFW sampling in the lower sections of Cedar Creek.

## 1.6 WILDLIFE

### 1.6.1 Avian Threatened or Endangered Species

The northern spotted owl is the only State or Federally threatened or endangered species known to occur in the vicinity of the project area. Two spotted owl habitat conservation areas (HCA), as mapped by the Willamette National Forest, occur in

Precipitation and evaporation data is from records collected at Detroit Dam, the closest weather recording station in location and elevation to the site. Detroit Dam is south of the Bornite Project.

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sections near, but not including, Section 31 containing the project area. Three pairs of spotted owls have been located in areas adjacent to, but not crossed by, the proposed power line corridor.

The northern bald eagle, a State and Federally threatened species, occurs on Detroit Reservoir and the Little North Santiam River to the west of the project area. The type and successional stage of habitats on and immediately surrounding the project site are not important to bald eagles.

The American peregrine falcon is a Federal and State endangered species and a Willamette National Forest sensitive species. Peregrines have been documented on the Willamette National Forest and two sightings have been recorded on the Detroit Ranger District (Willamette National Forest, 1988). There have been no records of peregrines nesting on the District. Although more peregrines undoubtedly move through the area than are detected, the low level of use on the District is by spring and fall migrants moving between nesting and wintering areas. As such, local use is quite limited.

Surveys for Townsend's big-eared bat, a Federal C2 candidate species and a State and Forest sensitive species, were conducted on and around the project area. This species was located in the area, including summer roost use of abandoned cabins along the mine access road, however, no Townsend's bats were detected at the project site, which offers only marginal habitat for Townsend's bat and other bat species.

**Raptors**

Red-tailed hawks and ravens, considered here as raptors because of similar nesting requirements, are the most common, or at least conspicuous, raptors in the vicinity of the project area. Other raptor species such as turkey vultures, all three accipiters, golden eagles, and spotted, barred, small screech, pygmy, and saw-whet owls may also be seasonally present in the surrounding area. There are no known raptor nests on the project site, and the early successional stage of vegetation types on site provide virtually no nesting opportunities.

A modest variety of breeding birds are present on the project site, although bird diversity and abundance are limited because of:

- The small size of the project area;
- The number and area of vegetation types (primarily Douglas fir/ red alder); and

ecosystems between the upstream and downstream sections of Cedar Creek was noted. Cedar Creek flows in a subsurface channel during dryer seasons of the year.

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- The age/structural heterogeneity (young/low) of vegetation types present.

Some of the more common species observed at the project site include the dark-eyed junco, mountain chickadees, red-breasted nuthatches, and varied thrushes (Thompson WRD 1991, 1992).

**Game Birds**

Ruffed and blue grouse, mountain quail, and band-tailed pigeons are the game birds present in the vicinity of the project site. No detailed surveys have been conducted to quantify their numbers on the project area or in the surrounding forest. Mountain quail were not observed in the drainage during other baseline surveys.

**Waterfowl and Shorebirds**

Aquatic habitat on the project site is limited to the 2 to 3-foot-wide unnamed tributary of Cedar Creek, sometimes referred to as Bornite Brook. It is flanked by a dense red alder stand. As such, the project site is unimportant to waterfowl and shorebirds. Adjacent reaches of Cedar Creek immediately south of the project site may be used by low numbers and diversities of waterfowl and shorebirds. The most commonly observed water bird along Cedar Creek is the American dipper.

### 1.6.2 Terrestrial Threatened and Endangered Species

There is no evidence that the project site or the surrounding forest is inhabited by any threatened or endangered species including the California wolverine, a Federal candidate species. Wolverine inhabit a large (hundreds of square miles) home range, possibly following migrating ungulate herds between seasonal ranges. Wolverine could conceivably use the project area, if elk and/or deer migrated through the area, or because of the site's location in the valley bottom and the funneling effect of valleys as movement corridors. However, habitats on site are not particularly attractive or important to wolverines.

No records exist of any other State or Federally-listed threatened or endangered species from the project area or its immediate vicinity. No indications of threatened or endangered species were found during baseline wildlife surveys.

**Big Game**

Roosevelt elk, black-tailed deer, and black bear are the big game species present in the vicinity of the project area. There are no site-specific or area data available on elk

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A modest variety of breeding birds are present on the project site, although bird diversity and abundance are limited because of:

- The small size of the project area;
- The number and area of vegetation types (primarily Douglas fir/ red alder); and

or deer numbers because forested habitats are difficult to systematically survey. However, elk densities for the general area are low and are considered one of the lowest of any area in the Willamette National Forest (M. Penninger, USFS, 1991, pers. comm.). Seasonal surveys conducted on and around the project site area indicated that elk were present in the Cedar Creek drainage in only token numbers. Deer were common. Elk and deer winter range in the area is classified on an elevation basis. Northern aspects below 2,400 feet and southern aspects below 3,200 feet are classified as winter range. The project area falls into the winter range classification. In addition, the majority of the project site (the portion below 3,000 feet) is designated a High Emphasis Area for deer and elk winter range. The Cedar Creek drainage is also contained within the Cedar Elk Emphasis Area (a management unit). This area was evaluated using an elk habitat model (Wisdom et al., 1986). Model results indicated that the area represented viable habitat, but could be significantly improved if forage quality could be increased. No calving areas have been identified in the project area and it is unlikely, based on habitats present, that the project area is used for calving.

No seasonal data are available on bear numbers or habitat use. It is likely that habitats on and surrounding the project site are occasionally used by bear during spring and summer. There are no seasonal food concentrations on the project area and the site offers little potential as denning habitat.

**Small Mammals**

Small mammals are ecologically important because they represent the prey base for terrestrial and avian predators. The project site and the surrounding forest supports a variety of small mammals, including shrews, ground and tree squirrels, voles, mice, pocket gophers, etc., although numbers and diversities have not been quantified.

**Predators and Furbearers**

Representatives of this diverse wildlife group include coyotes, bobcat, mountain lion, and weasels, all of which are thought to be at least seasonally present in the Cedar Creek drainage. These species may be occasionally present on site, using the area as part of a larger home range. Mountain lions probably migrate in and out of the area following the migratory movements of deer and elk. Coyotes are probably the most common of all these species on the project area.

**Herpetofauna**

A relatively wide variety of herpetofauna (reptiles and amphibians) inhabit the surrounding forest, although habitat potential on the project area is limited, because:

- The age/structural heterogeneity (young/low) of vegetation types present.

Some of the more common species observed at the project site include the dark-eyed junco, mountain chickadees, red-breasted nuthatches, and varied thrushes (Thompson WRD 1991, 1992).

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There is no evidence that the project site or the surrounding forest is inhabited by any threatened or endangered species including the California wolverine, a Federal candidate species. Wolverine inhabit a large (hundreds of square miles) home range, possibly following migrating ungulate herds between seasonal ranges. Wolverine could conceivably use the project area, if elk and/or deer migrated through the area, or because of the site's location in the valley bottom and the funneling effect of valleys as movement corridors. However, habitats on site are not particularly attractive or important to wolverines.

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**Big Game**

Roosevelt elk, black-tailed deer, and black bear are the big game species present in the vicinity of the project area. There are no site-specific or area data available on elk

- Most of the site is a young, mixed conifer stand;
- aquatic resources are limited to Bornite Brook; and
- much of the site has been disturbed by recent mineral activities and past logging activities, and there is little coarse woody debris present.

Nevertheless, several species of snakes and amphibians probably inhabit the site. Pacific giant salamander have been located in Bornite Brook on the project area and adjacent Cedar Creek.

## 1.7 SURFACE WATER HYDROLOGY

### 1.7.1 Quality

All of the surface water samples met EPA primary and secondary drinking water standards, and were within existing DEQ aquatic standards for the Santiam River Basin.

General parameters and major cations and anions were similar to the results shown in WWL (1991), with neutral pH and very low concentrations of species. A small seasonal variation in these parameters is seen. The only metals that were detected (on a total basis) were aluminum, barium, iron, and manganese. These were detected at limited locations.

### 1.7.2 Quantity

The project site is within the Santiam River basin, one of the major Willamette River watershed drainages on the western slope of the Cascades Range. Three streams occur on or adjacent to the project site - Cedar Creek, and the two unnamed streams referred to as Bornite Brook, and Vanishing Creek. The Bornite project site is within the Cedar Creek Valley, which discharges into the westward flowing Little North Santiam River. Bornite Brook is a tributary to Cedar Creek after it flows across the project site. Vanishing Creek flows onto the project site, but infiltrates into the colluvial material before the surface flow reaches Cedar Creek. Flows in the surface streams are variable and dependant on snowmelt and precipitation runoff.

The catchment area of Cedar Creek above its outlet to the Little North Santiam River is approximately 5800 acres (9 square miles). The catchment area of Cedar Creek above the Bornite site is approximately 2600 acres (4 square miles). Flow rates in Cedar creek immediately downstream of the site in 1991 have ranged from less than one to

or deer numbers because forested habitats are difficult to systematically survey. However, elk densities for the general area are low and are considered one of the lowest of any area in the Willamette National Forest (M. Penninger, USFS, 1991, pers. comm.). Seasonal surveys conducted on and around the project site area indicated that elk were present in the Cedar Creek drainage in only token numbers. Deer were common. Elk and deer winter range in the area is classified on an elevation basis. Northern aspects below 2,400 feet and southern aspects below 3,200 feet are classified as winter range. The project area falls into the winter range classification. In addition, the majority of the project site (the portion below 3,000 feet) is designated a High Emphasis Area for deer and elk winter range. The Cedar Creek drainage is also contained within the Cedar Elk Emphasis Area (a management unit). This area was evaluated using an elk habitat model (Wisdom et al., 1986). Model results indicated that the area represented viable habitat, but could be significantly improved if forage quality could be increased. No calving areas have been identified in the project area and it is unlikely, based on habitats present, that the project area is used for calving.

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**Herpetofauna**

A relatively wide variety of herpetofauna (reptiles and amphibians) inhabit the surrounding forest, although habitat potential on the project area is limited, because:

several hundred cubic feet per second. Flow rates from the 100-year storm at this location were calculated to be 4,440 cubic feet per second. Cedar Creek is a typical Cascade stream with numerous small waterfalls, plunge pools, quiet side channels, and fast flowing riffles. Physical habitat characteristics in Cedar Creek below the project site include an average gradient of 5.2 percent, average flow of 3.16 cubic feet per second, an average width of 20.8 feet and an average depth of 0.33 feet. The substrate is comprised of 51 percent boulders, 42 percent rubble, and 7 percent gravel. The boulder and rubble particles generally have their surface covered by fine sediments and are embedded in the stream channel. Pools constitute 86.6 percent of the stream channel. Woody debris is moderately abundant in the stream channel, covering less than 10 percent of the active channel area.

Just above the project site Cedar Creek flows in a subsurface condition in low flow conditions and is not visible in the creek channel. Cedar Creek then reappears in the stream channel at a bedrock colluvium interface adjacent to the project site.

Bornite Brook discharges into Cedar Creek after it crosses the project site. Bornite Brook is a fast flowing, perennial stream with low flows. Bornite Brook flows are greatly affected by seasonal conditions. Primary influences are precipitation, snowmelt, and groundwater inflow. The average characteristic values of Bornite Brook are depth: 0.17 feet, width: 7.0 feet. Gradient is variable with 27.6 percent and 11.2 percent measured in study areas. The substrate composition is 50 to 54 percent rubble and 25 to 36 percent boulders. Woody debris constitutes 30 percent of the active channel area.

Vanishing Creek flows nearly parallel Bornite Brook. The flow gradually diminishes as it flows across the project area. The infiltration area varies by seasonal flow. Flows in Vanishing Creek were measured at 0.01 cubic feet per second in September 1991.

## 1.8 GROUNDWATER HYDROLOGY

### 1.8.1 Summary of Geohydrologic Evaluation

Surface water sampling was begun during the first quarter of 1991, and has been conducted on a quarterly basis. Flows at the sampling sites have been gauged or estimated with the quarterly sampling. The results indicate that although there is a significant variation in flow rate, surface water quality shows neutral pH and very low solids concentrations, with very little temporal variation. Cedar Creek shows slightly lower solids concentrations than its tributaries.

- Most of the site is a young, mixed conifer stand;
- aquatic resources are limited to Bornite Brook; and
- much of the site has been disturbed by recent mineral activities and past logging activities, and there is little coarse woody debris present.

Nevertheless, several species of snakes and amphibians probably inhabit the site. Pacific giant salamander have been located in Bornite Brook on the project area and adjacent Cedar Creek.

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### 1.7.2 Quantity

The project site is within the Santiam River basin, one of the major Willamette River watershed drainages on the western slope of the Cascades Range. Three streams occur on or adjacent to the project site - Cedar Creek, and the two unnamed streams referred to as Bornite Brook, and Vanishing Creek. The Bornite project site is within the Cedar Creek Valley, which discharges into the westward flowing Little North Santiam River. Bornite Brook is a tributary to Cedar Creek after it flows across the project site. Vanishing Creek flows onto the project site, but infiltrates into the colluvial material before the surface flow reaches Cedar Creek. Flows in the surface streams are variable and dependant on snowmelt and precipitation runoff.

The catchment area of Cedar Creek above its outlet to the Little North Santiam River is approximately 5800 acres (9 square miles). The catchment area of Cedar Creek above the Bornite site is approximately 2600 acres (4 square miles). Flow rates in Cedar creek immediately downstream of the site in 1991 have ranged from less than one to

Significant Coordination Meetings
Attended by Allen Throop
1991

| | |
|---|---|
| Jan 25 | Meet with A. Gordon, Stan Dodd, Jim Alto |
| Apr 24 | Meet with Allen Gordon, Jim Alto, Phil DeDycker |
| May 13 | Meet with Janine Clayton |
| May 23 | USFS-Plexus meeting - Red Lion, Eugene |
| Jun 26 | Formosa trip with USFS personnel |
| Jun 30 | Plexus open house with environmental groups |
| Aug 26 | Plexus IDT meeting - Corvallis |
| Sep 03 | Plexus informational meeting - Mill City |
| Sep 04 | Plexus field trip |
| Sep 11 | TRT meeting - Corvallis |
| Sep 19 | Plexus-USFS scoping meeting - Salem |
| Sep 23 | Plexus IDT meeting - Detroit |
| Oct 02 | Plexus pre-bid meeting |
| Oct 03 | TRT-IDT response to baseline plan |
| Oct 24 | Plexus-DEQ meeting - Portland |
| Nov 01 | TRT status letter |
| Nov 04 | Plexus Board of Contracts |
| Nov 06 | Plexus Board of Contracts |
| Nov 15 | Plexus IDT meeting - Detroit |
| Dec 11 | Plexus IDT meeting - Detroit |
| Dec 17 | Plexus meeting - Albany |
| Jan 03 | Plexus IDT meeting - Detroit |
| Feb 10 | Plexus IDT meeting - Detroit |
| Mar 20 | State-USFS meeting RE: water characterization - Salem |
| Mar 23 | Plexus IDT meeting - Detroit |
| Apr 16 | Plexus, State, SRK meeting - Mill City |
| Apr 17 | Plexus IDT - Detroit |
| May 29 | Plexus IDT - Corvallis |
| Jul 13 | Plexus IDT - Detroit |
| Jul 23 | USFS, DOGAMI, Mariah meeting - Salem |

plexus

# THE BORNITE PROJECT

# PLAN OF OPERATIONS

Submitted to
The USDA Forest Service

June 7, 1991

Groundwater sampling was begun with one of the exploration drill holes in the first quarter of 1991 by sampling an artesian flow from a preexisting unplugged exploration drill hole. Drilling and installation of six new monitoring wells (for site characterization and operational monitoring) was started in the fourth quarter of 1991 and completed in January, 1992. Geohydrology data from the monitoring wells was supplemented with exploration hole logs and hydraulic testing of selected exploration holes.

Two hydrogeologic units have been defined, bedrock and an overlying colluvium. Results indicate bedrock beneath the site is generally of very low porosity and permeability. Hydraulic conductivity depends on the fracture spacing and continuity in the bedrock. Bedrock groundwater quality shows some variability, and contains the highest solids concentrations of water on site. The overlying colluvial terrace materials on site are of moderately high porosity and permeability. Colluvial groundwater has solids concentrations similar to those of surface water and lower than fractured bedrock water. Water levels indicate a general downward gradient from the colluvial terrace materials to bedrock, and a gradient within each hydrologic unit that drains toward Cedar Creek and the lower western end of the site. Water levels in the colluvium respond quickly to significant precipitation.

Water level and water quality data show a similarity between surface water flow and groundwater in the colluvium, and indicate that the primary source of recharge to the colluvial aquifer is from surface water flow. Water level and water quality data between bedrock and other waters do not show this similarity. This indicates a very limited hydraulic connection between bedrock and the overlying colluvium.

### 1.8.2 Hydrologic Units

The colluvium contains groundwater, and comprises the uppermost aquifer in the immediate site area. Due to the limited lateral and downgradient extent of the colluvium, the extent of this aquifer also is limited. Upgradient contributions to the colluvial aquifer are surface flow in Cedar Creek, groundwater flow in the colluvium beneath Cedar Creek, surface flow in Bornite Brook, and surface flow in Vanishing Creek. Groundwater in the colluvial aquifer must exit as surface water, since the colluvium pinches out at the downgradient or northwest end of the site.

The andesitic bedrock contains and yields small amounts of groundwater from fractures and joints. It comprises the lower groundwater system at the site in areas where the colluvium is present and overlies the bedrock. Where the colluvium is not present, the bedrock comprises the only groundwater system. Due to its low yield, the bedrock system is more of an aquitard than an aquifer by most typical definitions (Strachan,

several hundred cubic feet per second. Flow rates from the 100-year storm at this location were calculated to be 4,440 cubic feet per second. Cedar Creek is a typical Cascade stream with numerous small waterfalls, plunge pools, quiet side channels, and fast flowing riffles. Physical habitat characteristics in Cedar Creek below the project site include an average gradient of 5.2 percent, average flow of 3.16 cubic feet per second, an average width of 20.8 feet and an average depth of 0.33 feet. The substrate is comprised of 51 percent boulders, 42 percent rubble, and 7 percent gravel. The boulder and rubble particles generally have their surface covered by fine sediments and are embedded in the stream channel. Pools constitute 86.6 percent of the stream channel. Woody debris is moderately abundant in the stream channel, covering less than 10 percent of the active channel area.

Just above the project site Cedar Creek flows in a subsurface condition in low flow conditions and is not visible in the creek channel. Cedar Creek then reappears in the stream channel at a bedrock colluvium interface adjacent to the project site.

Bornite Brook discharges into Cedar Creek after it crosses the project site. Bornite Brook is a fast flowing, perennial stream with low flows. Bornite Brook flows are greatly affected by seasonal conditions. Primary influences are precipitation, snowmelt, and groundwater inflow. The average characteristic values of Bornite Brook are depth: 0.17 feet, width: 7.0 feet. Gradient is variable with 27.6 percent and 11.2 percent measured in study areas. The substrate composition is 50 to 54 percent rubble and 25 to 36 percent boulders. Woody debris constitutes 30 percent of the active channel area.

Vanishing Creek flows nearly parallel Bornite Brook. The flow gradually diminishes as it flows across the project area. The infiltration area varies by seasonal flow. Flows in Vanishing Creek were measured at 0.01 cubic feet per second in September 1991.

## 1.8 GROUNDWATER HYDROLOGY

### 1.8.1 Summary of Geohydrologic Evaluation

Surface water sampling was begun during the first quarter of 1991, and has been conducted on a quarterly basis. Flows at the sampling sites have been gauged or estimated with the quarterly sampling. The results indicate that although there is a significant variation in flow rate, surface water quality shows neutral pH and very low solids concentrations, with very little temporal variation. Cedar Creek shows slightly lower solids concentrations than its tributaries.

**BORNITE PROJECT**

**PLAN OF OPERATION**

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**OTHER INFORMATION**

# LIST OF FIGURES

## LIST OF TABLES

# ACKNOWLEDGEMENTS

A team of experts has been assembled to provide the technical input to this Plan of Operations. The following list includes the principal engineers and scientists involved with the effort to date:

| | | |
|---|---|---|
| Robert Allander | Mechanical Engineer | Minproc Engineers Inc. |
| James D. Alto | Mining Engineer | Plexus, Inc. |
| Murray Bath | Metallurgical Engineer | Mincproc Engineers Inc. |
| George F. Blankenship | Planner | Planning Information Corp. |
| Michael S. Burney | Archeologist | Independent Consultant |
| G.C. Cadwell | Metallurgical Engineer | Plexus, Inc. |
| Lyle A. Davis | Hydrologist | Water, Waste & Land Inc. |
| Phillip M. DeDycker | Environmental Engineer | P.M. DeDycker & Associates |
| John C. Folinsbee | Mining Engineer | Independent Consultant |
| Allen S. Gordon | Mining Engineer | Plexus, Inc. |
| Gregory J. Gosson | Geologist | Plexus, Inc. |
| David Johnson | Ecologist | Western Resource Development Corp. |
| Simon Miek | Metallurgical Engineer | Minproc Engineers Inc. |
| Gaylon Porter | Electrical Engineer | SSR Engineers Inc. |
| Larry G. Snider | Geologist | Plexus, Inc. |
| Clinton L. Strachan | Civil Engineer | Water, Waste & Land Inc. |
| Philip Thompson | Metallurgical Engineer | Dawson Metallurgical Laboratories, Inc. |

**PLAN OF OPERATIONS**
**FOR MINING ACTIVITIES**
**ON NATIONAL FOREST LANDS**
(0596-0022, USDA, Forest Service)

Submitted by:

Signature: Allen S Gordon Title: Vice President-Technical Services Date: June 7, 1991

Received by:

Signature:__________ Title:__________ Date:__________

(If more space is needed to fill out a block of information, use additional sheets and attach to form)

## I. GENERAL INFORMATION

A. Name of Mine\Project: Bornite Project

B. Type of Operation: Underground Copper Mine
(lode, placer, mill, exploration, development, production, other)

C. Is this a (new/continuing) operation? (CIRCLE ONE) If continuing a previous operation, this plan (replaces/modifies) a previous plan of operation (CIRCLE ONE)

D. Proposed start-up date of operation: Spring, 1993

E. Proposed duration of operations: 10 years

F. Proposed seasonal reclamation close-out date: N/A

## II. PRINCIPALS

A. Name, address and phone number of operator:

Allen S. Gordon, Vice-President, Technical Services

Plexus, Incorporated

185 South State Street, Suite 400

Salt Lake City, Utah 84111

(801) 363-9152

B. Name, address, and phone number of authorized field representative (if other than the operator). Attach authorization to act on behalf of the operator:

N/A

C. List the owners of the claims (if other than the operator):

Cyprus Minerals Corporation, Denver, Colorado

D. List name and address of any other lessees, assigns, agents, etc. and briefly describe their involvement with the operation, if applicable:

N/A

## III. PROPERTY OR AREA

Name of claim and the legal land description where the operation will be conducted:

See description in accompanying Plan of Operations, Section 2.2

WWL, 1992). Figure 4 is a cross section through the project area of the hydrologic units.

### 1.8.3 Monitoring Wells

Six monitoring wells were completed to provide groundwater hydraulics and groundwater quality data for site characterization and permitting of the Bornite Project. The wells were located in downgradient areas of the site for monitoring changes in water levels and water quality during and after project operation. Wells were constructed according to WRD and DEQ design specifications. WRD personnel visited the site during the well installation.

Three of the wells were completed in bedrock (bedrock wells), and three were completed in the overlying terrace materials (shallow wells). The wells were located in pairs, with one well in rock, and an adjacent well in terrace materials.

At each site of paired wells, the bedrock well was drilled and completed first. The well was drilled into rock a sufficient depth to intercept water-bearing fractures. After the bedrock well drilling was completed, the shallow well was drilled. The depth of completion for the shallow well was chosen from the depth of water encountered in the colluvial materials in the deeper bedrock well.

Differences in water quality between the shallow and bedrock wells can be seen. Shallow wells M4 and M5 show TDS concentrations below 30 mg/l, with cadmium and iron being the only detected metals. Rock wells show TDS concentrations over 100 mg/l, and detected barium, boron, cadmium, iron, manganese, and molybdenum. The rock wells show a similarity in water quality to samples obtained from exploration hole CC18, which penetrates the ore body to a total depth of 618 feet.

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## IV. DESCRIPTION OF THE OPERATION

A. **Access.** Show on a map (USGS quadrangle map or a National Forest map, for example) the claim boundaries and describe and show on the map all access needs, on and off the claim. Specify what Forest Service existing roads will be used, where maintenance or reconstruction is proposed and where any new construction is necessary. For new construction, include construction specifications such as widths, grades, etc. Show location and size of culverts. Describe maintenance plans. Describe the type and sizes of vehicles and equipment that will be traveling the access routes:

See description in accompanying Plan of Operations, Section 3.11

B. Attach map, sketch or drawing showing location and layout of the area of operation. Include names and locations or any streams, creeks, and springs. Describe and explain on the map the type of operation, method, or techniques you propose (examples: drilling, open pit mining, dredging, milling, etc.; include locations, capacity, size, amount, etc.). Show on the map and describe below the size and kind of all surface disturbance, such as trenches, pits, settling ponds, stream channels and run-off diversions, waste dumps, drill pads, timber disposal or clearance, etc. Include sizes, capacities, acreage, amounts, locations, materials involved, etc.

See description in accompanying Plan of Operations, Section 3.0

C. **Project Description**. Describe all aspects of the operation: how clearing will be accomplished, topsoil stockpiled, waste rock placed, tailing disposed of, etc. Calculate production rates and total volumes of waste rock and ore. Include justification and calculations for settling pond capacities and sizing of runoff diversion channels:

1. For first 12 months:

See description in accompanying Plan of Operations, Section 3.0

2. For the total life of the project:

D. **Describe the Equipment and Vehicles** you propose to use in your operation (Examples: drill, dozer, wash plant, mill, etc.). Include: sizes, capacity, frequency of use, etc:

See description in accompanying Plan of Operations, Sections 3.3 and 3.7

E. **Structures.** Describe and include justification for the structures or facilities planned for the operation. Include such things as storage sheds, mill buildings, thickener tanks, fuel storage, powder magazines, pipe lines, water diversions, trailers, sanitation facilities, etc. Include justification and calculations for sizing of tanks, pipelines and water diversions. The fuel storage facilities should include containment structures that will hold the volume of the largest storage tank in case of a tank failure or leak. Show the locations on the sketch map:

See description in accompanying Plan of Operations, Sections 3.7, 3.8, and 3.11

## V. ENVIRONMENTAL PROTECTION MEASURES (SEE 36 CFR 228.8)

A. **Air Quality.** Describe measures to be taken to minimize impacts on air quality such as obtaining a burning permit for slash disposal or dust abatement on roads:

See description in accompanying Plan of Operations, Section 4.4

B. **Water Quality.** State how applicable state and federal water quality standards will be met. Describe what measure or management practices will be used to minimize water quality impacts and meet applicable standards.

1. If water is to be used in the operations (processing ore, washing ore, solution make-up, etc.) state how the water will be stored, treated and disposed of. If ponds of any type are proposed, such as for storage or settling, state how they will be designed and built. Provide storage capacities and water balance calculations. State how ponds will be maintained on an annual basis.

2. Describe methods to control runoff and erosion to prevent entry into surface water for all disturbed areas, including waste and tailings dumps.

3. Describe proposed surface water and ground water quality monitoring, if required, to demonstrate compliance with federal or state water quality standards.

4. Describe what measures will be used to minimize potential water quality impacts during winter closure, if applicable.

5. If land application is proposed for waste water disposal, the location and operation of the land application system should be described.

See description in accompanying Plan of Operations, Section 4.6

C. **Solid Wastes.** State how any tailing, dumpage, or other waste produced by operations will be disposed of or treated so as to minimize adverse impacts. Include a statement that all unburnable garbage and refuse will be hauled off-forest to a sanitary landfill.

See description in accompanying Plan of Operations, Section 3.11

D. **Scenic Values.** State how scenic values will be protected. Examples are screening, slash disposal, timely reclamation, etc.

See description in accompanying Plan of Operations, Section 4.12

E. **Fish and Wildlife.** All practicable measures to maintain and protect fisheries and wildlife habitat affected by the operations must be taken, and should be defined. Most of those measures involve avoidance of critical habitat such as along streams and bogs when planning roads, dumps, etc. Opportunities during reclamation to prevent erosion or plant browse or forage species should be described.

See description in accompanying Plan of Operations, Sections 4.10 and 4.11

F. **Cultural Resources.** Describe procedures for protection of historic and archeological values. The forest Service is responsible for insuring that the area to be covered by the operating plan is inventories prior to plan approval to determine the presence of significant cultural resources and will specify protective and/or mitigation measures to be taken by the operator. If previously undiscovered cultural resources (historic or prehistoric objects, artifacts, or sites) are exposed as a result of operations, the operator shall not proceed until he is notified by the District Ranger that he has complied with provisions for mitigating unforeseen impacts as required by 36 CFR 228.4(e) and 36 CFR 800.

See description in accompanying Plan of Operations, Section 4.7

G. List all hazardous substances (byu name and quantity required) which you intend to use or generate during the proposed operation. Operations USING or GENERATING HAZARDOUS SUBSTANCES must attach copies of other Federal and State agency permits, including all stipulations and conditions pertaining to the permit.

See description in accompanying Plan of Operations, Sections 3.6 and 5.4

H. With regard to hazardous substances, discuss handling, storage, security (fencing), identification (signing), or other special operations requirements necessary to conduct the proposed operation.

See description in accompanying Plan of Operations, Sections 3.6 and 5.4

I. **Close-out and Reclamation.** This section should describe the removal of structures and facilities, and the reclamation of the access road. It should specify that roads no longer will be treated by the agency in accordance with that agency's laws, rules and regulations.

I/We have reviewed and agree to comply with all conditions in this plan of operations, including the recommended changes and reclamation requirements. I/We understand that the bond will not be released until the Forest Officer in charge give written approval of the reclamation work.

Allen S. Gordon June 7, 1991

Operator (or authorized official) Date

OPERATING PLAN APPROVAL:

Name, title Date

Authorized Officer Date

Public reporting burden for this collection of information is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Agriculture, Clearing Officer, OIRM, Room 404-W. Washington, D.C. 20250; and to the Office of Management and Budget, Paperwork Reduction Project (OMB #0596-0022), Washington, D.C. 20503.

## SECTION 1.0
## INTRODUCTION

The proposed Bornite Project is being developed by Plexus, Inc., a natural resources company based in Salt Lake City, Utah.

The Bornite Project will incorporate the development and operation of a highly mechanized 1,400 ton per day underground copper mine, operating five days per week, with an on-site 1,000 ton per day conventional flotation concentrator.

Bornite has an estimated 10-year life, which includes a minimum of eight years productive mine life plus two years of construction and reclamation. The project site is located in the Detroit District of the Willamette National Forest. Approximately 32 acres would be directly affected by the Bornite Project. All project-related facilities will be located in an area of second growth forest. No old growth forest will be directly affected by the project's construction or operation.

During the project's life, approximately 2.5 million tons of ore will be mined and processed. There will be an additional 260,000 tons of non-mineralized development rock mined and either stockpiled on the surface or used in constructing surface facilities.

The product of the flotation concentrator will be a premium high grade copper concentrate containing significant amounts of gold and silver. The copper concentrate will be trucked off-site to a railhead or a deep water port, where it will be shipped to a smelter outside of Oregon.

The sand-sized non-copper material separated from the copper mineral during the concentrating process, referred to as tailings, will be deposited as moist sand in a specially designed impoundment area adjacent to the ore processing facilities. Once the initial phase of the ore body has been mined, tailings will be periodically backfilled into the void created by mining the ore. It is estimated that over the life of the project, 1,267,000 tons of tailings will be emplaced underground, and 990,000 tons will be placed on the surface. Testing of representative samples of development rock and mill tailings have shown the materials to be non-acid generating. No metallic cations will be leached from the tailings or development rock.

Power for the project will be provided from the Tumble Creek substation located near Detroit, Oregon, via overhead distribution line.

## 1.1 REPORT SCOPE

The project described in this document is based on the results of exploration work on the property conducted by both Plexus and the previous property holder, Cyprus Minerals Corporation. The results of the exploration has lead Plexus to the project evaluation stage in which metallurgical testing and preliminary mine design have been accomplished with favorable results. The project is now at the stage where various permits and regulatory approvals are being sought. The first step of that endeavor is the submittal of an operating plan to the Willamette National Forest, the land management agency. This will be followed by individual permit applications being submitted to the various local, state and federal regulatory authorities with responsibility for aspects of the development, operation and decommissioning of the Bornite Project.

## 1.2 REVIEW OF OTHER PERMITS AND APPROVALS

The successful development of the Bornite Project will require the acquisition of a number of local, state and federal permits, and approvals. Each of the federal permits can only be issued after the completion of the required National Environmental Policy Act provisions. Individual permits required for the project include the following:

| AGENCY | PERMIT/APPROVAL |
| --- | --- |
| **Federal** | |
| Willamette National Forest | Operating Plan<br>Special Permits |
| Corps of Engineers | 404 Dredge & Fill |
| **State** | |
| Dept. of Geology & Mineral Industries | Operating/Reclamation |
| Dept. of Environmental Quality | Water Pollution Control<br>National Pollution Discharge Permit<br>Air Contaminant Discharge |
| Water Resources Dept. | Reservoir Construction<br>Groundwater Appropriation |
| Division of State Lands | Removal & Fill Permit |
| **Local** | |
| Marion County | Building Projects |

In addition to the permits mentioned above, several permits will be required from the Mine Safety and Health Administration (MSHA), from other local agencies for the handling and storage of explosives, and from the Oregon State Health Department for construction and operation of the sanitary waste system and for the provision of potable water.

## 1.3 COMPANY PROFILE AND RESPONSIBLE PERSONNEL

Plexus Resources Corporation is a Canadian company headquartered in Salt Lake City, Utah. The company conducts business in the United States through its wholly-owned U.S. subsidiary, Plexus, Inc. The Company has been successfully involved in mineral development since 1980.

Plexus acquires and develops mineral resource properties to produce both precious and base metals. Although the company has a grass-roots exploration program, its mining activities are concentrated on properties with known mineral deposits. The Company structures its operations to quickly evaluate existing and potential reserve expansions that can be developed in a timely, cost-efficient manner. The Company holds property interests and conducts activities through a variety of business arrangements, including joint ventures, leasehold rights, equity investments, financing contracts, royalty interests and fee ownership.

Currently, Plexus participates in a joint venture at the Denton Rawhide gold-silver mine, located in western Nevada. The Denton Rawhide mine is now in operation. Plexus also operates the Western World Mining Company, a joint venture developing a copper mining and milling operation in north central California. Plexus holds a substantial equity interest in Crown Butte Resources, Ltd., a company which is currently permitting a major copper-gold deposit on U.S. Forest Service land in Montana.

Plexus' address and telephone number is as follows:

185 South State Street
Suite 400
Salt Lake City, UT 84111
(801) 363-9152

**Corporate Officers**

ARTHUR H. DITTO, President, Chief Executive Officer, and Director

Mr. Ditto has more than 27 years in the mining and construction business. He can be considered the founder of Plexus Resources Corporation. As an Anaconda Company executive, he was responsible for development of a $217 million mining and processing project. Mr. Ditto is a professional engineer and a graduate of Montana College of Mineral Sciences and Technology in Mining Engineering.

DAVID B. ROVIG, Executive Vice President and Director

Mr. Rovig has been associated with Plexus since 1980. He is also Chief Executive Officer of Crown Butte Resources, Ltd., an associated company. Mr. Rovig is a professional engineer, with more than 26 years of experience in the industry. He graduated from Montana College of Mineral Sciences and Technology in Mining Engineering.

WWL, 1992). Figure 4 is a cross section through the project area of the hydrologic units.

### 1.8.3 Monitoring Wells

Six monitoring wells were completed to provide groundwater hydraulics and groundwater quality data for site characterization and permitting of the Bornite Project. The wells were located in downgradient areas of the site for monitoring changes in water levels and water quality during and after project operation. Wells were constructed according to WRD and DEQ design specifications. WRD personnel visited the site during the well installation.

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Differences in water quality between the shallow and bedrock wells can be seen. Shallow wells M4 and M5 show TDS concentrations below 30 mg/l, with cadmium and iron being the only detected metals. Rock wells show TDS concentrations over 100 mg/l, and detected barium, boron, cadmium, iron, manganese, and molybdenum. The rock wells show a similarity in water quality to samples obtained from exploration hole CC18, which penetrates the ore body to a total depth of 618 feet.

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### 1.8.4 Water Levels

Fluctuations in monitoring well water levels overtime indicate a significantly different response between colluvium wells and bedrock wells. This indicates that there is little hydraulic connection between the colluvium and bedrock.

ALLEN S. GORDON, Vice President, Technical Services

Prior to joining Plexus in January 1991, Mr. Gordon was responsible for operations management, mine development and engineering, exploration and environmental planning at Western States Minerals Corporation. He has worked 16 years in the mining industry holds a Master's Degree in Mining Engineering from the University of Idaho.

J. MICHAEL G. WASHINGTON, Vice President, Finance

A former Vice President and Chief Financial Officer of CoCa Mines, Inc., and previously Vice President of Finance and Director of Wharf Resources, Ltd., two significant North American gold producers, Mr. Washington's background includes 16 years in the mining industry, including management positions with Echo Bay Mines, Ltd. and Tenneco Minerals Company. He is a certified public accountant and a graduate of Montana State University.

# SECTION 2.0
# PROJECT OVERVIEW

## 2.1 PROJECT LOCATION AND ACCESS

The Bornite Project is located approximately 50 miles east of Salem, Oregon, in the western Cascades (see Figures 2.1 and 2.2). The project area is contained within a broad valley in the Cedar Creek drainage. Cedar Creek is a tributary of the Little North Santiam River. The property consists of 64 unpatented lode claims, held under a lease from Cyprus Minerals Corporation. The claims are within Sections 30 and 31, T8S, R5E and Sections 6 and 7, T9S, R5E, W.M. The powerline servicing the project will be routed adjacent to F-2207 and F-2233 to a location near Detroit, Oregon. All project facilities will be within Willamette National Forest boundaries. The project area is within the southern portion of the Lester Mining District, also known as the North Santiam Mining District.

The Bornite Breccia Pipe is located in the southwest 1/4 of Section 31, T8S, R5E. Limited exposure of the breccia pipe occurs approximately at the 2250 foot elevation near the bottom of the Cedar Creek drainage.

The project area is accessed either from the Little North Santiam River via State Highway 22, county Road 960, and Forest Service roads F-2209 and F-2207, or from French Creek via State Highway 22 and Forest Service roads F-2223 and F-2207. State Highway 22 and County Road 960 are double-laned, paved roads. Forest Service Roads F-2209 and F-2207 are single-laned, collector roads with a gravel surface.

Access from the Little North Santiam River requires crossing Shady Cove Bridge, which has been closed to vehicle traffic until the new bridge is completed in mid-1991.

## 2.2 LAND STATUS AND PROPERTY OWNERSHIP

Plexus, Inc. holds 64 unpatented lode mining claims under long-term lease from Cyprus Minerals Company of Denver, Colorado. This agreement was entered into in 1989. Location of the claims are shown in Figure 2.3. A list of the mining claims is shown on Table 2.1.

TABLE 2.1 Bornite Project Unpatented Claims.

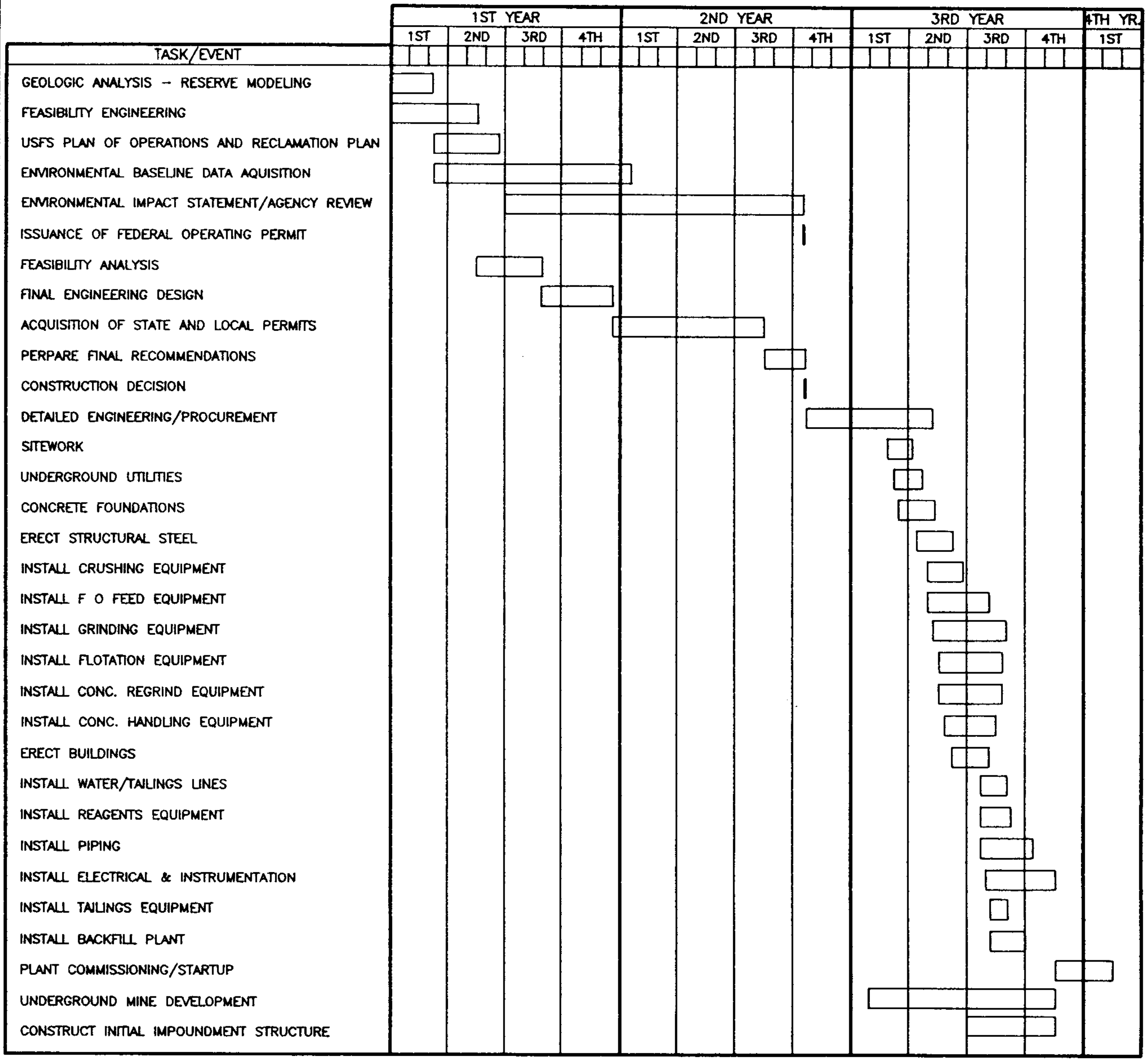
| CLAIM | SERIAL NO. | CLAIM | SERIAL NO. |
|---|---|---|---|
| FROG 31 | OR MC 4057 | FROG 30 | OR MC 19599 |
| FROG 33 | OR MC 4058 | FROG 49 | OR MC 19606 |
| FROG 34 | OR MC 4059 | FROG 51 | OR MC 19608 |
| FROG 35 | OR MC 4060 | FROG 52 | OR MC 19609 |
| FROG 38 | OR MC 4063 | FROG 53 | OR MC 19610 |
| FROG 40 | OR MC 4065 | FROG 54 | OR MC 19611 |
| FROG 81 | OR MC 4066 | FROG 55 | OR MC 19612 |
| FROG 82 | OR MC 4067 | FROG 56 | OR MC 19613 |
| FROG 83 | OR MC 4068 | FROG 57 | OR MC 19614 |
| FROG 84 | OR MC 4069 | FROG 58 | OR MC 19615 |
| FROG 85 | OR MC 4070 | FROG 59 | OR MC 19616 |
| FROG 86 | OR MC 4071 | FROG 60 | OR MC 19617 |
| FROG 87 | OR MC 4072 | FROG 61 | OR MC 19618 |
| FROG 88 | OR MC 4073 | FROG 62 | OR MC 19619 |
| FROG 89 | OR MC 4074 | FROG 63 | OR MC 19620 |
| FROG 90 | OR MC 4075 | FROG 11 | OR MC 124370 |
| FROG 91 | OR MC 4076 | FROG 12 | OR MC 124371 |
| FROG 92 | OR MC 4077 | FROG 13 | OR MC 124372 |
| FROG 32 | OR MC 18248 | FROG 14 | OR MC 124373 |
| FROG 17 | OR MC 19586 | FROG 15 | OR MC 124374 |
| FROG 18 | OR MC 19587 | FROG 16 | OR MC 124375 |
| FROG 19 | OR MC 19588 | FROG 43 | OR MC 124376 |
| FROG 20 | OR MC 19589 | FROG 45 | OR MC 124377 |
| FROG 21 | OR MC 19590 | FROG 47 | OR MC 124378 |
| FROG 22 | OR MC 19591 | PR 1 | |
| FROG 23 | OR MC 19592 | PR 2 | |
| FROG 24 | OR MC 19593 | PR 3 | |
| FROG 25 | OR MC 19594 | PR 4 | |
| FROG 26 | OR MC 19595 | PR 5 | |
| FROG 27 | OR MC 19596 | PR 6 | |
| FROG 28 | OR MC 19597 | PR 7 | |
| FROG 29 | OR MC 19598 | PR 8 | |

## 2.3 PROJECT PERMIT AND BOUNDARY

The proposed permit boundary for the Bornite Project is shown on Figure 2.4. The permit area is approximately 58 acres and reflects the 32 acres to be disturbed by the project and a buffer area for continued exploration.

## 2.4 SUMMARY OF PROJECT ACTIVITIES AND SCHEDULES

The project can be built and fully operational 9 to 11 months after the initiation. It is anticipated that construction will begin during the early spring of 1993, depending upon receipt of the requisite permits and approvals. Refer to Figure 2.5 for a chart of project activities and schedules.




*PLEXUS, INC.*

*BORNITE PROJECT*
*MARION COUNTY, OREGON*

**PROVISIONAL ENGINEERING AND CONSTRUCTION SCHEDULE**

PREPARED BY PLEXUS, INC.

FIGURE 2.5 MAY, 1991

## SECTION 3.0
## DESCRIPTION OF PROPOSED PROJECT

### 3.1 GEOLOGIC SETTING

The geologic setting of the Bornite Breccia Pipe is typical of known breccia pipe occurrences in western North and South America. Numerous intermediate to felsic composition stocks and dikes form high level intrusions within Tertiary age lava flows and tuffs of the Western Cascade Range, which is a favorable environment for breccia pipe formation. The Bornite property is part of a recognized metallogenic area - the North Santiam Mining District, a past copper producing district. The Cedar Creek drainage contains a broad area of propylitic alteration, localized areas of intense quartz-sericite-tourmaline alteration, and outcroppings of copper mineralization. The location of the Bornite Breccia Pipe was recognized from surface by a large area of highly anomalous copper in the soils (up to 2200 ppm) that developed over the pipe. The uppermost part of the mineralized breccia pipe forms a small area of weathered outcrop.

Mineralized breccia pipes are known to occur in clusters, and several other breccia pipe targets have been recognized on the property and will be part of an ongoing exploration program throughout the life of the project.

### 3.2 ORE BODY GEOLOGY

The Bornite Project is centered around the copper-bearing Bornite Breccia Pipe, a cylindrical feature associated with a Tertiary diorite/quartz diorite body intruding tertiary andesitic volcanic rocks (Figure 3.1).

The volcanic rocks are part of the Miocene Sardine Formation, which has been informally divided into two members:

- The upper member consists of interbedded andesitic to basaltic flows and andesitic tuffs and tuff breccias. These rocks are found in the upper elevations of the project area.

- The lower member consists of andesitic flows and interbedded polymictic breccia, which have been mapped and logged as andesite flow breccias.

A series of multiphase quartz diorite intrusive stocks and dikes cut across the Bornite property and are genetically related to the Bornite Breccia Pipe. The Cedar Creek stock, which hosts the majority of the Bornite Breccia Pipe, is approximately 500-600 feet in diameter and appears to plunge steeply to the northeast.

High angle faulting is common in the project area with the best exposures occurring along a roadcut approximately 1,500 feet northeast of Cedar Creek. The dominant trends on the faults are northwest, north and northeast with dips typically to the west.

### 3.2.1 Geometry and Structure

The Bornite Breccia Pipe is roughly cylindrical in shape and extends downward from surface for over 900 feet where intense brecciation gradually decreases into zones containing stockwork quartz veining. The pipe, which has a maximum diameter of 400 to 450 feet, narrows toward the surface and is relatively intact. Contacts with the country rock are typically sharp and locally characterized by sheeted faults. The pipe cuts both the lower member of the Sardine Formation and the Cedar Creek stock.

A series of moderate to steeply dipping, post-mineral normal faults bound the pipe on the southwest and the northeast. Evidence from drill core indicate the faults are generally widely spaced (150-200 feet) and consist of relatively narrow zones (1-2 feet) of crushed and broken rock. One exception is a 35-foot wide fault zone adjacent to the southwest side of the pipe. The faulting may have disrupted portions of the high grade shell, but does not appear to have resulted in any major offsets. Although northwest-trending structures are dominant in the Bornite Breccia Pipe area, it is likely that north-trending and northeast-trending structures may also occur, considering their presence regionally.

### 3.2.2 Mineralization

The main copper ore minerals present are bornite and chalcopyrite. Three general ore types have been defined in the Bornite breccia pipe:

- Veins in the sheeted fracture zone;
- High grade shell; and
- Interior pipe.

An example of the geometry of the Bornite breccia pipe and the spatial distribution of the three ore types is shown in Figures 3.2 and 3.3. The outer contact of the high grade shell is a sharply defined geological contact between outermost breccia and the enclosing wall rock of sheeted vein.

In the high grade shell, the ground preparation developed during the early genesis of the breccia pipe along the margin and cap was the perferred conduit for mineralizing fluids. The copper ore occurs as veinlets, disseminations, or complete replacement of the breccia matrix. Copper mineralization is weakly disseminated through the breccia clasts.

The Breccia Pipe's interior contains higher grade zones within generally low grade copper breccia. Areas of higher or lower permeability may have caused pooling of the mineralizing fluids.

Precious metal gold and silver mineralization appears confined to the outer shell and cap of the breccia pipe. High grade gold and silver values (>0.10 opt and >3.0 opt, respectively) are typically associated with higher copper values (>3%) and appear randomly distributed throughout the outer zone of mineralization.

### 3.2.3 Continuing Exploration

Mineralized breccia pipes are known to occur in clusters. Several areas on the Bornite property contain evidence of additional breccia pipes. There will be a continuous effort to explore these areas to replace ore reserves as they are mined. The exploration activities will involve geologic mapping, rock and soil sampling, geophysical surveying, trenching, drill road construction, and drilling.

## 3.3 DESCRIPTION OF PLANNED MINING OPERATIONS

Dictated by the size and shape of the ore body, the Bornite Project will include a modern, safe underground mine that will yield 1,400 tons of ore daily, five days per week. The equipment used underground will be rubber-tired diesel powered drilling, loading, and hauling vehicles. The equipment used underground is configured differently, but accomplishes many of the same tasks as surface heavy equipment.

Access to the ore body will be a declining tunnel-like ramp. Eventually, the underground mine will reach depths of more than 900 feet. Ore will be extracted from underground excavations called stopes. The ore will be trammed up the ramp in haulage trucks to the surface for processing.

### 3.3.1 Mine Production Schedule

The underground mine will produce ore at a rate of approximately 360,000 tons annually for its eight year productive life. There will be sufficient capacity to

# THE BORNITE PROJECT
# OPERATING AND RECLAMATION PERMIT
# TABLE OF CONTENTS

**Application for Reclamation Permit**

CONFIDENTIAL

## SIZE

Total acreage of this parcel owned, leased, rented, under contract, under claim or otherwise available to the applicant: 2100 acres ± .

Total acreage in the parcel which is potentially mineable (believed to contain the mineral(s) sought) 46 acres .

## VOLUMES

Total cubic yards excavated 7/1/72 to date None .

Estimated total quantity of mineral available 2.5 million tons (~~yards~~$^3$).

During ensuing permit year, what is the scheduled total cubic yards to be excavated? 80,000 yards .

THE ABOVE SECTION IS CONFIDENTIAL PER ORS 517.900.

## INSTRUCTIONS FOR COMPLETING FORM SMLR-1:

1. Complete sections 1, 2, 3, and 4.

2. In section 3:

   3B. Include all acres of any area affected by surface mining including overburden or spoils storage, stripped or cleared areas, and working area.

   3C. "New status" means a site on which no mining has occurred as of the date of this application.

   3D. Estimated volumes are accepted.

3. COMPLETE EITHER 5A OR 5B OR 5C:

   5A. An operating permit is required for any surface mining operation which involves more than 1 acre of land or more than 5,000 cubic yards of material during any 12 month period, EXCEPT if your mining operation is conducted entirely on land that was mined before July 1, 1972. If so, DO NOT SIGN 5A BUT COMPLETE 5B.

   5B. Sign this section ONLY if your surface mining operation involves more than 1 acre of land or more than 5,000 cubic yards of material during any 12 month period, AND ALSO is conducted entirely on land that was surface mined before July 1, 1972. (See ORS 517.770(1a)).

   5C. Complete this section only if your surface mining operation is less than 1 acre in size and involves less than 5,000 cubic yards per 12 month period OR fits one of the other qualifications listed. (See ORS 517.750(11) and ORS 517.770(2)).

   5D. Submission of a voluntary reclamation plan does not obligate the operator if otherwise entitled to exemptions indicated in 5B or 5C.

The colluvial wells show a correlation between water level and precipitation. Based on calculated migration times and volumes for precipitation to reach the colluvial aquifer, it is unlikely that direct downward percolation of precipitation would cause the rapid rise in colluvial well water levels. The likely cause of water level rise in the colluvial wells is recharge from sources such as Bornite Brook and Vanishing Creek, whose flows increase due to precipitation.

These water levels show a gradient for flow toward Cedar Creek and the lower end of the site. This is consistent with the locations of springs at the lower end of the site where the bedrock surface rises and the colluvium pinches out. Gradients in the colluvial aquifer from this data is roughly 10 percent, and gradients in the bedrock system are roughly 5 to 10 percent.

### 1.8.5 Hydrologic Properties

Based on geotechnical testing, the colluvial materials have a porosity of 30 to 40 percent, depending on the amount of cobbles and boulders present. The porosity of the andesite volcanic rock is estimated to be less than one percent. This is consistent with observation of exploration hole drill core and review of Rock Quality Designation (a measurement of fracture density) values from the holes.

The andesite bedrock is of very low porosity and permeability. Water storage and flow in the bedrock is limited to fractures and joints in the rock. From observation of exploration hole core and well pumping and recovery, permeable bedrock fracturing and jointing are limited. The calculated permeability based on well recovery tests is $10^{-9}$ cm per second (WWL, 1992).

The colluvium is of moderate porosity and permeability. The average porosity of the colluvium is roughly 30 to 40 percent, and the measured permeability ranges from $10^{-3}$ and $10^{-4}$ cm/sec (WWL, 1992). These values are significantly higher than those for the bedrock.

The recovery test data from the bedrock wells is consistent with results from exploration core drilling and local geologic analysis, that the bedrock has limited jointing and fracturing. The capacity to store and transmit groundwater depends on the degree of continuity of the jointing and fracturing. The recovery test data (from wells M1 and M2) indicate a low hydraulic conductivity or permeability substantiated by core. Bedrock water quality (from wells M1 and M2) has a higher pH and higher dissolved solids concentrations than other waters on site, indicating a slower rate of movement of the water.

nominally increase the mining rate in response to prevailing economic conditions. Initially the mine operations will be scheduled for two eight hour shifts daily, five days per week. Eventually, as the mining depth increases, a third shift may be required to sustain production levels.

### 3.3.2 General Mine Arrangement

At Bornite, copper ore is concentrated in higher grade sections along the outer margins of the pipe. Ore extends downward from the surface for more than 900 feet. The ore body outcrops is a very small area at about 2,250 feet elevation. From the outcrop to the 2,100 foot elevation, the top of the pipe is solidly mineralized with copper ore. From the outcrop, the ore body slopes to the south under rapidly thickening surface fluvioglacial deposits.

Underground extraction methods will allow for optimum recovery of the Bornite ore body. Minimal surface disturbance will result from the underground mining. Only two small openings to the underground workings will be visible from the surface, the mine portal and the collar of the ventilation raise (see Figure 3.4 and Figure 3.5).

Access to the ore body will be gained through a declining ramp constructed at a 12.5 percent downward grade. From the ramp, all material, personnel and equipment will enter and exit the mine. All of the ore and development rock will also be transported on this ramp system.

The size and shape of the ore body lends itself particularly well to low cost modern bulk mining methods. Extraction of ore from the stoping areas will be continuous. As now planned, there will be a minimum of 12 stopes in the ore body, with one to three operating at any given point in time. The number may change due to prevailing economic conditions.

Following ore extraction, the stopes will be filled with cemented mill tailings. Backfilling will provide structural support for later pillar extraction. In this way the extraction of the ore body will be maximized.

### 3.3.3 Underground Development

After the decision to proceed, about nine months prior to completion of the process plant construction, underground mine construction will begin. The primary mine access, the declining ramp will be advanced downward to the 1,800 foot elevation within the mine. At that point, a ventilation raise will be connected vertically to the surface.

The 16 foot by 15 foot ramp will be driven with equipment to be used later in the production activities. The ramp development cycle includes drilling, blasting and broken rock removal operations. Required ground support will be installed prior to starting the cycle again. The crew hired initially for ramp development will form the nucleus for the underground work force required later for ore production.

It is expected that the ventilation raise will be constructed by a contractor specializing in this type of underground construction work. The raise will be between 6 feet and 8 feet in diameter. It will likely be constructed using raise boring techniques, similar in many regards to drilling a large diameter drill hole, reamed out to an even larger diameter final opening.

### 3.3.4 Stope Development

Stope development will prepare the ore body for subsequent extraction. The rates at which stopes are developed will depend upon the required mining rate. Stope development will require connection to the primary access ramp and subsequent excavations for drilling levels, extraction levels and stope undercuts (see Figure 3.5 and Figure 3.6). The drilling and extraction levels will allow for drilling, blasting, and ore removal. Stope undercuts will provide open space for ore to be blasted during the stoping operation.

### 3.3.5 Extraction Methods

The geometry and strength of the surrounding country rock units at the Bornite Project indicate that a sublevel blasthole stoping method or the equivalent using delayed backfill is appropriate for the Bornite ore body.

Following stope development, the ore extraction cycle will involve the following operations: drilling and blasting; loading ore into haulage trucks; hauling ore from the mine to the surface crusher; and backfilling mined out stopes.

Refer to Figure 3.6 for a graphic description of the extraction cycle.

#### Drilling

To obtain the desired results and assure the efficiency of the overall mining operation, the proper drill and blast arrangement for producing adequate rock fragmentation must be selected. The drill and blast pattern will be designed to avoid ore dilution from the surrounding country rock.

Drill holes ranging in diameter from 4.5 to 6.5 inches will be completed by an In-The-Hole drill (ITH). The drill machine will be self propelled for easy transport. Blast holes will be drilled downward rom the drill level a distance of up to 180 feet. Drill holes will also be drilled upward from the stope undercut for roughly 40 feet. The resultant distance between levels will range from 150 to 220 feet depending on conditions. Anticipated drill hole spacing will be 8 feet by 8 feet and fanned to reach the limits of the ore body as indicated in the accompanying illustration.

**Blasting**

In the sublevel blasthole stoping system, vertical slices will be sequentially blasted into an opening at one end or the middle of within the stope until all of the ore within the stope has been excavated.

The blasting agent used will be an ammonium nitrate fuel oil mixture (ANFO). Higher density slurry or cast explosives will be used to initiate the ANFO detonation. Explosives trucks carrying the ANFO and slurry explosives will drive directly to the stope to pneumatically load the blast holes.

**Loading and Hauling**

Broken rock taken from the stopes will be loaded into 40 ton underground haulage trucks by six cubic yard load-haul-dump (LHD) type front-end loaders. Truck operators will load their own trucks. The haul trucks will then tram the ore from the extraction level to the surface by way of the ramp. At the surface, ore from the haul trucks will be discharged into the crusher hopper. If the crusher is not able to accept the load of rock, the ore will be temporarily set aside in a stockpile area. Stockpiled ore will be collected at a later time for crushing.

**Backfilling**

When extraction in a stope is complete, the stope will be backfilled with mill tailings. The complete particle size range of mill tailings will be used in a high density backfill. Development rock may be used to block openings prior to backfill placement. High density tailings mixed with 10 percent cement (by weight) will be used to fill the first 20 feet of each stope when subsequent pillar extraction will connect from below. The cement ratio will be reduced in areas not requiring the structural support of the fill.

### 3.3.6 Pillar Extraction

After the stoping areas are excavated and backfilled, stope pillars, sill pillars and other reminants will be systematically removed. All underground openings will remain stable during pillar removal because of the competence of the surrounding rock, the geometry of the ore body, and structural integrity of the cemented fill.

The high grade crown pillar at and near the surface will be excavated during the last phase of the mining operation. The ore in the crown pillar will be drilled, loaded and blasted from the surface and will fall into openings left from previous stoping activities. The ore will be loaded by LHD's into haulage trucks and brought to the surface for crushing and milling.

As currently planned, to mine the crown pillar, it will be necessary to remove up to 65,000 cubic yards of surface material for safety concerns and access. Once the underlying crown pillar has been removed, the excavation will be backfilled and the surface will be recontoured and revegetated.

### 3.3.7 Mine Services

Underground mining activities require support from the surface to provide a safe comfortable work place. Many of the required services have to be imported through an expansive network of piping, electric cables, and ductwork.

#### Ventilation

The mine fresh air ventilation system is made up of the access ramp as an intake airway and the ventilation raise as the exhaust airway. Estimates of fresh air requirements based on diesel horsepower used in the mine show that an airflow of 192,500 cubic feet per minute is required to maintain a clear atmosphere. A single large exhaust fan will be located on the ground surface at the ventilation raise collar. Several smaller auxiliary fans will be located underground to direct airflows to operating areas as required.

#### Electric Power

A single power cable will be hung in the access ramp as the heading is advanced. Electric power will be distributed throughout the mine to all working areas. Power requirements underground include ventilation, drilling, and water control systems. There will be electric motors underground totalling approximately 660 installed horsepower.

#### Compressed Air

Minimum compressed air requirements are anticipated for underground drilling. It is planned to install one 1200 cubic foot per minute compressor in a permanent installation. If additional compressed air is required on a periodic basis, portable compressors will be used to supplement the primary compressed air system.

#### Mine Water Supply

Fresh water required for drilling will be provided to working areas in a two inch diameter pipe. The mine water system will be connected to the main fresh water supply system.

#### Communications

A mine phone system will be installed to provide communications to working areas from the surface.

### 3.3.8 Mine Water Control

Known groundwater conduits will be avoided by the mining operations whenever possible. Unplanned inflows will be grouted or allowed to drain in a controlled manner. It is estimated that 300 gallons per minute will inflow to the underground workings on a continuing basis.

Pumps will be installed on the 1800 foot level and 1450 foot level. Water draining from various locations in the mine workings will be collected into sumps at each pumping station. Water from the sumps will be decanted and pumped to the surface. The sumps will be constructed to allow for periodic cleaning by mine equipment. Solids from the sumps will be disposed of underground or hauled to the surface for processing or storage in the tailings impoundment.

Three pumps will be required on the 1800 foot level and two pumps on the 1450 foot level. The system will be designed to handle a maximum flow of 600 gallons per minute with sufficient extra capacity for unexpected inflows.

### 3.3.9 Mine Equipment Requirements

The Bornite Project underground mine will be developed as a trackless operation, utilizing diesel-powered rubber-tired equipment. The drilling, loading and hauling unit operations will utilize specially designed equipment for underground use. While similar in application to surface equipment, underground vehicles are generally lower profile and more rugged than their surface counterparts. Table 3.1 summarizes the primary underground mobile development and production requirements.

**TABLE 3.1 Underground Development and Production Equipment Requirements.**

| | |
|---|---|
| Load-haul-dump (6 cy capacity) | 3 units |
| Drill Jumbo | 1 unit |
| Haulage Trucks (40 ton & 26 ton capacity) | 3 units |
| Service Trucks | 4 units |
| Road Grader | 1 unit |
| Explosives Truck | 1 unit |
| ITH Drill | 1 unit |
| Supervisors/Transportation Vehicles | 2 units |

Underground equipment will also include hand tools, small pneumatic rock drills, a variety of pumps, compressors, and auxiliary ventilation fans. The ventilation raise will also be equipped with a small man hois for emergency access and escape. As the mine deepens and the equipment ages, additional LHD's and haulage trucks will be added to replace or supplement existing units.

## 3.4 SITE CLEARING AND CONSTRUCTION

Surface facilities have been arranged into as small of an area as possible to minimize areas of clearing and potential disturbance. The tailings facility will be constructed in stages such that site clearing takes place only as needed. Reclamation of completed areas of the facility is conducted during operation.

Site clearing will take place only within the areas identified in Figure 3.7 and will consist of the following tasks:

- Removing salvageable timber;
- Clearing and grubbing of remaining vegetation; and
- Stripping salvageable topsoil or reclamation soil.

Where available, approximately 12 to 24 inches of reclamation soil will be stripped from areas to be cleared. The soil stripping depths and general soil classifications are based on U.S. Forest Service mapping, described in Section 4.8. Reclamation soil will be stockpiled in designated areas and in specified ways to preserve the soil for operational and post-closure reclamation.

Runoff from cleared areas will be collected within the site sediment control system for sediment removal before discharge (Figure 3.8). Refer to Section 3.9 for additional discussion of drainage and sediment control facilities.

## 3.5 DEVELOPMENT ROCK, USE, AND STORAGE CHARACTERISTICS

The rock excavated during mine development will come from two principal lithologic units: andesitic volcanic rocks and quartz diorite intrusive rocks. Five representative samples were selected for acid base characterization and for leachability of metals testing using standard EPA testing procedures.

The testing shows the development rock will not be acid generating and that metals will not be leachable. The testing also indicates that the development rock's physical and chemical properties fall well within Oregon DEQ draft tailings-solids treatment criteria (DEQ, 1991).

The development rock will be incorporated into surface structures specifically as the embankment for the tailings storage facility. Minor amounts of development rock will be used as fill in the underground working and a portion of the rock (selected for durability) will be used for erosion protection and drainage materials. Any excess development rock will be used in reclamation of the tailings storage facility. The schedule for development rock excavation is shown in Figure 3.9.

## 3.6 METALLURGICAL PROCESS DESCRIPTION

The Bornite process plant (mill) will be designed to treat 1,000 tons per day of ore from underground mining operations to produce a flotation concentrate for sale and further treatment. The concentrate will contain a higher percentage of the copper, gold and silver originally present in the ore.

Flotation, or froth flotation, is a widely-used process for the separation and concentration of valuable minerals from finely ground ores. Nearly a century old, the process is employed worldwide for treating a variety of metallic and non-metallic mineral ores.

Flotation is a mechanical process based on the differences in wettability among minerals when their surfaces are properly conditioned. A suspension of ore particles in water is exposed to finely divided air bubbles, to which the non-wettable (usually valuable) minerals become attached. The air bubbles carry the selected minerals to the surface of the slurry and form a stabilized froth which is skimmed off (rougher), while the other usually valueless minerals remain in the slurry. The separation may be enhanced by refloating the concentrate to increase its grade (cleaner) or refloating the tailing to recover remaining traces of valuable minerals (scavenger).

The Bornite flotation process will consist of several sequential steps. Run-of-mine ore is crushed in two stages at a rate of 120 tons per hour to a size of less than 5/8 inch. The crushed ore is conveyed to a fine ore storage bin with a capacity of 3,000 tons. Ore withdrawn from the storage bin is further reduced in a ball mill at a rate of 44 tons per hour. Water is added in the grinding process to produce a slurry of coarsely-ground ore.

The slurry is conditioned to prepare it for flotation, which separates the copper minerals as a concentrate. After thickening, the copper concentrate is filtered to produce a dewatered product suitable for shipping. The tailing is thickened and pumped to the tailings impoundment or backfilled underground.

Geochemical testing of the flotation products for Bornite ores confirms the success of the flotation process to remove metal-bearing minerals. The flotation process tailings are classified as non-toxic, do not generate acid, and do not leach toxic metals. These samples indicate that the tailings meet Oregon DEQ draft requirements for tailings-solids treatment criteria (DEQ, 1991).

### 3.6.1. Crushing

Run-of-mine ore from underground is delivered to the primary crusher dump hopper by 40-ton LHD trucks. Alternatively, ore from the mine development stockpile can be fed to the crusher by a front-end loader.

The crushing circuit consists of a primary jaw crusher and a secondary cone crusher in closed circuit with a screen. Product size is minus 5/8-inch.

Ore is withdrawn from the dump hopper and fed to the primary jaw crusher by a reciprocating plate feeder. The primary crusher reduces the run-of-mine ore to nominally minus 4 inches.

The primary crusher product is conveyed to a double-deck vibrating screen, fitted with a 3-inch upper deck and 5/8-inch lower deck. The combined plus 5/8-inch oversize is fed to the secondary cone crusher for further reduction. Secondary crusher product joins the discharge from the primary crusher and is returned to the screen. Screen undersize is conveyed to the 3,000-ton capacity fine ore bin.

A metal detector and magnet are provided to protect the cone crusher from damage by tramp metal.

Conveyor transfer and discharge points in the crushing area are hooded and vented via a baghouse and fan. Dust collected in the baghouse may be dumped or returned manually to the grinding circuit.

Before and shortly after mill startup, ore must be stored outside the mine. During this initial period, ore will be stored in the ore stockpile area south of the mine portal (Figure 3.4). As mine development proceeds and the mill is in full operation, the ore stockpile volume will be significantly reduced. The stockpile will be used for temporary storage of ore as required by unplanned mill mechanical problems. During normal planned operations, ore hauled from underground in the 40-ton trucks will be dumped directly into a hopper ahead of the primary crusher.

### 3.6.2. Primary Grinding

Crushed ore is reclaimed from the fine ore bin by two belt feeders, either one of which is capable of feeding the grinding circuit at 44 tons per hour. The belt feeders discharge onto a belt conveyor that transfers the ore into the mill building and discharges into the ball mill feed chute.

The 10.5 foot diameter by 14 foot long ball mill operates in closed circuit with hydrocyclones to produce feed to the flotation circuit with a particle size of 100 percent passing 297 microns (48 mesh). Mill discharge is pumped to the cyclones, the underflow returning to the mill, and the overflow passing to a stationary (DSM) screen to remove trash. Screen undersize is pumped to the flotation circuit.

### 3.6.3 Flotation and Regrind

Three stages of conventional mechanical flotation cells (Figure 3.10 and Figure 3.11) in a rougher-scavenger-cleaner arrangement produce concentrate with optimum grade and recovery. A ball mill regrinds the cleaner tailings for reflotation.

Screened cyclone overflow is pumped to the rougher cells, which produce a final concentrate. Rougher tailings flow directly to the scavenger cells. The tailing from these cells is pumped to the thickener for disposal. The concentrate is pumped to the cleaner cells, which produce a final concentrate and an intermediate-grade tailing. This tailing is reground in a ball mill, operating in closed circuit with a cyclone. Cyclone overflow flows by gravity to the scavenger circuit. The concentrates from the rougher and cleaner cells are combined in a hopper and pumped to the concentrate thickener.

### 3.6.4 Concentrate Dewatering

The concentrate thickener underflow is pumped to an agitated stock tank with 24-hour storage capacity. The thickened concentrate is pumped to a vacuum filter. The concentrate filter cake falls to a confined storage area below the filter. Concentrate is reclaimed by a front-end loader and loaded into highway trucks for shipment and eventual sale.

### 3.6.5 Concentrate Characteristics

In the flotation process used at the Bornite Project, a premium copper concentrate is produced. Maximization of the concentrate grade and reduction of the total quantities of concentrates produced will reduce the transportation costs and smelter changes. Daily production of concentrate from the 1,000 ton per day Bornite Project mill would be approximately 78 to 100 tons. Grade of the concentrate will be roughly 32 to 35 percent copper, or about 15 times that of the mill feed ore grade.

### 3.6.5 Reagents

Reagents are used to condition the ore slurry to promote the flotation process. Due to unique ore characteristics, minor quantities of reagents will be used at the Bornite Project. Typical reagents used in processes similar to that at the Bornite Project will be delivered to the project site in dry or liquid form. Even though the reagents are considered non-hazardous, they will be stored in a confined area so that leaks or spills can be easily contained and recovered safely. Details of the purpose, handling and storage of reagents that will likely be used at the Bornite Project are provided below.

Pumping and recovery test data from the colluvial wells is consistent with near-surface testing and observations and shows, that the colluvium is of moderate porosity and permeability, with zones within the colluvium that are more permeable than others. The water quality from the colluvial wells is similar to that from Cedar Creek.

From the fluctuations of well water levels with time and water quality data, the colluvial aquifer appears to be closely related to surface water flows in Bornite Brook, Vanishing Creek, and Cedar Creek. Surface water flows appear to be the major source of recharge to the colluvial aquifer.

Due to the configuration of the site, the colluvial aquifer pinches out at the northwest end of the site as the bedrock surface rises and is exposed in the area of the bridge across Cedar Creek. Groundwater in the colluvium must exit the site primarily as surface water flow, due to the low capacity for the bedrock to transmit water. This is confirmed by the presence of large springs at the lower end of the site that are of similar water quality to surface water and colluvial groundwater.

## 1.9 WETLANDS

Wetlands were identified and delineated according to procedures in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (1989), as requested by the Oregon Division of State Lands (DSL). The U.S. Army Corps of Engineers uses the Wetlands Delineation Manual (1987). The Vegetation was quantified by a point-intercept sampling method and the hydrophytic vegetation determined by use of a prevalence index and species dominance techniques. Soils were mapped by a certified soil scientist to an Order I and II level. Plate 1, contained in the back pocket of the application, is a map of the delineated wetlands.

The wetlands boundary with the uplands habitat was delineated based upon the observed presence and dominance of plants with indicator status of obligate, facultative wetland species; soil saturation; estimates of potential surface flooding and soil saturation during the growing season based upon topography, water marks on woody vegetation, water-borne sediment deposits, and drainage patterns. Specifically, the limits of the wetlands were based upon the presence and dominance of such plants, observed soil saturation around stream flows, springs, and seeps, plus the estimate of soil saturation during periods of higher stream flow. Soils were not a good diagnostic feature along Bornite Brook, as they were a gravelly fine sandy loom and had chromas of 3 and 4, which are too high to be classified as hydric.

The colluvial wells show a correlation between water level and precipitation. Based on calculated migration times and volumes for precipitation to reach the colluvial aquifer, it is unlikely that direct downward percolation of precipitation would cause the rapid rise in colluvial well water levels. The likely cause of water level rise in the colluvial wells is recharge from sources such as Bornite Brook and Vanishing Creek, whose flows increase due to precipitation.

These water levels show a gradient for flow toward Cedar Creek and the lower end of the site. This is consistent with the locations of springs at the lower end of the site where the bedrock surface rises and the colluvium pinches out. Gradients in the colluvial aquifer from this data is roughly 10 percent, and gradients in the bedrock system are roughly 5 to 10 percent.

### 1.8.5 Hydrologic Properties

Based on geotechnical testing, the colluvial materials have a porosity of 30 to 40 percent, depending on the amount of cobbles and boulders present. The porosity of the andesite volcanic rock is estimated to be less than one percent. This is consistent with observation of exploration hole drill core and review of Rock Quality Designation (a measurement of fracture density) values from the holes.

The andesite bedrock is of very low porosity and permeability. Water storage and flow in the bedrock is limited to fractures and joints in the rock. From observation of exploration hole core and well pumping and recovery, permeable bedrock fracturing and jointing are limited. The calculated permeability based on well recovery tests is $10^{-9}$ cm per second (WWL, 1992).

The colluvium is of moderate porosity and permeability. The average porosity of the colluvium is roughly 30 to 40 percent, and the measured permeability ranges from $10^{-3}$ and $10^{-4}$ cm/sec (WWL, 1992). These values are significantly higher than those for the bedrock.

The recovery test data from the bedrock wells is consistent with results from exploration core drilling and local geologic analysis, that the bedrock has limited jointing and fracturing. The capacity to store and transmit groundwater depends on the degree of continuity of the jointing and fracturing. The recovery test data (from wells M1 and M2) indicate a low hydraulic conductivity or permeability substantiated by core. Bedrock water quality (from wells M1 and M2) has a higher pH and higher dissolved solids concentrations than other waters on site, indicating a slower rate of movement of the water.

## Collector

A collector is added to the ore slurry before flotation to render the ore mineral surfaces non-wettable and facilitate their attachment to the air bubbles for removal as a concentrate froth. A variety of collectors is used in the mining industry. A proprietary dithiophosphate collector (American Cyanamid A3477) or the equivalent will be used at the Bornite Project.

The collector will be delivered as a liquid in 55-gallon drums, which will be stored under cover in a curbed containment area. As required, a drum will be brought into the flotation area of the plant, and the contents will be pumped into the collector mixing tank and diluted with water to a concentration of 5 to 25 percent. The prepared batch will then be transferred into the collector storage tank, from where it will be fed at a controlled rate into the ball mill feed chute and the scavenger flotation cells or column. Total collector usage is anticipated at 7,000 lbs. per year.

## Frother

The term frother refers to a variety of chemicals whose purpose is to assist the flotation process by producing a stable froth strengthing the bubble in the flotation cells. One frother, MIBC (methyl isobutyl carbinol) or the equivalent, will be used at the Bornite Project. The reagent will be delivered in 55-gallon drums and stored under cover in a curbed containment area. As required, drums will be brought into the flotation area, and the contents pumped into the frother tank. The mixture will be fed at a controlled rate to the rougher and scavenger flotation cells or columns. Total frother usage is expected to be between 20,000 and 25,000 lbs. per year.

## Flocculant

The Bornite Project may employ a flocculant from time to time to assist settling and thickening of concentrate and tailings slurries in their respective thickeners. Flocculants are generally high molecular weight organic polymers. They are added to mineral slurries in very small quantities to cause flocculation (agglomeration) of fine particles. Because of their increased mass, the flocculated particles settle readily, producing a thickened slurry and a clear supernatant solution.

Flocculant will be delivered as a dry granular solid, in 50-lb fiber drums or plastic-lined paper sacks. The drums or sacks will be stored under cover. The flocculant will be dispersed in water and allowed to become fully wetted while being gently agitated. After the solids have dissolved, the stock solution will be drained to a storage tank. The solution will be metered into an in-line mixing device for continuous dilution by a stream of water. The diluted flocculant solution will be fed into the concentrate and tailings slurry streams as it enter the thickeners. Flocculant usage will be minimal and only when required for process water clarification. Expected consumption will be 15,000 to 20,000 lbs. per year.

Although extensive laboratory testing indicates that no other reagents will be required for processing Bornite ores, actual operating conditions may vary. Potential changes in ore mineralogy may require the use of minor quantities of lime to adjust the pH of the flotation process solutions.

## 3.7 PROCESS FACILITIES DESCRIPTION

The process facilities will consist of three major structures with interconnecting belt conveyors. The first, the crushing and screening building, will be located adjacent to the mine portal. The elevation of the mine portal bench will be approximately 25 feet above the process plant bench to facilitate direct dumping of the loaded mine trucks into the primary crusher feed hopper. The second structure, the fine ore storage bin and reclaim tunnel, will be located 150 feet to the northwest of the crushing and screening building. This facility will have a minimum storage capacity of 3,000 tons of crushed ore to provide an uninterrupted flow of material to the concentrator. The third and largest of the structures will be the concentrator/mill building. This facility, located 100 feet to the southwest, will contain the grinding, flotation, concentration, tailings thickener, and reagent sections.

### 3.7.1 General

The process facilities will be designed and constructed in accordance with the latest federal, state and local codes to prevent the release of process materials to the environment and to minimize the overall impact of the project on the surroundings. See Figure 3.12 for an artist's rendering of the process area.

The site will be finished and graded with local materials following the natural contours of the land as much as possible. The top layer will be a compacted, all-weather road base gravel with a chemical agent used for dust control. Plant site surface runoff will be directed to a sediment pond prior to discharge.

All buildings will be pre-engineered steel structures with light gauge siding of a color that will blend in with the native soils and vegetation. Metal buildings and structural steel will be designed to withstand local seismic, wind and snow loads in accordance with standard industrial practice.

Buildings and process structures such as conveyors, bins, tanks and thickeners will be supported on steel reinforced concrete foundations. Concrete slabs and curb walls will be provided under all process areas to contain spillages and facilitate clean-up. Concrete will conform to local codes.

Belt conveyors, transfer chutes, hoppers and other bulk material handling devices will be designed and constructed to minimize dust generation and release. All belt conveyors, hoppers, bins and transfer chutes will be covered. Both bag-type dust collection systems and water spray dust suppression systems will be utilized. All mechanical equipment with drives and rotating parts will be equipped with safety guards in accordance with industry standards.

The entire process facility/mine portal area will be surrounded by a five foot high metallic chain-link fence to provide personnel security and prohibit ingress of wildlife. Fenced areas requiring additional security, such as electrical substations, will be provided with barbed wire standing above the chain-link. A security booth within the administration building will control main gate access. Control rooms located in the concentrator/mill building and the crushing and screening building will continuously monitor processing when in operation.

### 3.7.2 Crushing and Screening Facility

The crushing and screening building will receive run-of-mine ore by direct dumping of the 40 ton mine haul trucks into a 50-ton capacity hopper located within the structure. A 42-inch wide reciprocating plate feeder meters the ore into the first stage of crushing. The primary crusher will be a 36 inch by 48 inch jaw mounted on an independent concrete foundation. A series of two 36-inch wide belt conveyors will transfer crusher discharge product to a 8-foot wide by 18-foot long vibrating screen. Screen oversize material will feed the secondary shorthead cone crusher. The plate feeder, the cone crusher and the sizing screen will be mounted on structural steel. Platforms and stairways complete with grating and handrail will be provided for equipment access. A 24-inch wide belt conveyor will transfer screen undersize product to the fine ore bin. The crushers and screen will be serviced using a 5-ton monorail with electric trolley-hoist.

The crushing and screening building will be approximately 30 feet wide by 70 feet long with a nominal peak height of 40 feet. It will be provided with insulation, translucent paneling for natural light, high pressure sodium electric lighting, powered roof ventilators and propane fired unit heaters. The transfer tower located to the southwest of the crushing building will be an open structure approximately 16 feet wide by 20 feet long by 20 feet high. A combination control room and motor control center will be located on the upper level of the crushing building with a clear line of sight to dumping, crushing and screening operations.

### 3.7.3 Fine Ore Storage and Reclaim Facility

A 24-inch wide belt conveyor will deliver crushed material to the top of the fine ore bin. The 3,000-ton live capacity bin will be designed and constructed of mild steel plate with a concentrate ring beam foundation. It will be 50 feet in diameter and 66 feet in overall height. A 10-foot diameter corrugated steel pipe will form the reclaim tunnel. Within the tunnel, two 24-inch wide by 13-foot long belt feeders with steel reclaim hoppers will extract ore from the bin and meter it onto a 24-inch wide mill feed belt conveyor. Access into the tunnel from opposite sides of the bin will be provided. Lighting will be installed at the top of the bin and inside the reclaim tunnel, however, no powered ventilation or heating will be provided.

### 3.7.4 Grinding, Flotation and Concentration Facility

The concentrator/mill building will be approximately 60 feet wide by 88 feet long with the nominal roof peak height at 35 feet. This building will contain the following process unit operations:

- grinding and classification
- flotation
- flotation regrinding
- concentrate thickening
- concentrate filtering and storage
- reagent storage and plant services

The grinding circuit will consist of a 10.5 foot diameter by 14 foot long ball mill in closed circuit with a cluster of three 10-inch diameter cyclones. The mill and its 800 hp drive will be supported by independent concrete foundations. Access around the perimeter of the mill will be provided by structural steel platforms. The cyclones will be located above the feed end of the mill supported by structural steel. Cyclone underflow product returns to the mill while cyclone overflow product is pumped to the flotation section of the plant. The mill will be located in the northernmost corner of the building.

The flotation circuit will consist of a series of conventional 100 cubic foot and 40 cubic foot mechanically agitated flotation tanks. Structural steel supports and access platforms will be provided around the cells. The top of the cells and the cyclones will be serviced by a 2-ton monorail with an electric trolley-hoist.

The tailings from the scavenger cells will flow by gravity to an 80 hp ball mill for regrinding and then return to the flotation feed section. The concentrate from the rougher cells will gravity flow to a nominal 15-foot diameter conventional thickener. The thickened concentrate will be pumped to a 6,000-gallon capacity agitated stock tank. The regrind mill, concentrate thickener and stock tank are supported by independent concentrate foundations. A common structural steel access platform services the top of this equipment, which is located inside the southwest side of the building.

The concentrate filtration, storage and load-out circuit will be located in the southernmost corner of the building. It will consist of a 4-foot diameter by 6-foot long vacuum drum filter supported by a steel platform and will be located directly above a concrete bunker. The concrete bunker has storage for 5 days production of concentrate and will have its own exterior door for loadout by front-end loader.

The control room and motor control center room below are located inside the easternmost corner of the building. Both will be constructed out of concrete block and will be separately heated and ventilated.

The tailings thickener will be a 20-foot diameter, high-rate type and will be located outside the concentrator building. The concrete slab and curb under the thickener will divert spills onto the slab within the building. All spillage interior to the building will report to a central sump and be pumped back into the process.

The reagents mixing and storage section of the plant will be located in a "lean-to" adjacent to the southeast side of the building. A concrete containment slab, curbing and a sump will be provided for spillage. The largest reagent tank is 500 gallons.

The concentrator/mill building will be provided with insulation, translucent paneling, high bay, high pressure sodium lighting, powered roof ventilators and propane fired unit heaters.

## 3.8 TAILINGS MANAGEMENT

### 3.8.1 Tailings Facility

The tailings impoundment site shown in Figure 3.13 is located immediately above the mine site. The site is situated on a fluvioglacial terrace adjacent to and above Cedar Creek.

A site selection study was conducted for the Bornite Project. Two potential sites were identified from the study (Figure 3.14):

1. The site immediately above the mine site; and

2. A site in the bottom of the Cedar Creek valley approximately a half-mile south of the mine.

Because of the topography of the site area and the size of upstream watersheds, no other easily accessible tailings impoundment sites were identified.

The site immediately above the mine site was selected based on the following factors:

- a location adjacent to the mine site having a shorter pumping distance;

- having a smaller upstream catchment that will require diversion; and

- being out of the Cedar Creek flood plain or other major streams in the site area.

### 3.8.2 Tailings Backfill and Surface Management

Flotation tailings will be thickened at the mill to a solids content averaging 55 to 60 percent. During the majority of mill operation, the tailings will be pumped to the backfill plant (adjacent to the mine portal) for cement addition, when required, and placement to designated areas underground for mine backfill. During the project life, all underground areas, except for those required for post-closure access, will be backfilled.

The density of the backfilled tailings will be optimized to get as much tailings back into the mine as possible. The milled and backfilled tailings will not be as dense as the rock that was mined. Therefore, surface disposal of approximately 990,000 tons of tailings not backfilled is required. The anticipated schedule for tailings discharge as backfill or to surface disposal is summarized in Figure 3.15. This shows that when underground areas are ready for backfill, tailings will be routed to the backfill plant. When no underground areas are ready for backfill, tailings will be routed to the surface facility.

Tailings will be conveyed to either location by pipeline as a thickened slurry. The pipeline alignment is shown in Figure 3.4. It will be laid above ground in a shallow channel or buried beneath access roads. The tailings will be of relatively coarse grind, consisting of primarily fine-grained sand particles. The tailings will be free-draining (Figure 3.16).

### 3.8.3 Facility Design Criteria

The impoundment facility for surface discharge of tailings has been designed for the following criteria:

- to be stable in overtopping, static and seismic slope stability, and erosion during operation, decommissioning, and after reclamation
- to permanently contain the required volume of tailings, with potential ultimate capacity for one to two million tons of tailings. The average density of the tailings used in these calculations was 70 lbs./ft.$^3$ (based on laboratory test results on Bornite project tailings)
- to be amenable to staged construction of the facility, and staged and ongoing reclamation of the facility. This is desirable to minimize the area of visual impact and disturbance, and to minimize the area requiring collection of precipitation runoff
- to dewater the tailings as quickly as possible, and to minimize the volume of tailings fluid stored in the facility

### 3.8.4 Tailings Impoundment, Construction and Operations

The criteria listed above are achieved with the facility shown in Figure 3.17. The facility will include an impoundment constructed in an upstream manner, such that the tailings embankment crest moves upstream with time during the life of the project. This construction method makes the best use of available space and will allow reclamation of the facility's outside slopes during operation.

The facility has been designed to drain fluids from the tailings as quickly as possible. Although dewatering of tailings in the mill was considered for the project, the relatively coarse grind of the tailings allows fairly rapid drainage at the facility.

Fluids drained from the tailings will be collected by a series of drains beneath the tailings and conveyed to the process water pond (Figure 3.4). Beneath these drains, the facility will be underlain by an amended soil layer to meet Oregon DEQ requirements for non-acid generating tailings. This is shown in cross-section in Figure 3.17.

The tailings will be buttressed on the downhill sides by a starter embankment, consisting with development rock and site materials. Above the starter embankment, the perimeter of the facility will be formed by a zone of the coarse fraction of the tailings (Figure 3.15 and Figure 3.17).

Cyclone separation is likely to be used to separate the tailings slurry by particle size at the embankment. The coarse fraction (or cyclone underflow) will be discharged at the embankment. The fine fraction (or cyclone overflow) and majority of tailings fluid will be piped to specific areas within the facility away from the embankment.

Tailings fluids will be drained downward by gravity and decanted along the facility's uphill sides by the underdrains. These drains will convey the fluids by gravity to the process water pond. Tailings fluids will be pumped from the process water pond to the mill for reuse.

The tailings facility will be constructed in stages by working gradient from the process water pond. Reclamation of the facility's completed areas will proceed during operation. This is done to minimize the area of disturbance and area open to precipitation. The construction and operation schedule, based on the planned mine development and backfill schedule, is summarized in Figure 3.18. The fluid management and water balance aspects of facility operation are summarized in Figure 3.19. This schedule allows reclamation to take place when tailings are dicharged as mine backfill.

## 3.9 DRAINAGE AND SEDIMENT CONTROL

As shown in Figure 3.8, the project has three separate water systems:

- Mine water;
- Process water; and
- Site runoff water.

The project has been designed so that the water handled in each system is kept as low as possible.

**Mine water** will consist of groundwater collected in the mine water control system and drainage from tailings backfill. The water will be used as makeup water in the mill. The amount of water pumped will be controlled by avoidance of known potential water conduits and grouting in and around underground openings, as required. Excess mine water will be treated for sediments, residual petroleum products, and inorganic compounds to meet applicable discharge requirements and stream standards. Settlement will be accomplished with the mine water pond. An NPDES discharge permit will be required for any treated mine water system discharge to the environment.

**Process water** collected in the process water pond will be pumped to the mill for reuse. Small amounts of excess process water are expected during winter months that coincide with tailings discharge. This excess process water will be discharged to the mine water system for treatment and final discharge to Cedar Creek or by land application in accordance with DEQ requirements.

**Site runoff** water from precipitation and snowmelt on to the project site area surfaces will be collected in the sediment pond for settlement of suspended solids. Ore stockpile and fuel storage areas will be bermed and lined as separate systems from site runoff water.

## 3.10 DIVERSION OF TRIBUTARTY

Because it currently flows over the underground mine area, an unnamed tributary of Cedar Creek will be diverted . The stream will be directed into a channel sized to convey peak runoff from a 100-year storm (197 cfs). The diversion channel will be rock-lined for long-term erosional stability and clay-lined where needed for reduction of infiltration. Two culverts will be required where the access roads cross the channel.

A second diversion channel will divert runoff from the catchment above the mine portal area and convey this flow around the mine portal area. This channel has also been sized to convey peak runoff from the 100-year storm (178 cfs).

Channel alignments are shown in Figure 3.8. These channels will be triangular in cross-section. These diversion channels will be returned to near premining alignment (as described in Section 6.0).

## 3.11 ANCILLARY FACILITIES

### 3.11.1 Electrical Power

Electrical power for the project will be provided by Consumer's Power Tumble Creek Substation near Detroit. An overhead 24.9 kV line will be routed along existing U.S. Forest Service roads approximately 14 miles. The line will terminate in a main substation at the west side of the plant perimeter. (Refer to Figure 3.20).

The metering point for electric service will be at the Tumble Creek substation. The total annual energy usage is estimated to be 15,034,000 kWhr.

A primary transformer will reduce the line voltage to 4160 V. The 4160 V power will be distributed to the underground mine, the ball mill, the crushing and screening plant and the concentrator/mill motor control center. There will be motors with an estimated 600 kW maximum load in the mine, 630 kW maximum load in the crushing plant, 508 kW in the concentrator, 537 kW in the primary ball mill and approximately 100 kW elsewhere in various applications.

**Discussion of Alternatives**

**Utility Service From Tumble Creek Substation.** It is proposed that an overhead powerline be constructed along the existing U.S. Forest Service roadway (F-2223) from Detroit. At the top of the pass, the line will be built along existing F-2207. It is estimated that the actual length of distribution line required is approximately 14 miles.

An alternative line route nearby would use the existing 230 kV transmission line right-of-way. This would require constructimg an overhead line from the Tumble Creek Substation northward to the intersection with the Bonneville Power Administration's 230 kV line and constructing an overhead 25 kV line paralleling the existing 230 kV line westward to a point along the access road. At that point, the line would be constructed along the access road continuing into the mine site. The 230 kV transmission line is located in a timbered area. The clearing utilized for the existing construction is "selective clearing," which primarily addresses structures and electrical clearances to the conductors. This clearing method does not provide any opportunity for constructing a lower voltage line without extensive additional clearing of the existing timber for new poles. The proposed line would be three phase 4/0 ACSR overhead powerline. A typical pole structure for either route is shown in Figure 3.21.

Wetlands identified in the project area cover 2.96 acres. Disturbance of wetland will be less than one acre, since not all of the wetlands identified will be disturbed by the project.

### 1.9.1 Red Alder Riparian Community

The red alder riparian community along Bornite Brook does not have hydric soils, nor hydrophytic vegetation. It has a wetland hydrology only for a portion of the floodplain which is dominated by the riparian community. Only that portion of the riparian community immediately adjacent to the stream meets the criteria for classification as wetlands.

Classification of the red alder community as wetlands or riparian is purely academic, as any designs to recreate the stream must include a floodplain of sufficient width to allow for passage of floodwater. The new riparian community for the relocated stream and floodplain will be similar in structure and composition to the existing riparian community along Bornite Brook.

### 1.9.2 Zone of Springs and Seeps

The red alder riparian community in the zone of springs and seeps is a wetlands because the site has a wetlands hydrology, hydric souls, and hydrophytic vegetation. The mapped wetland is 1.74 acres in size. The actual wetlands, however, is probably smaller, because the boundary drawn around the zone of springs and seeps includes some upland habitats between the wet areas. No disturbances will occur in this area.

### 1.9.3 Vanishing Creek

The small zone of vegetation along the flowing water in a disappearing stream is a wetlands because it has a wetlands hydrology, hydric soils, and hydrophytic vegetation. The aquatic habitat is 0.10 acres while the wetlands are 0.21 acres in size.

### 1.9.4 Bogs

Bogs are wetlands because the meet the vegetation, soil, and hydrology criteria required for wetlands classification. The bogs are 0.01 and 0.03 acres in size.

Pumping and recovery test data from the colluvial wells is consistent with near-surface testing and observations and shows, that the colluvium is of moderate porosity and permeability, with zones within the colluvium that are more permeable than others. The water quality from the colluvial wells is similar to that from Cedar Creek.

From the fluctuations of well water levels with time and water quality data, the colluvial aquifer appears to be closely related to surface water flows in Bornite Brook, Vanishing Creek, and Cedar Creek. Surface water flows appear to be the major source of recharge to the colluvial aquifer.

Due to the configuration of the site, the colluvial aquifer pinches out at the northwest end of the site as the bedrock surface rises and is exposed in the area of the bridge across Cedar Creek. Groundwater in the colluvium must exit the site primarily as surface water flow, due to the low capacity for the bedrock to transmit water. This is confirmed by the presence of large springs at the lower end of the site that are of similar water quality to surface water and colluvial groundwater.

## 1.9 WETLANDS

Wetlands were identified and delineated according to procedures in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (1989), as requested by the Oregon Division of State Lands (DSL). The U.S. Army Corps of Engineers uses the Wetlands Delineation Manual (1987). The Vegetation was quantified by a point-intercept sampling method and the hydrophytic vegetation determined by use of a prevalence index and species dominance techniques. Soils were mapped by a certified soil scientist to an Order I and II level. Plate 1, contained in the back pocket of the application, is a map of the delineated wetlands.

The wetlands boundary with the uplands habitat was delineated based upon the observed presence and dominance of plants with indicator status of obligate, facultative wetland species; soil saturation; estimates of potential surface flooding and soil saturation during the growing season based upon topography, water marks on woody vegetation, water-borne sediment deposits, and drainage patterns. Specifically, the limits of the wetlands were based upon the presence and dominance of such plants, observed soil saturation around stream flows, springs, and seeps, plus the estimate of soil saturation during periods of higher stream flow. Soils were not a good diagnostic feature along Bornite Brook, as they were a gravelly fine sandy loom and had chromas of 3 and 4, which are too high to be classified as hydric.

Initially, one 2500 kVA transformer will be serving the entire load. Under this condition, the maximum voltage drop at full load on the high side of the transformer is 3.1 volts. Starting the largest motor causes a problem with a voltage dip of 14.7 volts, which will be seen by the rest of the plant. This problem can be alleviated by using a separate 750 kVA transformer to serve the largest motor.

**Service From Elkhorn to Mine Site.** Service from Elkhorn would require the reconstruction of 25 miles of existing single phase and small conductor three phase circuits to 3 phase 4/0 ACSR and the construction of approximately 5.2 miles of 25 kV 4/0 AL underground line into the mine site. The underground circuit is required to avoid clearing of old growth timber and pass across the Little North Santiam River. Construction of the Elkhorn source will require far greater delays to vehicular access than would the circuits originating at Tumble Creek.

Even with a separate 750 KVA transformer for the largest motor, the voltage dip seen by other consumers in the Elkhorn area exceeds 15 volts, which is unacceptable.

**New 230-25 kV Step-down Substation.** This option would tap a nearby 230 kV BPA transmission line that is approximately 4 to 5 miles from the site. Usually, utilities are reluctant to tap major transmission lines for distribution purposes unless the load is significant. BPA may be reluctant to tap their 230 kV line. If they did allow the tap, this option would require building a new 230-25 kV substation and building 4.3 miles of 3 phase 4/0 AL 25 kV URD 260 mil EPR jacketed cable and 3 miles of 4/0 ACSR overhead 25 kV line.

The transmission line is at this time not energized.

**On-site Generation.** Several sizes of generators are available. Many different combinations of sizes and capabilities can be assembled to meet power demands of the mine and mill. Several disadvantages are inherent in on-site generation ranging from expense to mechanical reliability to transportation of excessive fuel quantities. The most reasonable generator arrangement would include three 1,800 RPM-1275 kW units, with two active and one as standby. Estimated fuel consumption would be approximately 89 gallons per hour.

### 3.11.2 Access Road

Primary access to the Bornite Project (Figure 2.2) will be the existing roads system from Mehama and Gates via County Roads 960 (North Fork Road) and 967 (Gates Hill Road) respectively past Elkhorn to the Forest Service western boundary and road F-2209. It is approximately 13 miles from Mehama to the Forest boundary. Access on F-2209 continues for approximately one mile where it intersects with F-

2207 and continues past the Bornite property, approximately four miles. Total access from Mehama to the property boundary is approximately 18 miles.

Alternative access to the property can be achieved via French Creek road from Detroit, F-2223, and on F-2207 to the property. This alternative route consists of approximately 14 miles of rugged gravel road.

Traffic routing, load limitations and maintenance would be coordinated with the U.S. Forest Service and Marion County to minimize impacts to the existing road system. Truck traffic required for facilities operations is anticipated to be similar to that encountered for timber hauling.

Trucks will deliver fuel, cement, process reagents and supplies to the mine site at the rate of 3 to 4 deliveries per day. During the construction phase equipment would be delivered on multi-axle low boy trailers. All trucks would be sized appropriately for use on the existing roads and bridges. Delivery of the copper concentrate produced by the Bornite Project will be made in covered, 20-ton trucks, suitable for highway travel at the rate of five trips per day. In addition, some miscellaneous traffic will be incurred for services such as the pick-up of solid waste and sanitary waste.

It is currently envisioned that the majority of mine/mill personnel would be brought to work by van pool from Mehama to minimize the impact of traffic on the road system. Some management personnel would be required to have their vehicles on the property because of the nature of their work.

Plexus would be required to obtain a road use permit from the U.S. Forest Service. As part of the permit, the Company will provide a fee or services to cover the increased maintenance cost of forest roads. Increased use of the County road will be small and will be compensated for by the increased tax base from the mine.

### 3.11.3 Water Supply and Storage

Water supply for the project will be from wells sited subsequent to a detailed hydrological analysis. The well water will be pumped to the water storage tank above the tailings impoundment facility (Figure 3.8), and will be used for drinking water, wash water, and emergency supply, such as fire protection. The well water will be separate from other water used on the project site.

The majority of mill makeup water will be recycled from tailings facility and pumped from the process water pond. Additional mill makeup water will be supplied from the mine or the water well as required. The makeup water will be pumped from the mine water treatment pond. Water balance calculations indicate that these sources of water are likely sufficient for mine operation.

Fresh water required by underground drilling operations will be derived from the main water supply system. A two-inch diameter pipe will be installed in the underground access ramp to distribute water to the required working areas.

### 3.11.4 Ammonium Nitrate/Explosive Storage

Ammonium nitrate will be delivered as bulk prill (i.e. small solid grains). The prill will be stored in an approved 20-ton silo located just off the road leading to the ventilation raise (Figure 3.4). As required for usage, the ammonium nitrate will be mixed with diesel fuel to provide the desired explosive characteristics to be used underground.

Other high explosives, as required by the underground operation, will be stored in bullet proof explosives magazines. These magazines will be located at an appropriate distance from the ammonium nitrate storage silo. All employees responsible for explosives will be trained and certified by government agencies as required.

### 3.11.5 Cement Storage

Cement required for mine backfilling will be stored in a silo near the mine portal or other location above the underground workings to allow for efficient backfill placement. Approximately 30 tons will be stored on site. When backfill operations require more cement, deliveries will be arranged on an as needed basis.

### 3.11.6 Fuel Storage

Diesel fuel will be stored in an above ground vertical steel tank with a capacity of 7,500 gallons. Gasoline will be stored in an above ground horizontal tank with a capacity of 500 gallons. Both fuel tanks and dispensing pumps will be located in an impoundment with an impervious synthetic liner covered with rock as shown in Figure 3.4. The impoundment will be capable of holding 100 percent of the diesel fuel tank plus a 25-year, 24-hour rainfall event. A leak detection system will be provided to detect any leakage of fuels into the secondary containment.

### 3.11.7 Topsoil Stockpiles

Topsoil stockpiles will be in designated areas as shown in Figure 3.4 and Figure 3.7. Topsoil stripped from the mine site area will be stockpiled immediately east of the mine. Topsoil stripped from the tailings facility during initial construction will be stockpiled along the perimeter of the facility. Topsoil stripped during later stages of construction will be stockpiled on top of the tailings facility or used directly for facility reclamation.

### 3.11.8 Sanitary and Solid Waste Disposal

Waste produced on-site will be handled and disposed according to County and State requirements. Trash will be temporarily stored in a receptacle at the mine site and hauled off site to a licensed municipal waste disposal facility. Sewage will be temporarily stored in a holding tank at the mine site and hauled off-site to designated sewage treatment plant or disposed of in a conventional septic system, as appropriate and approved by the State of Oregon and the U.S. Forest Service. Wash water (gray water) will be discharged to tailings facility.

Vegetation stripped during site preparation and construction that cannot be salvaged for lumber or incorporated into mulch or topsoil for reclamation will be disposed of as directed by applicable U.S. Forest Service standards.

### 3.11.9 Potable Water

Wash water and drinking water will be pumped from wells near the mine area. Based on sampling and testing, groundwater from the site meets EPA drinking water standards. Biological treatment of drinking water is not anticipated but will be added if necessary. Primary water storage will be in a tank above the tailings facility. Additional storage of drinking water will be at the mine site.

Due to the temperatures expected at the site, water lines will be buried in shallow trenches to prevent freezing.

### 3.11.10 Maintenance and Warehouse Facilities

The workshop/warehouse will be located next to the mine portal. These facilities will be sized to provide the following:

- service/maintenance bays for 40-ton haul trucks;
- service/maintenance bays for light vehicles;
- warehouse facilities for mine and plant operations;
- workshop facilities for mine and plant operations;
- offices for senior maintenance and warehouse personnel;
- kitchen/lunchroom; and
- toilets, showers/changeroom facilities for mine personnel.

The building will be approximately 25 feet wide and 50 feet long with a 20-foot eave height.

### 3.11.11 Administration Building and Laboratory

An office building will be located just inside the main gate to conduct administrative activities and monitor gate traffic. This building will accommodate all of the operations administrative personnel requirements.

In addition to individual offices, the building will contain a:

- reception area;
- conference/training room;
- kitchen/lunchroom;
- fireproof vault;
- accounting department;
- drafting office; and
- toilets.

The building will be approximately 20 feet wide and 40 feet long with a 15-foot eave height.

The sample preparation, assay, and analytical laboratory will be located adjacent to the administration building. The laboratory facilities will be equipped to perform daily analyses of mine and mill samples used for operations control. The building will be provided with laboratory crushing, screening, separation, and drying equipment. The laboratory will be equipped with fire assay facilities. Additionally, the laboratory will contain an A.A. spectrometer, pH meter, sinks, and sample handling equipment. The building will be approximately 16 feet wide and 24 feet long with a 15-foot eave height.

#### 3.11.12 Security and Fencing

The mine and mill area will be fenced with one gate at the mine entrance from the U.S. Forest Service road. The gate will be manned by security personnel or office staff. A five-foot chain-link fence will be installed around the mine area, diversion channels, the mill area, and all water storage ponds.

#### 3.11.13 Outdoor Lighting

Exterior lighting will be required at several facilities to allow for safe operations after dark. Lighting is expected to be required at the crusher, mill, shop, and the portal area. This lighting will be hooded and directional to avoid unnecessary glare.

#### 3.11.14 Fire Protection and Accident Response

Water for fire protection will be available from several sources. The primary source will be from a designated portion of the potable water storage tank described above. Secondary sources will be from the mine water pond and sediment control pond.

Personnel at the mine will be trained for emergency medical response. Arrangements will be made with the local hospital in Stayton for ambulance response. Contingency plans will be formulated for helicopter evacuation for serious accidents and injuries.

#### 3.11.15 Safety and Training

A designated safety engineer will be employed on-site. Duties will include work place inspections in the mine, concentrator, and surface plant. In addition, duties will include employee training as required by Mine Safety and Health Administration, and organization of a mine rescue team.

## 3.12 SUMMARY OF GEOCHEMICAL TESTING

Several geochemical tests were run on tailings, development rock, and tailings fluids. The objective of the testing was to characterize acid-generating potential, leachability, and other parameters that may prove undesirable or detrimental to the environment.

Samples of tailings were obtained during metallurgical testwork and evaluated in April, 1991. Development rock testing utilized five samples representing various degrees of alteration and mineralization from exploration drill core. Development rock samples were taken from areas where planned underground openings will be constructed. Tailings fluids analysis was done on solution taken from metallurgical testing done in Salt Lake City, Utah. The results of this test on solutions should be considered only as a frame of reference for a worst case due to the poor quality of the water used in the metallurgical testing (Salt Lake City drinking water is much poorer quality than surface or groundwater from the Bornite Project area). Using water from the project site is expected to dramatically improve analytical values in the tailings fluid analysis.

A summary of findings are presented in Tables 3.2 through 3.5.

**TABLE 3.2 Summary of Geochemical Testing.**

ACID GENERATION/ACID NEUTRALIZATION

| Parameter | Tailings | Development Rock | DEQ Criteria |
|---|---|---|---|
| Total sulfur (%) | 0.03 - 0.25 | 0.04 - 0.20 | --- |
| Pyritic sulfur (%) | 0.03 - 0.07 | 0.03 - 0.18 | 0.1[b] |
| Acid Generation Potential (AGP)[a] (tons $CaCO_3$/1000 tons) | 0.9 - 7.8 | 1.3 - 7.2 | --- |
| Acid Neutralizing Potential (ANP) (tons $CaCO_3$/1000 tons) | 22.6 - 28.9 | 18.4 - 50.7 | --- |
| ANP/AGP[a] | 3.7 - 25.1 | 3.2 - 26.1 | >3 |

[a]Values based on total sulfur.
[b]Values based on sulfide sulfur.

**TABLE 3.3 Summary of Geochemical Testing.**

TCLP BATCH LEACH TESTING (EPA Method 1311)[c]

| Parameter | Tailings | Development Rock | DEQ Criteria |
|---|---|---|---|
| Arsenic | <0.03 | <0.02 - 0.03 | 5 |
| Barium | <0.02 | <0.14 - 0.39 | 100 |
| Cadium | <0.02 | <0.02 - 0.05 | 1 |
| Chromium | <0.02 - 1.70 | 0.03 - 0.27 | 5 |
| Copper | <0.02 - 0.05 | <0.0 - 0.28 | 1 |
| Lead | <0.10 | <0.10 | 5 |
| Mercury | 0.0018 - 0.0025 | <0.00002 | 0.2 |
| Selenium | <0.03 | <0.02 - 0.06 | 1 |
| Silver | <0.02 | <0.02 | 5 |
| Zinc | <0.01 - 0.01 | 0.10 - 0.15 | 1 |

[c]All values in mg/1.

**TABLE 3.4 Summary of Geochemical Testing.**

BATCH LEACH TESTING (EPA Method 1312)[d]

| Parameter | Tailings | EPA Drinking Water Standard (DWS) |
|---|---|---|
| Arsenic | <0.05 | 0.05 |
| Barium | 0.42 - 0.51 | 1.0 |
| Cadmium | <0.005 | 0.01 |
| Chromium | <0.01 | 0.05 |
| Copper | 0.01 - 0.05 | 1.0 |
| Lead | <0.05 | 0.05 |
| Mercury | <0.0003 | 0.002 |
| Selenium | <0.1 | 0.01 |
| Silver | <0.01 | --- |
| Zinc | <0.01 - 0.02 | 5.0 |

[d]All Values in mg/1.

## 1.10 GEOLOGY

The Oregon Cascade Range is divided into two major geologic units: Western and High Cascade Provinces. The study area lies entirely within the Western Cascade Province. The western Cascades are composed of 25 to 45-million year old formations of volcanic or pyroclastic origin. The Sardine formation dominates the area's geology. This formation includes flows of basalt and andesite which weathers slowly producing coarse, stony, well-drained soils. Several land forming processes, such as glaciation, erosion by water, and volcanic activity have all interacted to sculpt the existing topography of the study area.

The Bornite breccia pipe is potentially the most economically significant deposit in the western Cascades with a resource containing 147 million pounds of copper. The deposit geometry consists of a mineralized ring of copper sulphides up to 450 feet in diameter and 1,200 feet vertical extent. The core of the cylinder has only weak mineralization and may not be minable in an underground mining project. The cylinder of mineralization tops at the bottom of the Cedar Creek drainage and could only be mined by underground methods. Open pit methods are ruled out by topography and the vertical extent of the mineralization.

Mineralized rocks in the deposit consist of volcanic rocks of the Sardine formation consisting of tuffs, polymictic breccias and flows of andesite intruded by plutons of intermediate composition, including a complex intrusion of microdiorite, diorite, and granodiorite. Chemically the rocks are virtually identical and given the nature of andesite piles, the diorite, granodiorite intrusives may have been coeval sources to andesitic flows, lavas, and breccias deposited on surface.

The Bornite deposit is a copper-bearing tourmaline breccia pipe, one of the three ore mineralization types recognized for the district. The dominant mineralization are the copper sulphides, bornite, and chalcopyrite. Replacement textures indicate that chalcopyrite followed bornite in the depositional sequence. Deeper in the pipe, chalcopyrite is more dominant than bornite.

The mineralized breccia pipe is notably deficient in pyrite within the zone of copper mineralization. Chalcopyrite is the most abundant sulfide mineral present in the pipe comprising approximately 60 percent of the total sulfides, while bornite accounts for about 39 percent of total sulfides present. The remaining one percent of total sulfides consists of molybdenite, sphalerite, galena, tetrahedrite, chalcocite, covellite, and traces of pyrite.

Wetlands identified in the project area cover 2.96 acres. Disturbance of wetland will be less than one acre, since not all of the wetlands identified will be disturbed by the project.

### 1.9.1 Red Alder Riparian Community

The red alder riparian community along Bornite Brook does not have hydric soils, nor hydrophytic vegetation. It has a wetland hydrology only for a portion of the floodplain which is dominated by the riparian community. Only that portion of the riparian community immediately adjacent to the stream meets the criteria for classification as wetlands.

Classification of the red alder community as wetlands or riparian is purely academic, as any designs to recreate the stream must include a floodplain of sufficient width to allow for passage of floodwater. The new riparian community for the relocated stream and floodplain will be similar in structure and composition to the existing riparian community along Bornite Brook.

### 1.9.2 Zone of Springs and Seeps

The red alder riparian community in the zone of springs and seeps is a wetlands because the site has a wetlands hydrology, hydric souls, and hydrophytic vegetation. The mapped wetland is 1.74 acres in size. The actual wetlands, however, is probably smaller, because the boundary drawn around the zone of springs and seeps includes some upland habitats between the wet areas. No disturbances will occur in this area.

### 1.9.3 Vanishing Creek

The small zone of vegetation along the flowing water in a disappearing stream is a wetlands because it has a wetlands hydrology, hydric soils, and hydrophytic vegetation. The aquatic habitat is 0.10 acres while the wetlands are 0.21 acres in size.

### 1.9.4 Bogs

Bogs are wetlands because the meet the vegetation, soil, and hydrology criteria required for wetlands classification. The bogs are 0.01 and 0.03 acres in size.

## TABLE 3.5 Summary of Geochemical Testing.

TAILINGS FLUID ANALYSIS[e]

| Parameter | Tailings Fluid[f] | Primary DWS | Secondary DWS | Oregon DEQ STD. |
|---|---|---|---|---|
| Lab pH | 7.9 | --- | 6.5-8.5 | --- |
| TDS | 940 | --- | 500 | 100 |
| Calcium | 29 | --- | --- | --- |
| Magnesium | 7 | --- | --- | --- |
| Sodium | 257 | --- | --- | --- |
| Potassium | 20 | --- | --- | --- |
| Chloride | 330 | --- | 250 | 25 |
| Sulfate | 132 | --- | 250 | --- |
| Nitrate | 1.29 | 10 | --- | --- |
| Fluoride | 0.7 | N/A | --- | 1.0 |
| Arsenic | <0.004 | 0.05 | --- | 0.01 |
| Barium | 0.03 | 1.0 | --- | 1.0 |
| Cadmium | <0.0001 | 0.01 | --- | 0.003 |
| Chromium | <0.01 | 0.05 | --- | 0.02 |
| Copper | 0.05 | --- | 1.0 | .005 |
| Iron | 0.05 | --- | 0.3 | 0.1 |
| Lead | <0.05 | 0.05 | --- | 0.05 |
| Manganese | 0.23 | --- | 0.05 | 0.05 |
| Mercury | 0.0005 | 0.002 | --- | --- |
| Selenium | 0.012 | 0.01 | --- | --- |
| Zinc | 0.02 | --- | 5.0 | 0.01 |

[e]All values (except pH) in mg/l; metals reported on a dissolved basis; cations and anions reported on a total basis.

[f]Testing using Salt Lake City water.

## SECTION 4.0
## ENVIRONMENTAL CONSEQUENCES AND MITIGATION

### 4.1 INTRODUCTION AND IMPACT ASSESSMENT PROCESS

The following section briefly describes the existing conditions of various resources in the vicinity of the Bornite Project area. Data on resources have been compiled from previous studies such as the Detroit Ranger District of the Willamette National Forest, the U.S. Soil Conservation Service, Marion County, State Historic Preservation Office, U.S. Fish and Wildlife Service, and various universities. With the exception of the information on water resources, no detailed field surveys have been conducted on the property. Soils, biological, and geotechnical surveys will be completed as part of the impact assessment process mandated to the U.S. Forest Service under the requirements of the National Environmental Policy Act (NEPA).

During recent discussion held between various representatives of the Willamette National Forest and Plexus, it was agreed that the development of the Bornite Project could significantly affect the quality of the natural and human environment. An environmental impact statement (EIS) would be required as a prerequisite to issuing an approval of the Plan of Operation and Use Permits. The permitting process will be initiated by the acceptance of the development proposal as contained in this report. The environmental impact assessment process will then go through the following steps:

1. Selection of EIS "third party" contractor.
2. Development of a resource investigation plan and scoping document.
3. Completion of resource studies and draft EIS.
4. Solicit public comments on the draft EIS.
5. Prepare and issue a final EIS in accordance with the rules adopted by the Council on Environmental Quality.
6. Development of a mitigation plan and approval of the operating plan and use permit.

## 4.2 GEOLOGY AND SEISMIC SETTING

### 4.2.1 Existing Conditions

The site is located on the Cascade Range's western slope, which is dominated by Cenozoic volcanic rocks. Eocene to late Miocene pyroclastic rocks and flows dominate the western Cascades, and younger Pliocene to Holocene andesite and basalt dominate the high Cascades east of the site.

Volcanic units in the western Cascades consist of:

- Eocene Colestin Formation andesite, basalt, pyroclastic rocks and sediments;
- Oligocene to early Miocene Little Butte Volcanic Series andesite, basalt, and tuffaceous rocks;
- middle Miocene Columbia River basalt; and
- late Miocene Sardine Formation andesite, basalt, and pyroclastic rocks.

Intrusive rocks occur in the western Cascades, primarily as dike or stocks from Oligocene to Pleistocene age. An earlier intrusive series consists of fine-grained basalt and rhyodacite. A later series consists of medium-grained diorite to quartz monzonite. Mineralization in the region is associated with this later, coarser-grained intrusive series.

Dominant rocks in the project area are from the late Miocene Sardine Formation, and have been informally divided into two members. The upper or younger member consists of andesitic to basaltic flows, andesitic tuffs, and tuff breccias, found in the upper elevations of the project area. The lower member consists of andesitic flows and flow breccias. Intrusive rocks in the project area are consistent with those found in the western Cascades, consisting of older, fine-grained rhyodacite to basalt, and younger, coarser-grained dioritic rocks.

Faulting occurs throughout the Cascade Range, with the dominant trend as northwest. Faulting in the project area is predominantly high-angle, with trends from northwest to northeast and dips typically to the west.

### 4.2.2 Environmental Consequences and Mitigation

The proposed removal of copper ore and development rock from the underground mine would constitute an irretrievable commitment of a geologic resource. The adverse impact, however, is low.

The site is in a region of relatively low seismicity. From seismic zone maps, most of Oregon is in a Zone 1 area of minor seismicity (U.S. Army Corps of Engineers, 1982; ICBO, 1976). Accelerations in rock from seismic activity are expected to be relatively low (Algermissen and others, 1982), and seismic coefficients to be used in seismic stability analyses are relatively low (0.025 g, where g is the gravitational acceleration) (U.S. Army Corps of Engineers, 1982).

The potential for seismic activity in the area will be considered in the design of project facilities that are affected by seismic accelerations. This would include the tailings facility and its associated development rock and cycloned tailings embankments.

## 4.3 TOPOGRAPHY AND SITE CHARACTERISTICS

### 4.3.1 Existing Conditions

The project area is on the western slope of the Cascade Range, where elevations range from near sea level in the Willamette River valley (30 miles west of the site) to isolated peaks over 10,000 feet elevation in the Cascade Range (20 miles east of the site). The project area is characterized by steep-walled valleys with elevations ranging from 1,500 to 4,500 feet. The site is in the Cedar Creek valley, which is one of the tributaries of the Santiam River, a major river system draining the western slope of the Cascades and discharging into the Willamette River.

Cedar Creek valley has been glaciated, as evidenced by the u-shaped valley sections, glacial sours on the valley walls, glacial till on the valley floor, and scarcity of surficial soils on the valley walls upstream from the site, as compared to the v-shaped valley sections downstream from the site.

The project site is on a sloping bench along the side of the Cedar Creek valley. The bench slopes from 10 to 30 percent, which is significantly less steep than the surrounding valley slopes. The bench is roughly 40 to 80 feet above the level of Cedar Creek in the site area. This bench is of glacial origin. It is located in the Cedar Creek valley in a transition zone between glaciated and unglaciated areas. A generalized cross-section through this area is shown in Figure 4.1, based on previous exploration drilling in the mine area.

An unnamed tributary of Cedar Creek flows over the location of the proposed underground mine. This tributary will be diverted around the mine area and will rejoin the original creek bed upstream of its confluence with Cedar Creek. The stream will be relocated back to near its premining location after mine closure.

Tailings that are not backfilled in the underground mine will be placed in the tailings management facility immediately east of the underground mine. The highest part of the reclaimed surface of the tailings management facility will be less than 100 feet higher than the original ground surface. The remainder of the site will be reclaimed at elevations similar to those of the original ground surface.

Mine backfilling will take place in a staged manner, with the eventual complete filling of mined areas with tailings. Part of the backfilled tailings will contain cement for augmentation of strength in key structural areas. As a result of this backfilling method, infiltration into abandoned mine workings or subsidence and caving from the ground surface will not be experienced after mine closure.

### 4.3.2 Environmental Consequences and Mitigation

The topography conditions at the project site will significantly change configuration in only one area as a result of project activities. The reclaimed surface of the tailings management facility will be gently sloping (33 percent or less) and less than 100 feet higher than the original ground surface. Other areas of the project site will be reclaimed and shaped to surfaces similar to those prior to mining activity.

Because of these limited alterations of topography, generally low adverse impacts to the topography are expected.

## 4.4 AIR QUALITY

### 4.4.1 Existing Conditions

The Bornite Project is within the Willamette National Forest. The nearest community is Elkhorn, located approximately 10 miles west of the property. Air quality in the project area is excellent. Although the area has not been monitored, it is expected that annual total suspended particulates (TSP) are less than 15 micrograms per cubic meter with annual concentrations of particulates less than 10 microns in size (PM-10) in the range of 70% of the TSP levels. Local sources of particulates are minimal, but include smoke from slash burning and natural fires, home heating, fugitive dust from logging trucks and other vehicular traffic on gravel roads and pollen from vegetation sources. The bulk of the particulate occur in the summer, low precipitation months. Sources of other criteria pollutants are negligible; the levels of gaseous pollutants are near zero or at normal background levels.

The area is designated as an "attainment area" by the U.S. Environmental Protection Agency (EPA) which implies that the area is within the National Ambient Air Quality Standards for criteria area is designated as Class II under the federal Prevention of Significant Deterioration (PSD) regulations. The nearest Class I area, the Bull-of-the-Woods Wilderness Area, is approximately five miles east of the project site.

### 4.4.2 Environmental Consequences and Mitigation

The major air pollutants associated with the project will be fugitive dust, process-related particulate emissions, and limited gaseous emissions. The fugitive dust will result from vehicular traffic, construction activities, exploration drilling, and ore and development rock dumping. Some process-related particulates will result from crushing, conveying and transferring the ore. The gaseous emissions consisting of nitrogen oxides (NOx), carbon monoxide (CO), sulfur dioxide ($S0_2$) and non-methane hydrocarbons (HC) will be due to fuel combustion exhaust emissions resulting from diesel-fueled equipment and very minor emissions of particulates, CO and NOx from underground blasting.

Because the project is being designed to limit surface disturbance (approximately 32 acres at full development), limited surface haul road distances, the use of underground mining techniques, enclosing the crusher and fine ore stockpile, the estimated impacts of the project-related emissions on the existing air quality levels will be minor.

For the underground mine, the only source of air emissions will be the mine exhaust air from the ventilation raise. Diesel-fueled underground mining equipment will produce nominal tailpipe emissions due to scrubbing required on all vehicles. The cleaned engine emissions will ultimately be vented to the surface. The amount of dust from the underground drilling will be negligible at the surface because it will settle along the underground openings as air is drawn through the mine workings. Intermittantly, negligible quantities of smoke from blasting operations containing $NO_x$ and CO will be vented to the surface.

Measures to be used to control fugitive dust include the natural high level of precipitation versus evaporation that is characteristic of the area; the spraying of water on project roads or the use of EPA approved dust-suppressing surfactants if needed during the short, dry season; restricting the speed of vehicles and the use of van pooling for employee transport; minimal ore stockpiles sizes, maximized use of the limited volumn of development rock for construction purposes; and the prompt revegetation of topsoil stockpiles and progressive reclamation activities to keep disturbances as small as possible. In addition, the crusher, conveyors and drop points will be enclosed in a building with particulate emission controlled through a baghouse. Finally, because of the coarse grind of the ore, the tailings are not anticipated to be a source of particulates emissions.

If the alternative for on-site power generation is implemented $NO_x$, CO, $SO_2$, HC and TSP emissions will result from the diesel-powered generators. However, the air quality permitting process through the state Department of Environment Quality (DEQ) will require the application of Best Available Control Technology (BACT) and/or Lowest Achievable Emissions Rate (LAER) controls. Therefore, fuel combustion emissions will be low.

Overall, the air quality impacts are anticipated to be negligible as a result of the Bornite Project.

## 4.5 NOISE

### 4.5.1 Existing Conditions

Natural sources of noise in the Bornite Project area include wind, the stream, waterfalls and rapids, rain, insects, birds and other wildlife. Experience indicates that noise levels in natural environments, without manmade influences, may range from 20 to 45 decibels (dBa). In addition, manmade noise sources such as those associated with logging and recreation activities must also be added to the natural background levels. This means that noise levels at the project site, which is located adjacent to U.S. Forest Service road F-2207, would expand the baseline noise level range from 20 to 75 dBa. The noisest period would be the summer months when the area is used heavily for recreation activities, especially on weekends.

### 4.5.2 Environmental Consequences and Mitigation

The primary sources of project-related noise will be vehicles, the mine exhaust fan, the crusher and the mill. During construction and operations the noise levels will affect wildlife in the project area to some extent, but the rather low use of the area by wildlife will limit the level of this impact accordingly.

Noise generated from mobile equipment and vehicles is expected to be at the same level as that generated from logging trucks. Because the mining activities will occur underground, very little mine-related noise such as from development drilling and blasting will be noticeable. The crusher and mill will be enclosed and, thus, the noise will be attenuated by the buildings.

The noisiest project component will be the mine exhaust fan, which produces approximately 100 dBa, without mitigation. The exhaust fan noise can be reduced by providing a silencer diffuser or sound absorbing materials. This will reduce the noise levels from the fan by 25 dBa, measured at approximately 20 feet from the source.

Noise levels are also attenuated by distance; a doubling of distance results in an approximate six dBa decrease in noise levels. Topography, vegetation and meteorological conditions (wind, temperature, humidity and cloud cover) also effect sound. Thus, the noise levels produced at the mine site will be masked with existing background levels. At the Shady Cove Campground, located approximately four miles west of the mine, mine-related noise will not not be noticeable. Noise in other drainages is not anticipated because of the shielding affects of topography and vegetation and noise from other sources.

The overall effects of project noise on wildlife and humans are anticipated to be low because of the underground mining, enclosure of crushing and milling operations and source-specific mitigation measures.

## 4.6 SURFACE AND GROUNDWATER RESOURCES

### 4.6.1 Existing Conditions

The project is located on the western slope of the Cascade Range in central Oregon. Key aspects of site hydrology are summarized in the following subsections: climate, surface water, and ground water.

#### Climate

The site is characterized as a mild, wet climate. Mean average temperatures in the site area are mild, ranging from approximately 35 to 65 degrees Fahrenheit. Annual precipitation in the site area exceeds evaporation by a factor of roughly 3 to 1.

Annual precipitation in the site area averages approximately 87 inches, with almost 70 percent of precipitation occurring during the winter months of November through March. Annual pan evaporation averages approximately 33 inches, with more than 95 percent of evaporation occurring from April through October. Lake evaporation

### 1.10.1 Stratigraphy

The volcanic stratigraphy in the North Santiam District is characterized by its complexity in both the horizontal and vertical dimensions. Two stratigraphic sequences have been recognized in the vicinity of the Bornite breccia pipe - a lower sequence has been assigned to the Sardine formations and occurs from the bottom of stream valley to one elevation of approximately 3,950 feet. The upper sequence overlies the lower sequence across an erosional unconformity. This sequence is at least 1,300 feet thick and underlies the ridge crests of the area. The upper sequence includes the Elk Lake formation and the Hugh Creek ignimbrite. This sequence was deposited as a moderate relief structure eroded into the Sardine formation.

The Sardine formation includes andesite flows, andesite lapilli and lithic tuffs, sparse sediments, and intrusions. All lithologies have been masked by superimposed hydrothermal alteration which has obscured primary igneous textures.

In the eastern portion of the North Santiam District, the Sardine formation stratigraphy has been divided into Unit A and Unit B, distinguished from each other by the relative proportions of fragmental rocks and flows. Unit A consists of andesitic tuffs and tuff breccias with individual cooling units ranging from 35 to 154 feet thick, and Unit B consists of porphyritic andesite flows interbedded with lapilli tuffs. Along Cedar Creek, Unit B is approximately 1,800 feet thick.

### 1.10.2 Mineral Deposits

The Bornite breccia pipe is roughly cylindrical in shape and extends downward from surface from over 1,200 feet, where brecciation gradually decreases into zones containing stockwork quartz veining. The pipe, which has a maximum diameter of 400 to 450 feet, narrows toward the surface. Contacts with the country rock are sharp and locally characterized by sheeted zones. The ore body was formed when a vapor bubble generated by magma cooled and generated cracking of surrounding host rock. Following a pressure drop in the void cavity, caving occurred until the void was filled. Mineralizing fluids then percolated through the formation and deposited the copper sulfide mineralization. Figure 5 is an illustration of Breccia pipe formation.

The degree of hydrothermal alteration within the breccia pipe varies. Breccia fragments within the pipe have typically been replaced by a combination of quartz, sericite, chlorite, and carbonates. Local disseminated tourmaline and minor disseminated chalcopyrite are present.

## 1.10 GEOLOGY

The Oregon Cascade Range is divided into two major geologic units: Western and High Cascade Provinces. The study area lies entirely within the Western Cascade Province. The western Cascades are composed of 25 to 45-million year old formations of volcanic or pyroclastic origin. The Sardine formation dominates the area's geology. This formation includes flows of basalt and andesite which weathers slowly producing coarse, stony, well-drained soils. Several land forming processes, such as glaciation, erosion by water, and volcanic activity have all interacted to sculpt the existing topography of the study area.

The Bornite breccia pipe is potentially the most economically significant deposit in the western Cascades with a resource containing 147 million pounds of copper. The deposit geometry consists of a mineralized ring of copper sulphides up to 450 feet in diameter and 1,200 feet vertical extent. The core of the cylinder has only weak mineralization and may not be minable in an underground mining project. The cylinder of mineralization tops at the bottom of the Cedar Creek drainage and could only be mined by underground methods. Open pit methods are ruled out by topography and the vertical extent of the mineralization.

Mineralized rocks in the deposit consist of volcanic rocks of the Sardine formation consisting of tuffs, polymictic breccias and flows of andesite intruded by plutons of intermediate composition, including a complex intrusion of microdiorite, diorite, and granodiorite. Chemically the rocks are virtually identical and given the nature of andesite piles, the diorite, granodiorite intrusives may have been coeval sources to andesitic flows, lavas, and breccias deposited on surface.

The Bornite deposit is a copper-bearing tourmaline breccia pipe, one of the three ore mineralization types recognized for the district. The dominant mineralization are the copper sulphides, bornite, and chalcopyrite. Replacement textures indicate that chalcopyrite followed bornite in the depositional sequence. Deeper in the pipe, chalcopyrite is more dominant than bornite.

The mineralized breccia pipe is notably deficient in pyrite within the zone of copper mineralization. Chalcopyrite is the most abundant sulfide mineral present in the pipe comprising approximately 60 percent of the total sulfides, while bornite accounts for about 39 percent of total sulfides present. The remaining one percent of total sulfides consists of molybdenite, sphalerite, galena, tetrahedrite, chalcocite, covellite, and traces of pyrite.

(representing evaporation from ponds on site) is estimated to be 70 percent of measured pan evaporation (TCIWR, 1973; Linsley, Kohler, and Paulhus, 1975).

Precipitation and evaporation data used in site evaluation was from records collected at Detroit Dam, the closest weather recording station in location and elevation to the site. Average monthly data is summarized below (from NOAA, 1990), with values reported in inches.

**TABLE 4.1 Average Monthly Precipitation Data.**

| Month | Precipitation | Pan Evaporation | Lake Evaporation |
|---|---|---|---|
| January | 12.45 | 0.01 | 0.00 |
| February | 10.15 | 0.11 | 0.08 |
| March | 9.85 | 0.97 | 0.68 |
| April | 6.45 | 1.83 | 1.28 |
| May | 4.95 | 4.26 | 2.98 |
| June | 3.25 | 5.93 | 4.15 |
| July | 0.10 | 7.74 | 5.42 |
| August | 1.55 | 6.64 | 4.65 |
| September | 3.65 | 4.13 | 2.89 |
| October | 6.65 | 1.49 | 1.04 |
| November | 13.25 | 0.28 | 0.20 |
| December | 14.05 | 0.03 | 0.02 |
| Totals | 87.30 | 33.42 | 23.39 |

From a statistical evaluation of the Detroit Dam data, the 100-year recurrence interval wet year consists of 120.3 inches of annual precipitation and 18.0 inches of annual pan evaporation, using techniques outlined in Schwab and others (1981).

The 100-year recurrence interval dry year consists of 45.0 inches of annual precipitation and 45.8 inches of annual pan evaporation, using techniques outlined in Schulz (1980). This data indicates that precipitation exceeds lake evaporation (at 70 percent of pan evaporation) even in 100-year recurrence interval dry conditions.

Precipitation-frequency data for a specific storm in the site area is summarized below (from NOAA, 1972).

**TABLE 4.2 Precipitation Frequency Data.**

| Recurrence Interval (years) | Duration (hours) | Precipitation (inches) |
|---|---|---|
| 10 | 24 | 4.8 |
| 25 | 24 | 5.0 |
| 100 | 24 | 6.5 |

The site receives snow during the winter months and generally accumulates over the winter months until spring snowmelt. Data collected from stations in the western Cascades at similar elevations to the site are summarized below.

**TABLE 4.3 Water Content Of Snow.**

| Recurrence Interval (years) | Equivalent Inches of Water |
|---|---|
| 1 | 0.3 |
| 10 | 10.3 |
| 20 | 15.0 |
| 100 | 25.6 |

Calculations indicate that the maximum rate of snowmelt would be in late spring, with a maximum rate of approximately 5.5 inches per 24 hours (from calculations outlined in Schulz, 1980; Novotny and Chesters, 1981). This would produce runoff similar to that between the 25- and 100-year, 24-hour precipitation events.

**Surface Water**

The project site in within the Santiam River basin, one of the major watersheds on the western slope of the Cascade Range that drains from east to west and discharges into the Willamette River. The project site is in the Cedar Creek valley, which discharges into the westward-flowing Little North Santiam River. Cedar Creek initially flows from south to north, then turns downstream from the site to the west before discharging into the Little North Santiam River. No gauging stations are present on Cedar Creek or the Little North Santiam River.

The catchment area of Cedar Creek above the project site is approximately 2,600 acres (four square miles). Flow rates in Cedar Creek immediately downstream of the site in Spring 1991 ranged from 40 to 120 cubic feet per second. Flow rates from the 100-year storm at this location were calculated to be 3,000 cubic feet per second.

The Santiam River basin is designated for domestic water supply and recreation. Stream water quality standards established by the Oregon Department of Environmental Quality (DEQ), are listed below (DEQ, 1973). For parameters sensitive for aquatic life, these standards are more stringent than EPA drinking water standards.

Previous water quality sampling in the area has been limited to work for the U.S Forest Service related to timber harvest. Water quality sampling in the site area was conducted in March 1991 (WWL, 1991). Samples collected on Cedar Creek and the unnamed tributary to Cedar Creek met the DEQ water quality standards listed above. Cyanide and phenols were not analyzed.

**Groundwater**

Previous groundwater sampling and analysis in the site area is limited. Groundwater levels were measured in exploration holes at the Bornite site and indicate that groundwater quality is relatively close to the surface water.

One of these exploration holes that was making water (CC-18) was sampled in March 1991 (WWL, 1991). Water quality from this sample was analyzed and met EPA drinking water standards.

TABLE 4.4 Water Quality Standards (Source DEQ, 1973).

| Parameter | DEQ WQS | EPA DWS |
|---|---|---|
| Arsenic | 0.01 | 0.05 |
| Barium | 1.0 | 1.0 |
| Boron | 0.5 | --- |
| Cadmium | 0.003 | 0.010 |
| Chromium | 0.02 | 0.05 |
| Copper | 0.005 | 1 |
| Iron | 0.1 | 0.3 |
| Lead | 0.05 | 0.05 |
| Manganese | 0.05 | 0.05 |
| Zinc | 0.01 | 5 |
| Total Dis. Solids | 100 | 500 |
| Chloride | 25 | 250 |
| Cyanide | 0.005 | 0.2* |
| Fluoride | 1.0 | 1.4-2.4 |
| Phenols | 0.001 | --- |

*State DWS

To pump groundwater inflow from the underground mine, a mine water control system will be used. The volcanic rocks in the area are of low primary permeability and water production in rock is anticipated to come from fracture systems. Although the breccia pipe has experienced considerable fracturing, it has been recemented with calcite, silica, and other minerals.

As previously described, soils of fluvioglacial origin form a topographic bench south and west of the mine site. These soils appear to be well graded and of moderate to low permeability and extend to more than 110 feet deep south of the mine. These soils are shown in cross-section in Figure 4.2.

The only identified structure in the area that may conduct water is a steeply dipping fault system on the southwest side of the mine site. This system appears to contain crushed and broken rock, and is approximately 35 feet wide (based on exploration drilling). This system is beneath the fluvioglacial soils and tens of feet from the proposed underground workings.

Based on the geology and structure of the mine area, the average water pumping rate from the mine is expected to be 300 gpm. Brief periods of mine development may require pumping rates of up to 600 gpm. This water pumping estimate is based on experience with other mines in fractured rock systems similar to the Bornite area, and is not based on specific ground water exploration work of field testing.

Groundwater produced from the mine is expected to have water quality similar to existing groundwater, with potential impact from partial oxidation of mineralized areas. This expected mine water quality is likely to be similar to existing groundwater quality from drill hole CC-18. This water quality analyses is compared with Oregon DEQ Stream Standards in Table 4.5.

**TABLE 4.5 Groundwater Quality at the Bornite Project Site.**

| Parameter (mg/l) | Drill Hole | DEQ WQS |
|---|---|---|
| TDS | 120 | 100 |
| Chloride | <3 | 25 |
| Fluoride | <0.5 | 1.0 |
| Arsenic | <0.005 | 0.01 |
| Barium | <0.05 | 1.0 |
| Cadmium | <0.0001 | 0.003 |
| Chromium | <0.005 | 0.02 |
| Copper | <0.005 | 0.005 |
| Iron | 0.03 | 0.1 |
| Lead | <0.005 | 0.05 |
| Manganese | 0.034 | 0.05 |
| Zinc | <0.005 | 0.01 |

## 4.6.2 Environmental Consequences & Mitigation

### Surface Water

Mine facilities have been designed to minimize disturbance to surface water in the site area. Runoff from upstream, undisturbed areas around the mine site will be diverted. Runoff above the mine site will be diverted . Runoff within mine facilities will also be collected and reused or treated to appropriate standards and discharged.

Mine facilities will not affect the flow of Cedar Creek because the facilities will be located on the bench above the creek. Mining will require the diversion of the tributary to Cedar Creek around the underground mine area. This tributary will be returned as closely as possible to its original alignment and pre-mining condition. The tailings impoundment facility will require diversion of upstream runoff, which will remain after reclamation.

Operation of the mine is expected to have a low adverse impact on surface water flow and quality. Runoff from undisturbed areas will be diverted around the mine facilities. Runoff and process water within disturbed areas will be reused as much as possible. Excess water will be treated prior to discharge.

After reclamation, the site is expected to have a low adverse to no identifiable impact on surface water flow and quality. This is due to the reclamation and revegetation of all disturbed areas, and the inert geochemical characteristics of tailings and development rock that will be impounded on site.

### Groundwater

Control of water inflow to the underground mine will be required as part of mine water control. This will involve pumping water collected in the underground workings and grouting of specific, permeable structures to reduce the rate of inflow into the mine. Underground workings are planned to avoid known structures that may serve as water courses. Where the pumped water cannot be used for makeup water in the mill due to excessive quantities, it will be treated to applicable standards and discharged. After mine closure, the water pumping operation will cease and water levels will be allowed to return to pre-mining levels. Mine water control operations are expected to have a low adverse impact on groundwater flow and quality.

Mill tailings will be placed in the mine as backfill and on the surface in the tailings facility. Geochemical testing indicates that the tailings are inert and do not generate acid or leach metals. Discharge of tailings into the mine as backfill is expected to have a low adverse effect on groundwater flow and quality due to the inert geochemical characteristics of the tailings. Discharge of tailings to the tailings management facility is expected to have a low adverse effect on groundwater flow and quality due to the inert geochemical characteristics of the tailings and the drainage of tailings to be achieved during operation.

## 4.7 CULTURAL RESOURCES

### 4.7.1 Existing Conditions

A Class I file and literature search conducted with the Detroit Ranger District, Willamette National Forest, Mill City, and the Oregon State Historic Preservation Office, Salem, yielded ten cultural resource inventory reports detailing archeological and historical sites and isolated finds within and near the Bornite Project area. The inventories date between 1980 and 1989. Seven of the 10 cultural resource inventories occur partially or wholly within T8S, R5E, Section 31. Of these seven inventories, two yielded cultural resources consisting of archeological sites and a chipped stone isolated find.

Archeological sites that have been found in other parts of the Willamette National Forest, include toolstone quarries, habitation sites, seasonal camps, plant food gathering areas, rock shelters and caves, rock cairns, aboriginal trails, petroglyphs and pictographs, basket trees, and religious sites. In addition, numerous historic sites are known to exist within the Forest. However, there are no historic remains currently known for the proposed Bornite Project area.

One of these seven inventories mentioned previously consisted of a survey by Felicia Rounds Beardsley and Elaine Larson (Larson 1989) on seven exploration drilling sites and their access roads for the Bornite Project (Beardsley 1990). According to Larson (1989:2), between 23 and 24 acres were inspected during the inventory. No archeological or historical resources were encountered during the inventory (Larson 1989:5).

Although the inventory failed to yield any archeological and/or historical resources, the general area for the Bornite Project is considered a "high probability area." Larson (1989:2-3) wrote:

> All areas covered under the survey fall into high-probability ground. For the purposes of the survey, high-probability ground is defined as areas that contain at least one natural or cultural feature generally associated with cultural depositions. This includes ridge tops, saddles, springs, live or intermittent stream drainage, stream

terraces, stream confluences, meadows and their forested margins, large rock outcrops, and slopes of less than 20 percent.

Larson (1989:5) recommended that "Reentry surveys must be scheduled for the area." She further stated "Only those areas indicated on the project map have been included in the current survey. Expansion of the project area will require additional cultural resource work prior to initiation."

Likewise, Beardsley (1990) wrote:

> Only those areas specifically described in the minerals exploration plan (seven proposed drilling sites and their access roads) were included in the present inventory. Any expansion of the mining project outside of these drilling sites will require additional cultural resource work prior to initiation. Reentry surveys must be scheduled for the project area.

### 4.7.2 Environmental Consequences and Mitigation

The Bornite Project area has the potential to both uncover buried archeological and/or historical remains during ground-disturbing activity (see Beardsley 1990), and to cause adverse impact to those same remains through alteration of the remains and their immediate setting. An additional inventory should be conducted for the proposed project area. If the additional inventory fails to detect surface artifacts, Willamette National Forest cultural resource personnel may recommend that some limited subsurface testing take place to inspect for buried cultural material, and/or the proposed copper mine be monitored during ground-disturbing activities.

If additional inventory, testing, or monitoring were to yield cultural material, it would have to be evaluated for eligibility to the National Register of Historic Places (NRHP). If the find or finds were evaluated to not be eligible to the NRHP, then no further work would be required. If the find or finds were found to be eligible to the NRHP, then a Data Recovery Plan will need to be prepared and approved by Willamette National Forest, the Oregon SHPO, and the Advisory Council on Historic Preservation (ACHP).

It is unlikely that cultural remains will be discovered with additional inventory. This conclusion is based on the results of the Larson (1989) inventory and the on-site visit conducted on April 23, 1991, by Michael S. Burney, an independent archeologist, where no cultural remains were observed during a cursory field examination.

## 4.8 SOIL RESOURCES

### 4.8.1 Existing Conditions

Descriptions of the soil resources of the project sites are based upon data from the Soil Resources Inventory of the Willamette National Forest by Legard & Meyer (1973) and on data from the U.S. Soil Conservation Service (SCS) survey for Marion County, Oregon.

The soils of Willamette National Forest were mapped according to areas of similar soil, parent material, landform, and vegetation information into units called landtypes. The project site is characterized by landtype 16, which consists primarily of landtype 16 but has minor amounts of landtypes 13, 15, 17, and 66. Landtype 16 typically occurs on moderate to steep midslopes, toe slopes, and valley locations that are smooth to somewhat dissected. Slopes range from 20 to 70 percent. The landscape is well-drained, and permeability is rapid in the surface soils and rapid to moderate in the subsoils.

Landtype 16 has deep to very deep soils derived from colluvium, glacial till, and alluvium. Surface soils are usually thin, gravelly loam and sand loams with a pH of about 6.6. Subsoils are usually thick, gravelly, cobbly loams that range from sandy loams to silt loams. Bedrock materials are variable and consist of andesites, basalts, tuffs, and breccias. Depth to bedrock varies from six to greater than 12 feet. Table 4.6 lists the characteristics of the litter, surface, and subsoil horizons.

The SCS has not mapped the project site. However, a review of data in the Marion County, Oregon, area soil survey and recent field observations suggest that the project site could have soils of the McCulley and/or Kinney-Horeb associations.

The McCulley Association is characterized by well-drained clay loam over clay on two percent to 70 percent slopes. The soils have formed in till and colluvium and occur at elevations of 800 feet to 2,000 feet. The annual precipitation is 55 to 75 inches, and the length of the frost-free season is 165 days to 190 days.

The McCulley soils are well-drained and have a surface layer of dark, reddish-brown clay loam with a subsoil of dark, reddish-brown clay. A substratum of weathered, basic igneous agglomerate is at some depth between 40 inches and 12 feet.

The Kinney-Horeb Association is characterized by well-drained and moderately well-drained dominantly cobbly loams and loams over cobbly clay loam or cobbly loam on zero percent to 70 percent slopes. The soils are gently sloping to very steep and have formed in till and colluvium. Elevations range from 1,000 feet to

3,500 feet. The annual precipitation is 60 to 90 inches, and the length of the frost-free season is 120 days to 165 days.

The Kinney soils are well-drained and have a surface layer of very dark brown, cobbly loam with a subsoil of dark, yellowish-brown cobbly clay loam. The upper part of their substratum is dark yellowish-brown cobbly loam, and the lower part is variegated olive-brown to dark-red, weathered, basic igneous agglomerate.

The Horeb soils are moderately well-drained and well-drained. They have a surface layer of very dark brown loam, a subsoil of dark, yellowish-brown gravelly loam, and a substratum of mottled, dark, grayish-brown cobbly loam.

### 4.8.2 Environmental Consequences and Mitigation

Approximately 32 acres of Landtype 16 will be disturbed during the eight-year life of the project. Prior to disturbance, an Order I soil survey will be conducted to determine the appropriate depth for topsoil removal. Based upon existing data, 27 to 44 inches of topsoil is available for salvage. However, only 12 to 18 inches of the best topsoil will be salvaged and used in reclamation operations.

Numerous landtypes and soil associations occur along the access road and electric transmission line corridors. Impacts to soil resources from these activities will be minimal, as no soil disturbances are planned for the access road. Soil disturbances for the transmission line include holes for support structures adjacent to an existing road disturbance.

Copper sulfide minerals (bornite and chalcopyrite) occur in the brecciated margins of the pipe and decrease in grade toward the center. The highest copper grades occur in the margin or shell of the breccia pipe. The degree of brecciation within the pipe varies. Copper grade varies within three zones of the breccia pipe, a high grade shell, sheeted vein, and the interior pipe. The high grade shell would have been the preferred conduit for mineralizing fluids and sites for ore deposition. The sheeted veins occur as veins within the margin of the breccia pipe where permeated with mineralizing fluid. The interior pipe contains some higher grade zones (>1.5% Cu), but generally contain less than 0.5% Cu. Areas of higher and lower permeability may have caused pooling of the mineralizing fluids forming higher and lower grades of copper mineralization. Figure 6 is a cross section of the orebody with copper bearing zones identified.

Gold and silver mineralization occur as small particles and are associated with higher grade copper zones. This limits the gold and silver mineralization to the outer margins of the breccia pipe.

### 1.10.3 Area Seismic Setting

The seismicity of the Bornite site is ranked as low to moderate. A review of historical seismicity in a 100-mile radius from the project and seismic sources and capable faulting was conducted for the tailings impoundment design. A seismic study was done by the U.S. Army Corps of Engineers for Detroit and Big Cliff Lake dams located south of the project site. The Army Corps recommended using 0.22g as the maximum earthquake acceleration and 0.11g as the operating basis earthquake acceleration (Harper, Stone, 1992). These accelerations are based on conservative (higher acceleration rates) assumptions on seismicity east of the site. Lower accelerations are noted in more current Algermissen maps, so the more conservative acceleration of 0.22g is used to design the tailings impoundment.

### 1.10.4 Geotechnical Analysis an Identification of Hazards

Backhoe trench locations were selected in the study area to evaluate foundation conditions and borrow material quality and quantity. Trenches were located to include tailings disposal facility embankment areas, diversion channel areas, and mine facility areas. In order to minimize site disturbance during exploration, trench locations were selected along existing Forest Service roads or exploration hole access roads.

Near-surface soils are generally uniform and relatively dense, with a significant portion of material larger than six-inch size. The percentage of fines from grain-size distribution testing of the gravel and smaller fraction varied from roughly 10 to 35 percent. From drilling of monitoring wells (WWL, 1992), these materials extend to over

### 1.10.1 Stratigraphy

The volcanic stratigraphy in the North Santiam District is characterized by its complexity in both the horizontal and vertical dimensions. Two stratigraphic sequences have been recognized in the vicinity of the Bornite breccia pipe - a lower sequence has been assigned to the Sardine formations and occurs from the bottom of stream valley to one elevation of approximately 3,950 feet. The upper sequence overlies the lower sequence across an erosional unconformity. This sequence is at least 1,300 feet thick and underlies the ridge crests of the area. The upper sequence includes the Elk Lake formation and the Hugh Creek ignimbrite. This sequence was deposited as a moderate relief structure eroded into the Sardine formation.

The Sardine formation includes andesite flows, andesite lapilli and lithic tuffs, sparse sediments, and intrusions. All lithologies have been masked by superimposed hydrothermal alteration which has obscured primary igneous textures.

In the eastern portion of the North Santiam District, the Sardine formation stratigraphy has been divided into Unit A and Unit B, distinguished from each other by the relative proportions of fragmental rocks and flows. Unit A consists of andesitic tuffs and tuff breccias with individual cooling units ranging from 35 to 154 feet thick, and Unit B consists of porphyritic andesite flows interbedded with lapilli tuffs. Along Cedar Creek, Unit B is approximately 1,800 feet thick.

### 1.10.2 Mineral Deposits

The Bornite breccia pipe is roughly cylindrical in shape and extends downward from surface from over 1,200 feet, where brecciation gradually decreases into zones containing stockwork quartz veining. The pipe, which has a maximum diameter of 400 to 450 feet, narrows toward the surface. Contacts with the country rock are sharp and locally characterized by sheeted zones. The ore body was formed when a vapor bubble generated by magma cooled and generated cracking of surrounding host rock. Following a pressure drop in the void cavity, caving occurred until the void was filled. Mineralizing fluids then percolated through the formation and deposited the copper sulfide mineralization. Figure 5 is an illustration of Breccia pipe formation.

The degree of hydrothermal alteration within the breccia pipe varies. Breccia fragments within the pipe have typically been replaced by a combination of quartz, sericite, chlorite, and carbonates. Local disseminated tourmaline and minor disseminated chalcopyrite are present.

**TABLE 4.6 Soil Profile Characteristics.**
**Landtype 16**

| Horizon | Thickness | Characteristics |
|---|---|---|
| Litter | 0" to 2-3" | Needles, leaves, twigs, and decomposing organic matter. |
| Surface | 27" to 44" | Very dark, grayish brown to dark brown, shotty loams and gravelly loams; weak, fine, granular, and subangular blocky structure; 30 percent to 60 percent, rounded and subangular gravels, cobbles, and stones by volume; pH ranges from 6.0 to 6.5. |
| Subsoil | 69" to 76" | Dark brown to dark, yellowish brown, gravelly cobbly loams ranging to gravelly sandy loams and gravelly stony loams; 40 percent to 75 percent rounded to angular gravels, cobbles, and stones by volume; pH ranges from 6.0 to 6.5. |

## 4.9 VEGETATION RESOURCES

### 4.9.1 Existing Conditions

During the 1950's through the 1970's, the 58-acre project permit area and a large surrounding area was timbered and subsequently planted with Douglas fir (Pseudotsuga menziesii). Today, a dense stand of Douglas fir up to 30 feet tall and with diameter-at-breast-height (dbh) up to eight inches characterize the site. Numerous other trees have invaded the Douglas fir stand during the last 30 years. Western hemlock (Tsuga heterophylla), somewhat less dense than Douglas fir, are up to 30 feet tall and have dbh up to 12 inches. Western red cedar (Thuja plicata) are infrequently present as saplings up to 10 feet tall. Red alder (Alnus rubra) and Oregon ash (Fraxinus latifolia) are also sparsely represented amid the conifers. Almost all of the tree regeneration is western hemlock.

The density of this even-aged seral forest stand precludes development of understory forest vegetation. Understory shrub and herbaceous cover are both sparse. The infrequently occurring shrubs include red huckleberry (Vaccinium parviflorum), bitter cherry (Prunus emarginata), currant (Ribes spp.), and bunch cherry (Cornus canadensis). Sword fern (Polystichum munitum) is present. The only forb discernable during the later winter site visit was a violet (Viola spp.). A few other forbs are present, as is moss. The litter cover is dense.

Red alder forms a separate forest stand along the unnamed tributary to Cedar Creek. The width of the red alder stand along this small stream is variable, ranging from a few feet up to 30 feet. This linear stand broadens to include a portion of the steep, south-facing slope. The mature alders are dense, up to 30 feet tall, and have dbhs up to eight inches. The understory is dominated by a dense growth of perennial forbs. The forbs could not be identified because of the absence of vegetative growth at the time of the late winter visit.

A small seral shrub stand dominated by vine maple (Acer circinatum) occurs on the steep south-facing slope above the unnamed tributary. Pacific yew (Taxus brevifolia) and dwarf Oregon grape (Berberis nervosa) are associated with the vine maple.

The Douglas fir and red alder stands of the project site represent seral stages following timbering. The composition and density of these seral forests are related to the type of disturbance, available seed source, and environmental conditions. This dense even-aged stand of Douglas fir and the invading hemlocks have eliminated most of the understory vegetation characteristic to the earlier weed and shrub successional seral stages. Red alder's dominance around the unnamed stream and the south-facing slope is probably related to a greater availability of moisture.

**Climax Forest Association**

The project site is in the western hemlock zone as described by Franklin and Dyrness (1973) and illustrated by the Land and Resource Management Plan, Willamette National Forest (1990). An exact determination of the potential Climax Forest Association in this western hemlock zone will be made on surrounding undisturbed, older-aged stands during the coming growing season. Preliminary review of data for Cedar Creek timber sales indicate that the project site could be either western hemlock or perhaps a Pacific silver fir series, occurring in an area of cold air drainage.

Most lower elevation forests of this region fall into the western hemlock series. In the Cascades, the western hemlock series extends from British Columbia south to the divide between the North and South Umpqua Rivers (Franklin and Dyrness

1973). Important species include: Douglas fir, western hemlock, western red cedar, big leaf maple (Acer macrophyllum), dwarf Oregon grape, salal (Gaulteria shallon), rhododendron (Rhododendron nacrophyllum), swordfern, vanilla leaf (Achylis triphylla), oxalis (Oxalis oregana), twin flower (Linnaea borealis), and redwoods violet (Viola spp.) (Willamette National Forest 1990).

Climatic conditions of the western hemlock zone, as described in the Willamette National Forest Land Resource Management Plan, reflect a strong maritime influence, with mild, wet winters and relatively dry, sunny summers. Temperatures range from slightly below freezing in winter to 90° F to 100° F in summer. Precipitation amounts vary from about 60 inches to more than 100 inches per year, mostly falling as rain or snow in the winter. Winter snowpack is not usually deep nor long lasting.

### Threatened, Endangered, or Sensitive Plants

No federally listed threatened or endangered plants are in the Willamette National Forest, but the U.S. Forest Service has documented 10 sensitive species as present in Region 6. As illustrated by Table 4.7, they include: one federal candidate plant, state of Oregon threatened, endangered, or sensitive plant species, and U.S. Forest Service (USFS) Region 6 sensitive species. None of the plants of Table 4.7 have been documented on the project site, an area timbered in the early 1950s.

Most of the sensitive plants are either common to elevations higher than the project site or characteristics to habitat not present at the project site. Gorman's aster (Aster gormanii) has been documented in the Cedar Creek drainage in the Cedar Fly timber sale area (Alexander 1990) about two miles from the project site. This plant is not likely present on the project site, as it usually occurs above 4,000 feet in elevation on dry rocky slopes and scree. The project site extends from 2,200 feet to 2,400 feet in elevation and does not have dry rocky slopes.

### Old Growth Forests

The permit area, a timbered area, does not have old growth forests or potential old growth groves.

### Wetlands

A portion of the red alder stand along the unnamed tributary to Cedar Creek may be jurisdictional wetlands. Red alder itself is listed as a facultative plant and, hence, is as likely to occur in upland as wetland habitats (U.S. Fish and Wildlife Service

Table 4.7 Threatened, Endangered, or Sensitive Plants in the Willamette National Forest.

| Scientific Name | Common Name | Status | Habitat |
|---|---|---|---|
| Aster gormanii | Gorman's aster | Threatened Oregon<br>USFS sensitive | Dry rocky slopes and scree above 4,000' |
| Calamagrostis breweri | Brewer's reedgrass | Threatened Oregon | Moist meadows, high altitude<br>USFS sensitive |
| Draba aureola | golden alpine draba | Oregon and USFS sensitive | Open slopes, above 7,500' |
| Frasara umpquaensis | Umpquaensis swertia | Federal candidate<br>Category 2<br>Oregon and USFS sensitive | Moist meadows |
| Gentiana newberryi | Newberry's gentian | Threatened Oregon<br>USFS sensitive | Moist meadows, high elevation |
| Hieracium bolanderi | Bolander's hawksweed | Threatened Oregon<br>USFS sensitive | Steep rocky slopes; perhaps serpentive soils |
| Lycopodium annotinum | stiff clubmoss | Threatened Oregon<br>USFS sensitive | Wet meadows, bogs, swamps |
| Ophiogiossum vulgatum L | adder's tongue | Endangered Oregon<br>USFS sensitive | Wet meadows, edge of ponds |
| Polystichum californicum | California sword fern | Threatened Oregon<br>USFS sensitive | Rock crevices, outcrops |
| Romanzoffia thompsonii | Thompson's mist maiden<br>Oregon and USFS sensitive | Wet rocky slopes | |

1988). If wetlands are present, they would include the wettest portion of the red alder stand and represent only a fraction of an acre in area.

### 4.9.2 Environmental Consequences and Mitigation

The proposed project would eliminate 32 acres of vegetation consisting primarily of a 30-year-old seral growth of Douglas fir. No vegetation would be eliminated along the Cedar Creek access road and only selective clearing would be required along the French Creek and Elkhorn transmission line alternatives.

Impact to the forest vegetation removal would be mitigated by reclamation operations, which would plant a Douglas fir and western white pine forest.

Based upon existing data, there will be no adverse effect to threatened, endangered, and sensitive plants at the project site. It is unlikely that the transmission line alternative or access road would affect such plants. Prior to project construction, the project site will be visited by a botanist to determine if such plants are present.

The project will not affect old growth forest or potential old growth groves.

The project will affect the red alder stand along the unnamed tributary to Cedar Creek, an area with potential wetlands. If wetlands are present along this stream and affected, new wetlands will be created on a 1:1 basis.

## 4.10 WILDLIFE AND HABITAT UTILIZATION

### 4.10.1 Existing Conditions

The project area, and much of the surrounding area, has been disturbed by recent and past logging and mineral exploration activities. The majority of the proposed mine site is a 25- to 30-foot-tall stand of Douglas fir and western hemlock planted following timber harvest in the early 1950s. A 15- to 30-foot-tall stand of red alder occurs in a narrow band along the flanks of the unnamed tributary of Cedar Creek and flares into a broader stand just north of the permit area boundary.

The unnamed, perennial tributary runs northeast-southwest through the project site, is only two feet to three feet wide, and has a flow of a few cubic feet per second. Mineral exploration activities have disturbed some of the Douglas fir/western hemlock habitat. The project site is 2,200 feet in elevation. Additional description of local vegetative communities is provided in Section 4.9 Vegetation Resources.

Habitat surrounding the project site are a mixture of old growth forest and large clearcuts from historic to recent logging activities, both innervated by Cedar Creek and logging roads. Peaks surrounding the project area in the Cedar Creek drainage rise to approximately 4,500 feet. Cedar Creek, a tributary of the Little North Santiam River, flows northwest, just south of the project site. Forested and clearcut habitat adjacent to the Cedar Creek Road (to be used as the mine access road) and the Fisher Creek Road (to be used as the general route of two transmission line alternatives) have not been specifically surveyed, although these habitats are similar to those described above.

**Threatened and Endangered Species**

The northern spotted owl (Strix occidentalis caurina) is the only state or federally threatened or endangered species known to occur in the vicinity of the project area. A spotted owl habitat conservation area (HCA), as mapped by the Willamette National Forest, occurs just over 0.5 miles from the project area. The surrounding forest has also been surveyed for the spotted owl.

The northern bald eagle (Haliaeetus leucocephalus alascanus), a state and federally threatened species, occurs on Detroit Reservoir and the Little North Santiam River to the west of the project area. The type and successional stage of habitat on and immediately surrounding the project area are not important to bald eagles.

There is no evidence that the project site or the surrounding forest is inhabited by the California wolverine (Gulo gulo luteus), a federal candidate species. Wolverine inhabit a large (hundreds of square miles) home range, possibly following migrating ungulate herds between seasonal ranges. Wolverine could conceivably utilize the project area if elk and/or deer migrated through the area, or because of the site's location in the valley bottom and the funneling effect of valleys as movement corridors; however, habitat on-site are not particularly attractive or important to a wolverine.

No recent records exist of any other state or federally listed threatened or endangered species from the project area or its immediate vicinity. Although no specific surveys of the project area have been conducted for any threatened, endangered, or candidate species, other than the spotted owl, it is unlikely that any larger species are present.

**Big Game**

Roosevelt elk (Cervus elaphus roosevelti), black-tailed deer (Odocoileus hemionus columbianus), and black bear (Ursus americanus) are the big game species present in the vicinity of the project area. There are no site-specific or area data available on elk or deer numbers because the forested habitat are difficult to systematically survey. However, elk densities for the general area are low and are considered one of the lowest of any area in the Willamette National Forest (M. Penninger 19___). Elk and deer winter range in the area is classified on an elevational basis. Northern aspects below 2,400 feet and southern aspects below 3,200 feet are classified as winter range. The project area falls into the winter range classification. No calving areas have been identified in the project area, and it is unlikely, based on habitat present, that the project area is used for calving.

No seasonal data is available on bear numbers or habitat use. It is likely that habitat on and surrounding the project site are occasionally used by bear during spring and summer. No seasonal food concentrations are on the project area, and the site offers little potential as denning habitat.

**Raptors**

Red-tailed hawks (Buteo jamaicensis) and ravens (Corvus corax), considered here as a raptor because of similar nesting requirements, are the most common, or at least conspicuous, raptors in the vicinity of the project area. Other raptor species, such as turkey vultures (Cathartes aura), all three accipiters (Accipiter spp.), golden eagles (Aquila chrysaetos), and large spotted owls [see above], barred owls (S. varia), small screech owls (Otus asio), pygmy owls (Glaucidium gnoma), and saw-whet owls (Aegolius acadicus) may also be seasonally present in the surrounding area. There are no known raptor nests on the project area and the early successional stage of vegetation types on-site provides virtually no nesting opportunities.

A modest variety of breeding birds are present in the project area, although bird diversity and abundance are limited because of:

- The small size of the project area;
- The number of vegetation types (Douglas fir/red alder); and
- The age/structural heterogeneity (young/low) of vegetation types present.

Some of the more common species, not mentioned elsewhere in this report, include the dark-eyed junco (Junco hyemalis oregonus), mountain chickadees (Parus gambeli), red-breasted nuthatches (Sitta canadensis), and varied thrushes (Ixoreus naevius).

**Game Birds**

Ruffed grouse (Bonasa umbellus), blue grouse (Dendragapus obscurus), and mountain quail (Oreotyx pictus) are the game birds present in the region of the project site. No surveys have been conducted to quantify their numbers on the project area or in the surrounding forest.

**Waterfowl and Shorebirds**

Aquatic habitat on the project site is limited to the 2- to 3-foot-wide, unnamed tributary of Cedar Creek flanked by a dense red alder stand. As such, the project area is unimportant to waterfowl and shorebirds. Adjacent reaches of Cedar Creek immediately south of the project site may be used by low numbers and diversities of waterfowl and shorebirds.

**Small Mammals**

Small mammals are ecologically important because they represent the prey base for terrestrial and avian predators. The project site and the surrounding forest support a variety of small mammals, including shrews, ground and tree squirrels, voles, mice, pocket gophers, etc., although numbers and diversities have not been quantified.

**Predators and Furbearers**

Representatives of this diverse wildlife group include coyotes (Canis spp.), bobcat (Lynx rufus), mountain lion (Felis concolor), mink (Mustela vison), river otter (Lutra canadensis), and beaver (Castor canadensis), all of which are thought to be at least seasonally present in the Cedar Creek drainage. Based on habitat affinities, it is unlikely that the three latter species utilize the project site to any degree. The three former species may be occasionally present on site, using the area as part of a larger home range. Mountain lions probably migrate in and out of the area following the migratory movements of deer and elk. Coyotes are probably the most common of all these species on the project area.

**Hepetofauna**

A relatively wide variety of herpetofauna (reptiles and amphibians) inhabit the surrounding forest, although habitat potential on the project area is limited because:

- Most of the site is a young, mixed conifer stand;
- Aquatic resources are limited to the small unnamed tributary; and
- Much of the site has been disturbed by recent mineral activities and past logging activities.

Nevertheless, several species of snakes, frogs, and salamanders probably inhabit the site. The unnamed tributary would appear to provide suitable habitat for the tailed frog (Ascaphus truei), a unique species on the U.S. Forest Service Region 6 list of Endangered, Threatened or Unique Species.

### 4.10.2 Environmental Consequences and Mitigation

#### Threatened and Endangered Species

It is unlikely that there will be any adverse effect of mine development, operation, or reclamation on any state or federally listed threatened, endangered, or candidate species. The spotted owl is the only such species known to occur in the project area vicinity. The mine and all ancillary facilities are outside of the designated HCA and are more than 0.5 miles distant. Portions of the selected transmission line corridor that require tree clearing will have to be "cleared" of spotted owl HCAs or be rerouted.

#### Big Game

Elk and deer use of the proposed mine and surrounding area is low on a year-round basis. Nevertheless, big game that may have seasonally utilized the project area will be displaced from the site and a surrounding area for the proposed eight-year life of the mine. The significance of this temporary loss of habitat will be minor because of the low number of animals involved and the large area of surrounding habitat available to accommodate them.

No new roads are proposed that would increase human access into the area, although human use (mining and recreational) will increase, perhaps, for the long term. This may lead to increased hunting pressure (legal and illegal) on local wildlife resources. Van pooling employees to work should reduce road-kill probabilities, although a larger resident population (employees, their dependents, and support personnel) resulting from mine operations will increase local big game highway mortality.

## Raptors

The small size and present habitat value of the mine area relative to the large home range of most raptors, the low value of the site to raptors, and the large area of surrounding habitat, will result in minor effect to the local raptor community.

## Breeding Birds

Virtually all breeding bird use of the mine site will be lost for the proposed eight-year life of the mine. An additional 20 years will be required for the site to develop forest vegetation similar to existing conditions. Considering the present slow decline of North American breeding bird numbers because of loss of Central and South American wintering habitat, it is likely that birds displaced from this relatively small mine site could be accommodated elsewhere in the surrounding forest.

Even from a cumulative effect perspective, a large portion of the Cedar Creek and adjacent drainages have been logged, probably reducing the abundance of some old growth forest interior species. This may have locally affected hundreds or thousands of acres of habitat. The proposed mine would not add to this loss because it is only 30-year-old growth.

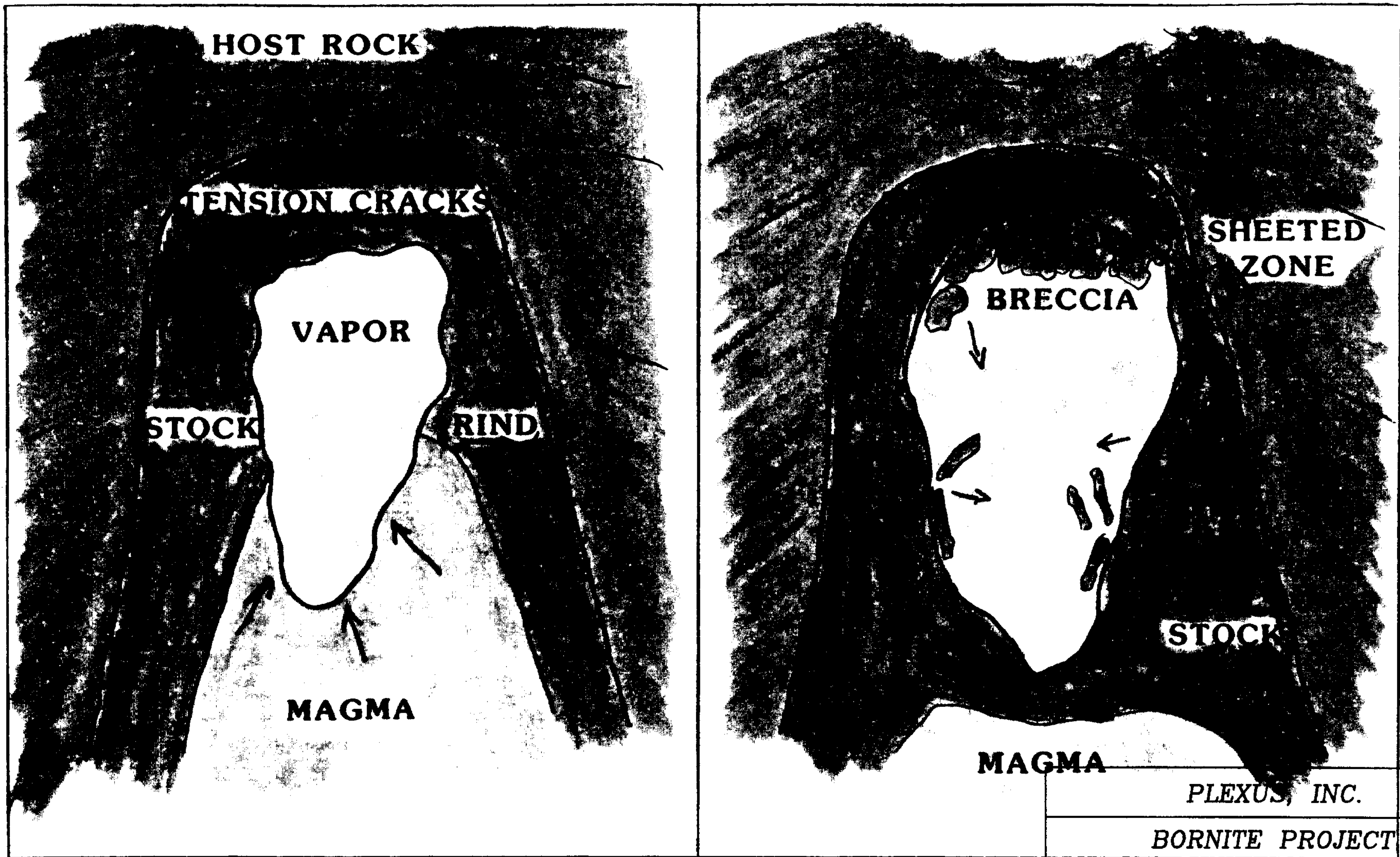
## Game Birds

Because the importance of the project site to the three galliformes is not well known, the effect of the eight-plus years of displacement from the site is uncertain. However, it is likely that this wildlife group, like those discussed above, will only be minimally affected for a short time. The affect will be limited to those birds on-site and in the immediately adjacent surrounding area. Indirect mining affects, from increased recreational and hunting pressure, will likely increase in the Cedar Creek drainage and in the surrounding drainages as people disperse.

## Waterfowl and Shorebirds

Waterfowl and shorebirds should not be affected on-site because of the lack of habitat. Disturbances to the low number of waterbirds using creeks adjacent to entrance roads should be minor. Hunting on local creeks should be low because of the marginal waterfowl habitat. Increased waterfowl hunting may occur off- site in more productive waterfowl areas that are exploited by members of the new workforce.

# BRECCIA PIPE GENESIS




| |
|---|
| *PLEXUS, INC.* |
| *BORNITE PROJECT*<br>*MARION COUNTY, OREGON* |
| BRECCIA PIPE FORMATION |
| PREPARED BY PLEXUS, INC. |
| FIGURE 5 \| NOV, 1992 |

Copper sulfide minerals (bornite and chalcopyrite) occur in the brecciated margins of the pipe and decrease in grade toward the center. The highest copper grades occur in the margin or shell of the breccia pipe. The degree of brecciation within the pipe varies. Copper grade varies within three zones of the breccia pipe, a high grade shell, sheeted vein, and the interior pipe. The high grade shell would have been the preferred conduit for mineralizing fluids and sites for ore deposition. The sheeted veins occur as veins within the margin of the breccia pipe where permeated with mineralizing fluid. The interior pipe contains some higher grade zones (>1.5% Cu), but generally contain less than 0.5% Cu. Areas of higher and lower permeability may have caused pooling of the mineralizing fluids forming higher and lower grades of copper mineralization. Figure 6 is a cross section of the orebody with copper bearing zones identified.

Gold and silver mineralization occur as small particles and are associated with higher grade copper zones. This limits the gold and silver mineralization to the outer margins of the breccia pipe.

### 1.10.3 Area Seismic Setting

The seismicity of the Bornite site is ranked as low to moderate. A review of historical seismicity in a 100-mile radius from the project and seismic sources and capable faulting was conducted for the tailings impoundment design. A seismic study was done by the U.S. Army Corps of Engineers for Detroit and Big Cliff Lake dams located south of the project site. The Army Corps recommended using 0.22g as the maximum earthquake acceleration and 0.11g as the operating basis earthquake acceleration (Harper, Stone, 1992). These accelerations are based on conservative (higher acceleration rates) assumptions on seismicity east of the site. Lower accelerations are noted in more current Algermissen maps, so the more conservative acceleration of 0.22g is used to design the tailings impoundment.

### 1.10.4 Geotechnical Analysis an Identification of Hazards

Backhoe trench locations were selected in the study area to evaluate foundation conditions and borrow material quality and quantity. Trenches were located to include tailings disposal facility embankment areas, diversion channel areas, and mine facility areas. In order to minimize site disturbance during exploration, trench locations were selected along existing Forest Service roads or exploration hole access roads.

Near-surface soils are generally uniform and relatively dense, with a significant portion of material larger than six-inch size. The percentage of fines from grain-size distribution testing of the gravel and smaller fraction varied from roughly 10 to 35 percent. From drilling of monitoring wells (WWL, 1992), these materials extend to over

**Small Mammals**

Many small mammals on the mine site will be killed by mine development activities. The effect of this on the local predator population will be minor, as discussed in previous and subsequent sections. Following reclamation activities, small mammal populations should return to present or higher levels.

**Predators and Furbearers**

Most species of predators and furbearers whose home ranges overlap the project area are wide ranging. Therefore, repercussions to those species whose home range includes the project site will be minimal.

## 4.11 AQUATIC RESOURCES

### 4.11.1 Existing Conditions

The 58-acre permit area is characterized by an approximate 2,000-foot section of a Class III tributary to Cedar Creek. Cedar Creek, a Class I perennial stream, parallels the southwest boundary of the project for a distance of about 2,600 feet. The unnamed tributary has a drainage basin of approximately 60 acres. It is about two to three feet wide, appears to be perennial, and has an estimated flow of one to two cubic feet per second.

**Fish**

It is unlikely that the unnamed tributary has fish because of the low flow and steep gradient; 400-foot elevational rise in 2,000 feet. Cedar Creek, however, does have fish. It is unlikely that anadromous fish are present in Cedar Creek near the project site, because of the many cascades and waterfalls downstream from the project site. Rainbow trout (Salmo gairdneri) and cutthroat trout (Salmo clarki), both native resident fish, are present in Cedar Creek upstream of the falls (Halemeier 1990). Rainbow trout are stocked in Cedar Creek upstream of the Little North Santiam River. This area receives light to moderate fishing pressure (Alexander 1990).

**Invertebrates**

No invertebrate surveys have been conducted in the unnamed tributary of Cedar Creek. Invertebrate surveys in Cedar Creek indicate populations in order of abundance: caddisflies, mayflies, true flies (Diptera spp.), and simulidae larvae (Halemeier 1991).

**Threatened, Endangered, and Sensitive Species**

The two federal candidate fish species listed for the Willamette National Forest include Oregon chub (Hybopsis crameri) and bull trout (Salvelinus confluentus). Neither of these fish are known to occur in Cedar Creek (Halemeier 1991).

The Mount Hood primitive caddisfly, a federal candidate species, is the only invertebrate of concern in the Detroit Ranger District. This invertebrate has not been documented in Cedar Creek.

### 4.11.2 Environmental Consequences and Mitigation

The project will result in the relocation of an approximate 1,000-foot section of the unnamed tributary. There will be no repercussion to fish by the stream location because none are likely present.

The construction phase of the project and the relocation of the unnamed tributary is likely to generate a minor, short-term sedimentation impact to Cedar Creek. Sediments have the potential to affect spawning success, benthic macroinvertebrate communities, and food chain interactions.

The operational phase of the project will protect water quality by diversion channels, sedimentation ponds, mine water ponds, and a water processing pond. Additionally, a forested buffer zone between the permit area and Cedar Creek will range from 200 feet to 450 feet.

There will be no adverse effect to threatened, endangered, or sensitive fish or invertebrates.

## 4.12 VISUAL RESOURCES

### 4.12.1 Existing Conditions

This section identifies and describes existing visual resources that could be affected by the construction and operations of the proposed project. The area evaluated for this analysis includes the proposed permit area (described in Section 2.1). Visual resources are described using the U.S.Forest Service Visual Management System (VMS).

This methodology was developed by the Forest Service for describing and managing visual resources in national forests. (Please see page III-111 of the Final Environmental Impact Statement for the Willamette National Forest Land and Resource Management Plan for a description of the Visual Management System.) It includes inventories of variety classes, sensitivity levels, distance zones, visual quality objectives, and visual absorption capability. Information concerning visual resources in the study area was taken from the Willamette National Forest Land and Resource Management Plan, supplemented by visual resource investigations performed by Planning Information Corporation.

Visual quality objectives (VQOs) set standards or goals for the visual management of the landscape and are assigned on the basis of variety classification, sensitivity level, and distance zone analysis. There are five VQOs, each describing a different degree of acceptable alteration of the natural landscape. The degree of alteration is measured by visual contrast with the surrounding landscape. The five visual quality objectives are presentation (P), retention (R), partial retention (PR), modification (M), and maximum modification (MM). (Please see pages III-112 through 114 of the Final Environmental Impact Statement for the Willamette National Forest Land and Resource Management Plan for a description of the Visual Quality Objectives.)

Within the Willamette National Forest, the visual quality objectives are divided into those for viewshed and those for nonviewshed areas. A viewshed corridor (VSC) " . . . includes the visible areas adjacent to important travelways that traverse the forest. These areas are the most sensitive portions of the forest in relation to the public's concern for scenic quality." Neither the proposed Bornite Project area nor the Cedar Creek Valley are located in a viewshed corridor.

Visual absorption capability (VAC) is another concept the U.S. Forest Service uses in its visual management system. VAC provides an indication of the relative ability of the landscape to absorb visual impact without being substantially altered. It is based on consideration of slope, vegetation, regenerational potential, sensitivity, and color contrast between vegetation and soils, among other factors. VAC classifications are high, medium, and low, with a high VAC meaning that the physical characteristics of the landscape are such that it could absorb a potential visual impact without being substantially altered.

The Bornite Project proposed permit area is located within Management Area 14a of the Willamette National Forest Land and Resource Management Plan. The Scenic Resources management standards and guidelines for Management Area 14a

(MA-14a-02) state that "All design and implementation practices should be modified as necessary to meet or exceed the VQO of Maximum Modification."

Management Area 14a lies within the Western Cascades geologic province which is characterized by " . . . general conformity in ridge crests separated by deep valleys with moderately steep, highly dissected, side slopes . . . Some rock cliffs and rock outcrops exist. Vegetation is characterized by dense stands of large trees including western hemlock, Douglas fir, and true fir. Most areas have a continuous cover of overstory and understory vegetation. Deciduous species such as alder and maple are often intermixed along drainages . . . The visual experience of forest visitors in this landscape type is characterized by views that are focused or directed at points or features in the landscape by road or trailside vegetation or landform structure. To a lesser extent, visitors will also experience landscape spaces enclosed by a continuous physical barrier of trees, hills, or mountains."

The proposed permit area lies within the Cedar Creek drainage, which " . . . offers a variety of form, line color, and texture as forested slopes are broken up by rock outcrops, meadows, debris chutes, and old cuttings (Detroit Ranger District undated). The Bornite Project site lies on the location of an old cutting unit. Other cutting units are visible from road FS-2207 both above and below the proposed permit area. A dense strip of second growth timber and understory screens the proposed permit area from view by travelers on F-2207 below and immediately adjacent the permit area. Above the proposed permit area, the site would be intermittently visible to travelers on road F-2207. Immediately above the site, breaks in the vegetation alongside the road will allow fleeting glimpses of the project to travelers on road FS-2207. As the road gains elevation, the project site will be visible for longer periods of time from several points on the road.

Based on the slope, existing vegetation, and regenerative capacity, the project site is classified as having a high visual absorption capability.

### 4.12.2 Environmental Consequences and Mitigation

Moderate visual impacts will result from project construction at the proposed permit area. Site clearing, tailings pond impoundment, and surface facility construction activities will create localized effect to visual resources moderately contrasting the landscape elements of color, form, line, and texture. All surface structures would be painted a U. S. Forest Service-approved color. The high visual absorption features of topography and screening will absorb most visual change at and below the site.

Above the proposed permit area, along the portions of Forest Service Road F-2207 from which the project would be visible, visual impacts would be more substantial, although distance and the relatively small size of the disturbed area would tend to lessen the visual effect. Visual impacts will last for the eight-year duration of the project and for several years post-closure until reclamation vegetation matures. The VQO of Maximum Modification should be obtained when reclamation vegetation matures.

## 4.13 SOCIOECONOMICS

### 4.13.1 Existing Socioeconomic Conditions

This section provides a description of existing socioeconomic conditions within the area likely to be affected by the proposed Bornite Project. The study area for this analysis includes Marion County, specifically the southeastern portions of the county, and the northeastern portions of Linn County. The proposed project site is located in Marion County.

Socioeconomic conditions discussed in this section include the local economy and employment, population, housing, and tax base. Because most project employees would be drawn from the local labor pool, the project's effect on local government facilities and services are likely to be negligible and therefore have not been assessed.

#### Economy and Employment

The economy of Marion County is based primarily on government employment and agriculture. Government employment totaled nearly 27,000 workers during 1988; nearly 16,000 of these were employed by state government (the capitol of Oregon is located in Marion County) (Oregon Employment Division 1990a). More than 9,000 proprietors and workers were employed in agriculture in Marion County during 1988; however, a large number of seasonal workers are probably not included in these statistics. Total employment in Marion County during 1988 was over 119,000 (BEA 1990). Average Marion County wage per employee during 1988 was $17,287 (Oregon Employment Division 1990a).

During 1988, an average of 460 workers were employed in the forestry industry, 2,850 employees worked for lumber and wood products companies, and 975 were employed in the paper manufacturing industry in Marion County. An average of 57 workers were employed in the mining industry. Unemployment for the Salem Metropolitan Statistical Area (MSA), which includes Marion and Polk counties, averaged 5.4 percent or 7,600 during 1990 (Fairbanks 1991).

The communities along Highway 22 in the North Santiam Canyon are much more dependent on the lumber and wood products industries than Marion County as a whole. Several mills are located in these communities. Like elsewhere in the Pacific Northwest, the North Santiam Valley timber industry is experiencing the effect of decreasing timber sales resulting from environmental regulation. Dozens of workers at wood products mills have been laid off in the North Santiam Valley during the last year (Fairbanks 1991).

The Linn County economy is based on agriculture and wood products. Approximately 5,500 workers were employed in agriculture in 1988 (BEA 1990), and an average of about 115 workers were employed in forestry, 4,800 in lumber and wood products, and 1,100 in paper production. Mining jobs averaged about 20 during 1988. Linn County had a total of approximately 31,000 jobs in 1988, and the average Linn County wage per employee was $19,802 (Oregon Employment Division 1990b).

Unemployment in Linn County averaged 7.8 percent during 1990 or about 3,450 unemployed workers. Linn County has been particularly hard hit by layoffs in the timber industry. The county lost more than 500 timber industry jobs during the past year alone (Fairbanks 1991). Linn County employment in the lumber and wood products industry fell by 19 percent between 1980 and 1989.

**Population**

Table 4.8 displays 1980 and 1990 U.S. Census population figures for Marion and Linn counties and selected communities near the proposed project site. The table also displays the percentage change between the two census periods.

Population in Marion County (fifth largest in the state), grew by 11 percent between 1980 and 1990, compared to 2 percent for Linn County (eighth largest). In fact, Linn County population appears to be declining in recent months, largely as a result of layoffs in the wood products industry (Fairbanks 1991). The wood products-dependent North Santiam Canyon communities of Mill City, Detroit, and Idanha also lost population during this period.

**Housing**

The 1990 census found 86,869 housing units in Marion County and 36,482 in Linn County (U.S. Bureau of the Census 1991). It is not currently known how many of these units in each county are vacant, for rent, or for sale. In the North Santiam Canyon (from Lyons to Detroit), an estimated 40 units were for sale in May of 1991.

Sales prices ranged from $25,000 to $175,000, with most units in the middle of the range. Very few rental houses are available; most have waiting lists (Quinlan 1991).

### Tax Base

The major taxes that Bornite Project would be subject to include ad valorem property tax and corporate excise tax. Bornite Project employees would be subject to personal income tax on wages.

For property tax purposes, the property and improvements at the Bornite site would be valued (at 100 percent of market value) on January 1 each year by the Marion County Assessor. Plexus would then pay taxes based on the levies of the local taxing districts. These tax revenues would accrue to Marion County and the applicable taxing districts.

**TABLE 4.8 1980-1990 Population**
**Marion and Linn Counties and Selected Communities.**

| Community | 1990 | 1980 | % Change |
|---|---|---|---|
| Marion County | 228,483 | 204,692 | 11 |
| Aumsville | 1,650 | 1,432 | 15 |
| Detroit | 331 | 367 | -9 |
| Gates | 499 | 455 | 10 |
| Idanha* | 289 | 319 | -9 |
| Mill City* | 1,555 | 1,565 | -1 |
| Salem* | 107,786 | 89,233 | 20 |
| Stayton | 5,011 | 4,396 | 13 |
| Sublimity | 1,491 | 1,077 | 38 |
| Unincorporated | 72,926 | 91,951 | -20 |
| Linn County | 91,227 | 89,495 | 2 |
| Albany | 29,462 | 26,511 | 11 |
| Lyons | 938 | 877 | 7 |
| Unincorporated | 35,484 | 37,520 | -5 |

* Portions of these communities are located within another county.

Source: Portland State University, Center for Population and Research.

Plexus would pay Oregon corporate excise tax at the rate of 6.6 percent of Oregon net income. These funds would accrue to the Oregon State General Fund. Plexus employees would pay personal income tax on salaries at the rate of 5 percent for the first $2,000 for singles ($4,000 married), 7 percent for the next $3,000 ($6,000 married), and 9 percent for all income above $5,000 ($10,000 married). Personal income revenues tax also accrue to the state general fund (Oregon Department of Revenue 1990).

### 4.13.2 Socioeconomic Consequences and Mitigation

#### Local Economy and Employment

The Bornite Project is slated to begin construction during early spring of 1993, depending on receipt of the requisite permits and approvals. The construction activities will occur over the following nine to eleven months with an average of 85 workers and a peak of 100 workers on-site during this period. Construction activities will include site clearing and earth moving activities, and construction of surface facilities. Underground mine construction activities would continue during the operations phase.

Site clearing and earth moving work will very likely be performed by contractors from the North Santiam Canyon communities whose employees will commute daily from their homes to the project site. Surface facilities (concrete pads and buildings, setting of the crusher, mill, fine ore bin, etc.) would very likely be constructed by contractors from Salem, Albany, or Portland. Employees of these contracts would also commute on a daily or perhaps weekly basis. Weekly commuters would require work-week lodging (motels or recreational vehicle parks) in the North Santiam Canyon area for the short period they are in the area.

The capital cost of the Bornite Project is anticipated to be $13 million in 1991 dollars. Of that, $3 million will be spent on mining and milling equipment that may be purchased outside Oregon. The remaining $10 million will be spent for labor, equipment, and supplies, primarily in Marion and Linn counties.

The operations phase of the project is scheduled to begin in fall 1993, and continue for approximately eight years based on current ore body estimates. The operations phase would employ an estimated 79 to 85 workers. Of these, approximately 65 jobs, or 82 percent, will be filled from the local labor pool in Marion and Linn counties. These estimates are based on the skill requirements of the project workforce, the skill and craft composition of the available local labor pool, and Plexus' intention to develop a training program. The remaining 14 jobs, which is

18 percent of the total, will require technical and managerial skills that may not be available in the local workforce.

Salaries for hourly operations workers will range from $10 to $15 per hour plus overtime, with most jobs paying at the higher end of the wage scale. Total annual operations payroll is estimated to be just over $2.5 million, with an average annual wage per employee of approximately $31,600. In addition, each employee will receive benefits, including workman's compensation insurance, social security, federal and state unemployment insurance, medical insurance, and paid vacation and holidays, all of which will average an estimated 38 percent of his or her salary.

In Oregon, each mining job generates an estimated additional .5 jobs in the local economy (Fairbanks 1991). Using this multiplier, the Bornite Project will result in an additional 37 jobs in Marion and Linn counties. These jobs will occur mainly in the retail and service sectors and be filled by workers from the available local labor pool.

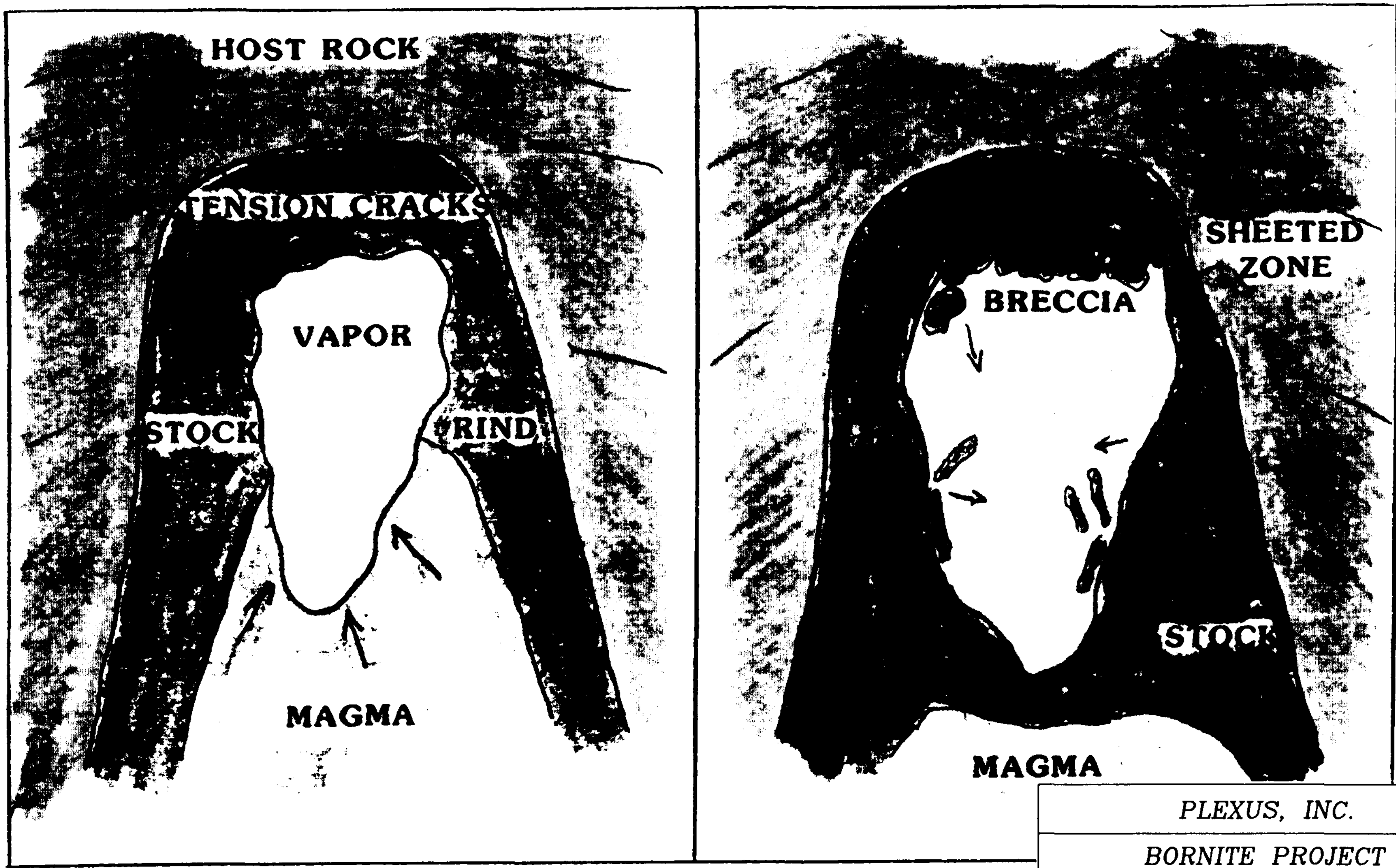
Annual mine operation materials purchases are estimated at $1.7 million. Of that amount, purchases from Marion County and other Oregon vendors will total an estimated $1.3 million. In addition, annual fuel purchases will total approximately $140,000. It is anticipated that fuel will be supplied by an eastern Marion County vendor.

**Population**

Bornite Project employees moving into the area to take jobs will generate additional population for the county and communities where they locate. Eighty-two percent of project employees are anticipated to be drawn from the local labor pool. These locally hired workers will therefore generate no new population. Induced workers are also anticipated to be drawn from the local labor pool and will therefore stimulate no new population effects.

However, both locally hired project workers and locally hired induced workers will help stem the population decline in North Santiam Canyon communities, which are anticipated to lose population because of the depression in timber sales.

The 18 percent of the total workforce (14 workers) that is estimated to in-migrate to take Bornite Project jobs will generate an estimated additional 42 people in Marion and Linn counties, distributed to the communities of Mill City, Lyons, Stayton, Sublimity, Aumsville, Gates, Detroit, Idanha and the unincorporated areas around those communities. This estimate is based on an average of three persons per household. The average household size for Marion County is 2.6; the average for Linn County is 2.5 (U.S. Bureau of Census 1991).

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***MARION COUNTY, OREGON***

BRECCIA PIPE FORMATION

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| | | |
|---|---|---|
| | FIGURE **5** | NOV, 1992 |

However, project employees and spouses are more likely to fall within childbearing age than the general population. Therefore, this analysis assumes the higher three persons per household figure.

**Housing**

Although no estimates of available housing units were developed for this analysis, it is reasonable to assume that 14 families could find rental or sales units in the eight communities and unincorporated areas listed above. The in-migrating project employees will be in relatively high-salaried managerial and technical positions, and therefore will be likely to have the resources to purchase a home.

Because no large inventory of rental housing appears to be available in any community, in-migrating workers and their families are likely to distribute themselves across all communities. Some workers will prefer to live close to the project site, others will prefer a larger community or to live closer to Salem and the many amenities that a city provides. Consequently, the project's population effects on any one community and that community's public facilities and services are likely to be negligible.

**Tax Base**

All calculations are in 1991 dollars. Based on a project valuation of $11 million and a fiscal year tax levy of $27 per thousand dollars, the Bornite Project will generate an estimated annual $300,000 in property taxes to Marion County and the following jurisdictions: Chemeketa Community College, Marion ESV Elementary School, Marion ESD High School, and the Detroit School District. Not surprisingly, the property tax levy is set each year; consequently, these estimates could change substantially depending on the annual tax rate.

Based on an estimated Oregon annual net revenue of $3,000,000, the Bornite Project will generate an estimated $230,000 in corporate excise tax to the state general fund.

Personal income taxes in Oregon are largely determined by the provisions of the U.S Internal Revenue Code, which allows certain exemptions and deductions. Therefore, estimates of personal income taxes paid by the Bornite Project employees have not been calculated for this analysis.

## 4.14 LAND USE, RECREATION AND TRANSPORTATION

### 4.14.1 Existing Conditions

#### Land Use

This section identifies the existing land use on the proposed Bornite Project permit area, as well as existing and proposed uses on surrounding areas. Information obtained for the land use inventory and analysis was obtained from the Willamette National Forest Land and Resource Management Plan, supporting documents, and from interviews with Forest Service personnel.

The permit area is located within Willamette National Forest Management Area (MA) 14a. The management emphasis for MA 14a is General Forest, which provides for " . . . intensive management of vegetation for timber production and other resource uses. Multiple resource values are maintained or enhanced."

Currently, MA 14a " . . . consists of forested lands physically suited for growing commercial tree crops and production of multiple uses such as timber, wildlife habitats, water quality, soil productivity, recreation, forest access, and cultural sites."

Timber on the permit area has been harvested within the last 30 years, and other old cutting units are located in the Cedar Creek Valley. Other current uses include wildlife habitat, dispersed recreation, which is discussed in the following section, and mineral exploration.

The permit area is located within the North Santiam Mining District of the Willamette National Forest. According to the Land and Resource Management Plan, " . . . Forest encourages, facilitates, and administers the orderly exploration, development, and production of mineral resources to meet present and future needs of the nation integrated with the use, conservation, and protection of other resources."

#### Recreation

This section identifies the existing recreation resources and uses on the proposed permit area and surrounding areas. Information obtained for the recreation inventory and analysis was obtained from the Willamette National Forest Land and Resource Management Plan, supporting documents and from interviews with U. S. Forest Service personnel.

The U.S. Forest Service uses Recreation Opportunity Spectrum (ROS) classes as a framework for stratifying and defining classes of outdoor recreation environments, activities, and experience opportunities. The six ROS classes include:

- Primitive;
- Semiprimitive Non-motorized;
- Semiprimitive Motorized;
- Roaded Natural; and
- Roaded Modified.

Page III-94 of the Final Environmental Impact Statement for the Willamette National Forest Land and Resource Management Plan provides a description of the ROS classes. According to the plan, area management practices within MA 14a should result in a physical setting that meets or exceeds the ROS class of Roaded Modified. Roaded modified is described as " . . . substantially modified natural environment."

The permit area has traditionally not been used for recreation purposes. A dispersed campsite is located on a small cleared area adjacent to the bridge across Cedar Creek just below the permit area. The most frequent recreation activity in the area surrounding the project site consists of vehicular travel on F-2207 to and from the saddle above Cedar Creek, where hikers park to take the primitive trail down to Opal Lake and the Opal Creek area. Other trails located near the top of the Cedar Creek drainage include the Elkhorn Ridge Trail (F-3347), which overlooks portions of the Cedar Creek Valley and is heavily used from F-2223 to Phantom Natural Bridge, and the French Creek Trail (F-3349) (Crist 1991; Detroit Ranger District undated).

The area along F-2209 and the Little North Santiam River is heavily used for dispersed river-related recreation activities during summer months, especially on weekends.

**Transportation**

This section identifies and describes the highways and roads that will serve as access to the Bornite Project site. Information for this section was obtained from the staff of the Oregon Department of Transportation, the Marion County Road Department, and the Willamette National Forest.

Highways and roads that provide access to the project site will include Oregon State Highway 22, Marion County Roads 967 and 960, and Forest Service Roads F-2223, F-2207, and F-2209.

**State Highway 22.** From Mehama east to Detroit, State Highway 22 is a narrow, paved, two-lane road without much shoulder pavement. Additional passing lanes are needed because of congestion with tourists, fishers, hikers, and winter skiers. It has some steep grades and is snow-plowed regularly when necessary (Parker 1991).

**County Road 960.** The North Fork Road, or County Road 960, connects Mehama through Elkhorn to the U.S. Forest Service's western border and F-2209. Fourteen miles are paved, and the road varies from 20 feet to 22 feet in width. The county keeps the paved section of the road, which is as far as Elkhorn, open in winter but hasn't paved the last three miles to its junction with F-2209. The road is subject to frequent slides and, therefore, requires frequent patching and substantial repairs (Sharbono 1991).

**County Road 967.** This road, also known as the Gates Hill Road, connects State Highway 22 to County Road 960. It is considered the worst road in the county by the district's road supervisor. It is a gravel road, little improved in recent years, which ranges from 16 feet to 20 feet in width. Few residents use the road for access but logging trucks do use it. The county does not attempt to keep the road open in the winter (Sharbono 1991).

**F-2209.** Using U.S. Forest Service nomenclature, the F-2209 road is an "improved gravel road" from the western boundary of the National Forest just beyond Elkhorn east to F-2207. It is a continuation of Marion County Road 960, and shares the name North Fork Road. West from its junction with F-2207 it receives low maintenance. The road's grades are not so steep as those on F-2207. It is usually open all winter due to lack of heavy snowfall. When the road is blocked by snow, those using the road customarily plow it themselves (Gagne 1991; Walker 1991). F-2209 is heavily used during summer months, primarily by people recreating along the Little North Santiam River (Crist 1991).

**F-2207.** The F-2207 road runs east and south from its junction with F-2209 to the proposed Bornite Project site. From there, it runs primarily south to its junction with F-2223 following Cedar and French creeks. It is a graveled road, varying in width from 10 feet to 16 feet, with some wider passing lanes. Snow is not plowed in the winter, and the road often has falling rock during that time. A new bridge at Shady Cove is scheduled for completion in June 1991. Until the bridge is finished, F-2207 cannot be used by vehicles to access F-2209 (Gagne 1991; Walker 1991). Both F-2207 and F-2223 are heavily used by recreation visitors during summer months (Crist 1991).

F-2223. This paved road runs northwest from State Highway 22 at Detroit to its junction with F-2207. It does not have snow removal and, therefore, is not open year round, although even heavy snowfall does not usually stay on the ground long (Gagne 1991; Walker 1991).

### 4.14.2 Environmental Consequences and Mitigation

#### Land Use

Plexus controls 64 20-acre lode mining claims at the permit site. (See Section 2.1 for a complete description of the project location and access.) The permit application includes 58 acres, of which an estimated 32 acres will be disturbed by project construction and operation activities. Construction disturbances will last for an estimated nine to eleven months, operation disturbances will occur for an additional eight years under present ore body estimates. Disturbed areas will then be reclaimed.

Construction and operation of the Bornite Project will only minimally affect adjacent and surrounding land use patterns. The project will be compatible with the General Forest emphasis for Management Area 14a. The project will also be compatible with the Forest-Wide Guidelines for Mineral and Energy Resources (FW-289 through FW-292).

#### Recreation

Construction and operations of the Bornite Project will have a minimal direct effect on recreation resources. The dispersed campsite located adjacent the bridge on Cedar Creek below the permit area will be affected by noise and activity from the project. Indirect effect to recreation resources will include the project-related traffic (described in Section 4.14.2.3 below) on F-2209 and F-2207, roads heavily used by recreation visitors to the forest during summer months, and the project's visual effect, which will be viewed by recreation visitors from the upper reaches of F-2207 and the Elkhorn Trail. These indirect effects will continue through the life of the project. Visual effects will continue until reclamation vegetation matures.

#### Transportation

Access to the permit area will be gained by State Highway 22 to Mehama, County Road 960, which is the North Fork Road, until it becomes U.S. Forest Service Road F-2209, F-2209 until its junction with F-2207, and F-2207 approximately three miles to the proposed permit area. This will be the authorized route for materials, vendors, and employee transportation. Some employees living in Mill City, Gates, Detroit, or Idanha may select County Road 967, the Gates Hill Road. During the summer, employees from Detroit or Idanha may select F-2223 to F-2207 to the project site.

During the nine- to eleven-month project construction phase, an average of four semitrailer and 17 to 20 car/van-pool round trips per day will be generated. The construction phase will occur during spring, summer, and early fall. Therefore, the round trips associated with the construction phase will result in a moderate increase in traffic on County Road 960, F-2209 and F-2207.

The operations phase of the project will require an average of two to three round trips per day for materials and vendor deliveries and four to five round trips per day for shipments of concentrate. Project operations will involve three shifts per day, which will generate an average of seven to 10 employee round trips per shift, or 26 round trips per day, assuming private transportation at three persons per vehicle. If Plexus develops van pooling, round trips per shift will be reduced to three or four, which is 11 total round trips per day, plus minor ancillary administrative traffic.

Operations-related traffic will generate moderate increases in traffic to county and Forest Service roads, particularly during shift changes.

## SECTION 5.0
## EMISSIONS AND POLLUTION CONTROLS

### 5.1 FUGITIVE DUST CONTROL

Dust emissions from mining operation of drilling and blasting will be minimized by the enclosure provided by the underground mine. Most airborne dust will settle out within the mine workings and the exhaust ventilation air will not exceed the capacity limits of 20 percent. Total enclosure provides about 85 percent control efficiency for particulates (Tintinic, 1984). Development rock will be placed on the surface and used as construction material for the plant site and the initial tailing embankment.

Under normal conditions ore will be brought to the surface by 40 ton underground haul trucks and dumped directly into a grizzly and fed to the enclosed crusher. There will be a small run-of-mine ore stockpile near the crusher to allow for continual feed. If necessary, the stockpile can be sprayed with water to prevent dust. However, the ore coming to the crusher will nominally be in the 4 inch to 30 inch size range with very few fines as a percentage.

The crushing and ore storage and conveying system will be completely enclosed from the grizzly to the mill, with particulate emission control being provided by a baghouse. In addition, each drop point and exchange will be wetted by spray bars. Water sprays at material handling operations and transfer points have been shown to provide 70-95 percent emission control (AP42, Section 8/9). This application of water sprays for wet supression of particulates emissions from the crusher, screens, and conveyor belt transfer points should provide more than 80 percent control efficiency. There will be no particulate emissions from the flotation concentrating circuit due to the wetted nature of the ores after they have entered the ball mill.

Particulate emissions from the transport of materials will be minimized by using the development rock as construction material, the transport of tailings as a slurry in pipelines. The tailing management facility will be contructed in stages with each stage reclaimed when completed.

The transport of concentrates will be accomplished in covered trucks. Access roads at the project site have been kept very short in length to minimize surface disturbance. However, if the roads dry to a level that dust is produced, they will either be wetted or an approved dust supression agent applied.

## 5.2 OTHER EMISSIONS

Because the metallurgical process selected for the Bornite Project is mechanical versus a hydrometallurgical (chemical dissolution of metals) or pyrometallurgical (smelting) process, there will be no gaseous emissions generated in the mill. In addition, gaseous emissions anticipated from the project are small and limited to emissions from internal combustion engines. These emissions will be controlled by using acceptable catalytic convertor or scrubber systems. The major $NO_x$ emission source would be diesel-powered generators if used. These emissions will be controlled through good maintenance and operating practices. In addition, BACT can be achieved by controlling $NO_x$ emissions using ignition timing retard of four degrees as BACT. The control of $NO_x$ emissions by this method will provide 25 percent control efficiency (Savel).

Specific controls used for the Bornite Project will be determined in consultation with the Oregon Department of Environmental Quality as part of the air quality permitting process.

## 5.3 SEDIMENT CONTROL

Sediment control at the site will be achieved by control of runoff as outlined below. Due to the precipitation at the site and the natural condition of watersheds in the area, sediment control will be a key part of surface water control for the site.

The site will have three separate water control systems: (a) mine water, (b) process water, and (c) site runoff water. The project has been designed such that the amount of water handled in each system is kept as low as possible. This minimization of water in each of these systems will be aided by diversion of water around the mine site, such that runoff from undisturbed areas above the site is conveyed around the site without mixing with or afffecting runoff within the site.

Site runoff water (from precipitation and snowmelt on the mine area surfaces) will be collected in the sediment pond, located in the lower part of the mine site area. The sediment pond has been sized to contain mine site runoff from the 10-year storm as well as provide sufficient residence time for settlement of suspended sediments in mine site runoff. The sediment pond will be unlined to facilitate cleanout of sediments during operation.

Ore storage and fuel storage areas within the mine site will be bermed and lined as separate systems from site runoff water.

## 5.4 ON-SITE SPILL PREVENTION AND CONTINGENCY PLAN

This outline On-Site Spill Prevention and Counter-measure Plan (SPCC) defines procedures to deal with any emergency situation associated with a spill of substances with significant contaminant potential at the Bornite Project. The SPCC's primary purpose is to define and describe basic management responses to spills and to provide an emergency operational handbook for emergencies, such as an accidental release of process chemicals or fuel. Potential environmental contaminants at the site will include petroleum products and chemical reagents. The SPCC addresses emergency responses to spills of each of these materials. The SPCC plan is developed in accordance with Oregon Revised Statutes, Chapter 468 (1986 and 1987).

Specific objectives of the SPCC are to:

- Reduce the potential for accidental spills and environmental contamination through a well-defined materials management program;
- Provide the operating staff with the necessary information to properly respond to a hazardous material or petroleum spill event;
- Clearly define responsibilities for spill notification and control of spills; and
- Provide a response and cleanup program that minimizes or eliminates environmental impacts.

These objectives will be achieved under the direction of the Emergency Response Team Coordinator, who will coordinate and direct a professional team trained in actual emergency response actions.

The basic steps to be taken in any emergency spill situation are:

- Protect the lives of people.
- Render emergency first aid.
- Notify proper authorities.
- Contain and neutralize the spill.
- Conduct site cleanup and remove contaminated materials from the site.
- Monitor potentially affected water resources.
- Document and report incident.

- Reassess spill prevention and response procedures.

The Bornite Project personnel will develop the capability to handle an emergency spill before the start-up of on-site activity, thereby minimizing the threat of environmental contamination and injury to humans or wildlife after the introduction of potentially harmful materials to the site.

### 5.4.1 Emergency Response Team

The Emergency Response Team will be comprised of mine personnel who are specially trained in spill containment and neutralization procedures, and in first-aid treatment. All Emergency Response Team members will be well-trained and equipped with the knowledge and materials needed to fulfill their duties. Team members will be issued copies of the SPCC and will receive annual emergency response training, including a review of the SPCC.

Team members will be available by telephone on a 24-hour basis. In an emergency, the Emergency Response Team coordinator will be contacted immediately and will be responsible for notifying other team members as needed.

### 5.4.2 Materials Management Program

Proper storage and handling of substances with contamination potential will significantly reduce the probability of a spill. In addition to a thorough materials management program, special safety provisions at the Bornite Project will include an on-site, fully equipped spill treatment trailer.

#### Emergency Spill Response

A fully equipped emergency spill response trailer will be maintained on-site for immediate mobilization during a spill event. The trailer will contain:

- First aid supplies, including
- A set of instructions on first-aid treatment
- Standard first-aid kit, including bandages, scissors, tweezers, soap, antiseptic medicine, etc.
- Portable dam for fuel spill containment
- Log book to document trailer inspections and use

100 feet beneath the terrace surface. Boulders of up to four-foot size were encountered during monitor well drilling. No significant variation with depth was seen in the percentage of fines. Coarser materials are generally found near to the outside and upper end of the terrace (WWL, 1992).

## 1.11 MINERALOGY AND GEOCHEMISTRY

The Bornite breccia pipe is related to a multiple phase intrusive diorite (Plexus, 1992). The breccia pipe consists of a fine-grained diorite border, a coarser-grained diorite interior, and an intrusive breccia (a mixture of the diorite and intruded andesites). Both the volcanic and intrusive rocks in the area have been subject to hydrothermal alteration, dominantly characterized by the copper sulfides bornite and chalcopyrite. Trace amounts of other sulfide minerals, including sphalerite and molybdenite, have been noted in some core specimens. Mineralogy of the Bornite deposit is listed in Table 4.

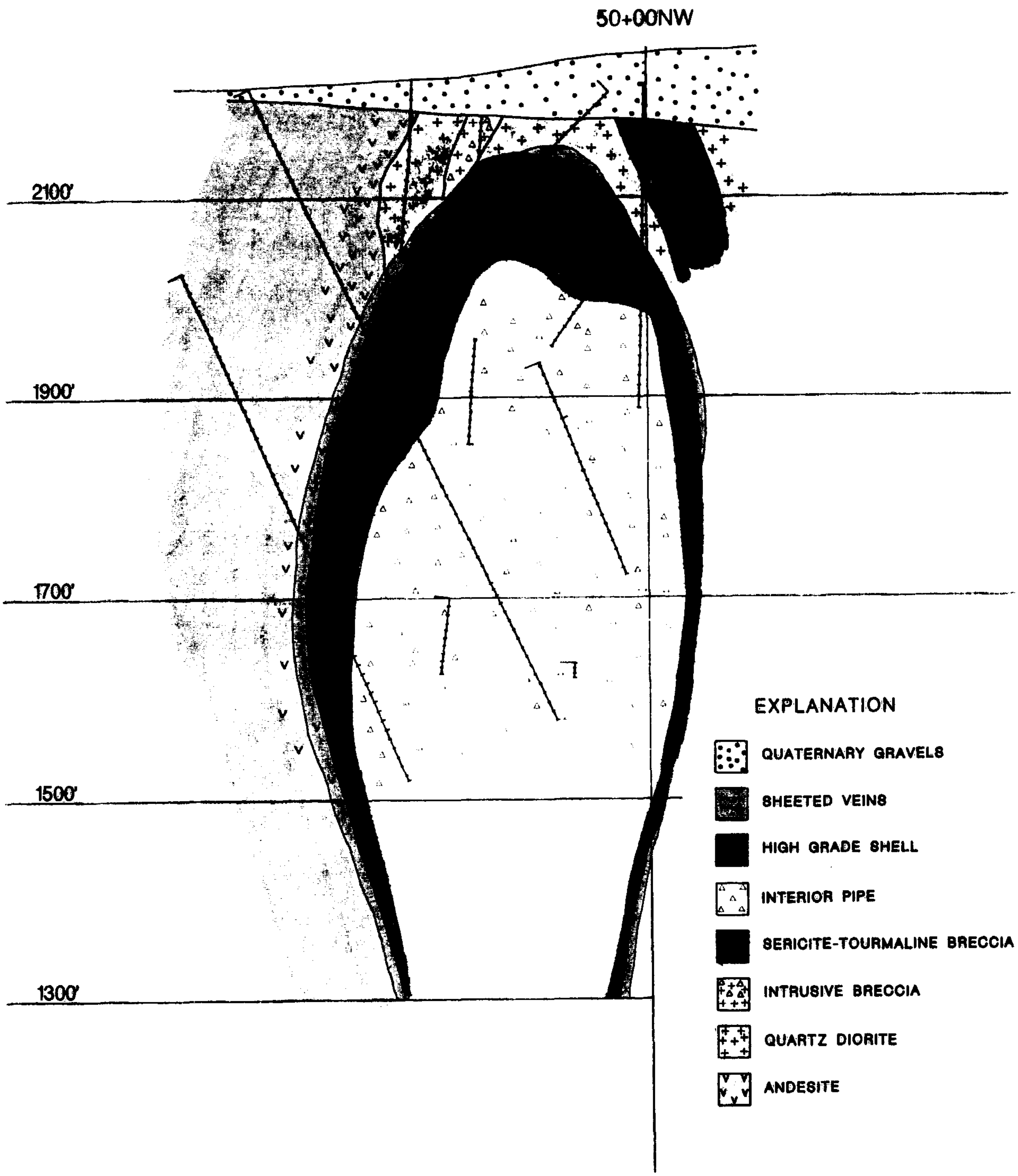
**Table 4. Bornite Mineralogy**

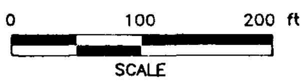
| Major Ore Minerals | | Minor Sulfide Minerals | | Major Gangue Minerals | |
|---|---|---|---|---|---|
| Bornite | $Cu_5FeS_4$ | Chalcocite | $Cu_2S$ | Sericite | $K_2Al_4(Si_2Al_6)O_{20}(OH)_4$ |
| Chalcopyrite | $CuFeS_2$ | Molybdenite | $MoS_2$ | Quartz | $SiO_2$ |
| Electrum | AuAg | Galena | PbS | Chlorite | $(Mg,Fe^{+2})_5(Al,Fe^{+3})_2Si_3O_{10}(OH)_8$ |
| | | Sphalerite | (Zn,Fe)S | Tourmaline | $(Na,Ca)(Mg,Fe^{+2},Fe^{+3})_3B_3Al_3(Al,Si_2,O_9)_3(O,OH,F)_4$ |
| | | Tennantite | $(Cu,Fe)_{12}As_4S_{13}$ | Calcite | $CaCO_3$ |
| | | Wittichenite | $Cu_3BiS_3$ | Dolomite | $CaMg(CO_3)_2$ |
| | | Pyrite | $FeS_2$ | Ankerite | $Ca(Mg,Fe)(CO_3)_2$ |
| | | | | Barite | $BaSO_4$ |
| | | | | Beryl | $Be_3Al_2(SiO_3)_6$ |

## 1.12 SUMMARY OF WASTE CHARACTERIZATION

Geochemical tests were performed on tailings, development rock, and tailings fluids. The objective was to characterize acid generating potential, leachability, and other parameters that may prove detrimental to the environment (WWL, 1992).

The ratio of acid neutralizing potential to acid generating potential (ANP/AGP) ranged from 3.7 to over 100 (WWL,1992). To be classified as acid generating, the material would exhibit an ANP/AGP ratio less than 3.0 (DEQ, 1992).

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*MARION COUNTY, OREGON*

GEOLOGICAL SECTION OF ORE BODY
5075 NORTHEAST

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| | | |
|---|---|---|
| | FIGURE 6 | NOV., 1992 |

- Spill Contingency Plan
- 100 feet of 1-1/2 inch diameter rubber hose
- Centrifugal pump
- 50 feet by 50 feet impermeable plastic sheet
- Monitoring equipment, including:
- Water sample bottles
- Preservatives
- Empty 100-gallon tank for initial containment of concentrated spills or to mix treatment fluid for diversion pond
- Full safety gear, including:
- Respirators
- Waders
- Rubber gloves
- Waterproof suits
- Face shields
- Hard hats/helmets
- Tool kit
- Shovels

**Storage and Handling of Process Chemicals**

To minimize the potential for accidental spills and environmental contamination, process chemicals at the Bornite Project will be stored and handled in strict accordance with the following guidelines.

**Diesel Fuel** will be stored in a 7,500 gallon tank adjacent to the shop area.

**Gasoline** will be stored in a 500-gallon tank adjacent to the shop area. Light-duty vehicles will be refueled directly from the tanks.

**Ammonium Nitrate** and other explosives will be stored on-site in a controlled access area at a safe distance from the principal areas, separate from the storage of process chemicals.

**Methyl Isobutyl Carbinol (MIBC)** or the equivalent will be received in 55-gallon drums and stored in the process area.

**Dithiophosphate: A 3477** or the equivalent will be received in 55-gallon drums and stored in the process area.

**Flocculant** will be received in 55-gallon drums or bags weighing not more than 100 pounds and stored in the process area.

### 5.4.3 Fuel Spills

Without question, fuels, including diesel, gasoline and lubricating oils, must be handled carefully to avoid spills. Strict adherence to the transportation plan will significantly reduce the probability of fuel spills. On-site fuels will be stored in facilities designed to contain spills. Fueling sites will be located and constructed to minimize fuel losses.

Three types of spills must be considered:

- Spills during transport to the site;
- Fuel losses in storage and fueling area; and
- Fuel spills in areas not designed for containment, such as fuel trucks servicing construction equipment.

Following are actions to be taken in response to fuel spills.

#### Spill Containment

If possible, all flammable materials in and adjacent to the spill site should be removed immediately. Fuel spills must then be contained as soon as possible after the loss has occurred to prevent its spreading and to simplify cleanup procedures.

**Fueling Pad Spills.** Fueling pads will be designed to contain all spilled fuel. No further containment should be required.

**Land Spills.** To prevent the spill from spreading laterally, construct an earthen dike or dam of sufficient size to intercept both the fuel and affected water.

**Removal of Fuel and Contaminated Material**

**From Fueling Pad.** Fuel may be removed by suction and used or placed in the designated disposal area in containers. The containers will be moved to an approved disposal site.

**From Land.** Remove free product by suction. Contaminated soil beneath the spill must then be removed. Both the product and soil will be moved to an approved disposal site. If considered a potential groundwater contamination problem, monitoring wells should be installed to determine the extent of fuel in the groundwater. If groundwater is contaminated, the fuel must be removed with recovery wells or trenches, and the water/fuel mixture taken to a disposal area.

**From Water.** A suction pump may be used to remove fuel, or a commercial skimmer may remove fuel mechanically. If neither method is feasible, incineration may be used with the approval of fire control authorities.

The major concern in fuel spills that enter water is to protect water users and aquatic life. Rapid containment and absorption are the most important factors in handling such spills.

### 5.4.4 Chemicals and Reagents

While none of the chemicals or reagents proposed for use has been classified as hazardous, stringent procedures in the design of on-site storage facilities will reduce the possibility of spills.

**Spills**

**Storage Areas.** Storage areas are designed to contain chemical and reagent spills, and clean-up will consist of removal of the spilled substance and placement into containers for reuse or disposal to an approved disposal site.

**Land.** Spills must first be contained by diking for liquids to prevent spreading, by diversion of runoff or streams for spills near water. Vehicles and people must be diverted from the spill site and barricades used to prevent unauthorized entry. Spilled substances must be removed and placed in an approved disposal site.

**Water.** For spills into water (streams and ponds) diversion of water around the spill must be considered to avoid spreading. Diking of smaller water bodies may be used for containment of the spilled substance. After containment, the spill must be neutralized and removed, if appropriate.

Removal may consist of pumping to an approved storage area, into containers for storage or possibly into the operation process waters.

## SECTION 6.0
## RECLAMATION PLANS AND DECOMMISSIONING

### 6.1 INTRODUCTION

The reclamation and decommissioning plan for the Bornite Project has been prepared to comply, in concept, with the requirements of the Willamette National Forest and the Oregon Division of Geology and Mining Industries (DOGAMI). The existing environmental conditions of the Bornite Project area are discussed in general terms in Section 4.0 of this document. A detailed site investigation will be completed during the upcoming months, as a precursor to the completion of a project related environmental impact statement. Using the information generated in these field studies, the reclamation plan provided below will be given additional detail and a definitive plan provided. In general, the goals of the reclamation plan are:

- To stabilize the site to prevent erosion and sedimentation on both a short and long term basis;
- To re-establish a productive vegetation and wildlife habitat consistent with predevelopment conditions and the accepted landuse objective.
- To achieve a visual compatability with the surrounding landscape.

The Bornite Project is being planned to keep the site disturbance as small as possible and to begin restoration and reclamation activities in a concurrent manner. In this manner, at the end of the active project life, approximately 50 percent of the disturbance will require final reclamation. This will include roads, the final phase of the tailing facility and the plant/mine site.

### 6.2 RECLAMATION APPROACH TECHNIQUES

The objective of the Reclamation Plan is to produce a geologic and erosionally stable post-mining topography which will have a hydrologic regime similar to predisturbance conditions and will be capable of supporting productive forest growth with a high value for use by wildlife.

The objective will be achieved through a program of sound operations engineering and planning, which creates: a tailings area with 3:1 slopes; reestablishes the natural flow of surface water across the site; salvages topsoil for reclamation; and reclaims the area with native forest species.

## 6.3 SUITABILITY OF TOPSOIL, DEVELOPMENT AND TAILINGS

Based on existing data for Landtype 16, it appears that 27 inches to 44 inches topsoil is available for reclamation. However, there may be considerable variation in topsoil depth and quality throughout the site due to the variable nature of bedrock. Therefore, the actual stripping depth will be based on an Order I soil survey conducted prior to salvaging operations. Assuming an average salvageable depth of 18 inches, approximately 63,000 cubic yeards of the topsoil will be available for reclamation during the eight year life of the project.

Landtype 16 soils, because of their favorable pH (6.0-6.5), high silt content, and depth should provide an adequate volume and quality of topsoil for revegetation. Fertilizer, especially nitrogen and possibly phosphorus, and potassium, may be utilized to augment a general low fertility. The well-drained and high permeability of the soils suggest a tendency for erosion and low soil moisture in late summer. Therefore, a straw mulch will be used to reduce erosion and retain soil moisture, and drought tolerant tree species will be used in reclamation.

The mine development rock and tailings are expected to be permeable and geochemically inert materials. Therefore, topsoil and fertilizer are planned to establish vegetation on the tailings facility exterior slopes.

## 6.4 TOPSOIL REMOVAL

The project would impact about 32 acres of Landtype 16, which has soils of the McCully and Kinney-Horeb associations. An Order I soil survey will precisely determine the quality, depth, and availability of topsoil resources. Next, the vegetation will be removed, with 12 inches to 18 inches of the best topsoil salvaged and stockpiled.

Topsoil will first be removed from the entire mine facilities area and salvaged from the tailings area as space is needed each year for tailings disposal. It may be possible to remove topsoil in advance of the expanding tailings and immediately reapply the "fresh" topsoil to the tailings impoundment area being reclaimed.

## 6.5 TOPSOIL STORAGE

Following removal, topsoil will be transported to the storage area where it will remain until needed in the reclamation process. The topsoil storage pile will be located on upland sites to minimize erosion by water. Side slopes will be no steeper than 3:1. Storage piles will be stabilized by seeding with the species listed in Table 6.1. This seed mix will be drill-seeded or hand-broadcast at twice the seeding rate. During the life of the topsoil storage piles, the protective vegetation cover will be monitored to detect any erosion or weed infestations. Following seeding, the surface will be mulched with clean straw at 3,000 pounds per acre and crimped.

## 6.6 INTERIM RECLAMATION

That portion of the tailings embankment initially created will be seeded with a stabilizing grass mixture (see Table 6.1) and planted to forest trees as soon as it is created. Each year, that portion of the tailings impoundment filled with tailings will be topsoiled and seeded with stabilizing grasses and planted to trees. The topsoiling, seedbed preparation, seeding, fertilization, and mulching process for the interim reclamation areas are discussed in the final reclamation section.

**TABLE 6.1 Revegetation Grass Mixture.**

| Scientific Name | Common Name | Application Rate (PLS)* |
|---|---|---|
| Bromus marginatus | Mountain brome | 3 |
| Dactylis glomerata | Orchardgrass | 3 |
| Festuca arundinacea | Tall fescue | 3 |
| Lolium multiflorum | Annual rye | 3 |
| Lolium perenne | Perennial ryegrass | 3 |
| | Total | 15 |

* PLS = Pure Live Seed

## 6.7 DECOMMISSIONING OF FACILITIES

Upon closure all process buildings and related facilities will be removed from the site and salvaged. Concrete foundations will be broken up and placed either in the mine workings or in the process water pond and buried. Subsequent to the removal of all facilities, the site will be graded to re-establish a natural drainage. The sediment control pond which is an unlined pond, will be incorporated into the final grading of the site. The synthetic liners in the process water and mine water ponds will be freed from their anchors, and folded in on themselves and covered with fill material prior to the placement of topsoil and revegetation.

Unless designated by the U.S. Forest Service for land management or recreation purposes, all roads will be closed and reclaimed following mine closure. The compacted roads will be ripped, graded and water-barred to permit natural drainage and revegetation. Fencing will be removed to re-establish access to the site.

Power lines and poles will be removed from the mine site and adjacent corridors with any disturbance being regraded and revegetated. Wells and water lines established to provide project water will be removed with the wells backfilled and closed in accordance with state of Oregon requirement.

Current plans call for the backfilling of underground workings. Once backfilling is completed, the mine entry and ventilation raise will be permanently closed, either by blasting and recontouring the entry ways or by sealing them with concrete plugs.

## 6.8 FINAL RECLAMATION

Areas for final reclamation include the mine facilities site and the final phases of the tailings site. The final site contours will resemble those shown on Figure 6.1.

### 6.8.1 Topsoil Replacement

After developing the post-mining contours, remaining unreclaimed surface of the tailings and mine facilities site will be ripped or chiseled to eliminate areas of compaction and create a condition appropriate for the rooting of trees. Next, topsoil will be removed from storage and placed on the tailings embankment to a depth of 24 inches, and on the tailings and mine facilities site to a depth of 12 to 18 inches.

### 6.8.2 Fertilization

Nutrients may be required to enhance the topsoil's fertility. Immediately prior to topsoil replacement, topsoil samples from the topsoil storage pile will be tested for nitrogen, phosphorus, and potassium. If fertilizer is required, it will be drilled or broadcast at appropriate rates into the top six inches of soil.

### 6.8.3 Seedbed Preparation

Seedbed preparation will be accomplished using harrows, disks, and cultipackers. Topsoil materials will be conditioned to a depth of six inches with these implements when the topsoil is sufficiently dry to minimize clogging and compaction. All tillage operations will be conducted on the contour to minimize soil erosion. The final finished seedbed will result in a furrow-like configuration with the height between furrow ridges and bottoms being between two and six inches. This will minimize erosion, optimize available soil moisture, and produce a soil surface appropriate for broadcast or drill seeding. Seedbed preparation will occur just before seeding to minimize the time the seedbed is subjected to wind and water erosion.

### 6.8.4 Seed Mixtures and Planting Rates

Following topsoiling, the area to be reclaimed will be seeded with a grass mixture (Table 6.1) to retard erosion from wind and water. This grass seed mixture is composed of introduced annual and perennial hay grasses adapted to the high moisture of the area. These species will eventually disappear from the site as the forest species increase in dominance and shade the area. To eliminate competition for moisture and nutrients between the trees and grasses, the trees will be planted in nonseed bands six feet wide and extending across the contour of the slope.

Two native forest species will be used in reclamation because they are adapted to the elevation, rainfall, and expected soil conditions. Douglas fir (Pseudotsuga menziesii) and western white pine (Pinus monticola) will be planted at an approximate density of 540 trees per acre. This is equivalent to a grid with a 9-foot spacing. The ratio of Douglas fir to western white pine will be 60:40. Two-year-old bare root 20 or 21 stock trees will be used.

### 6.8.5 Mulching

Following seeding, straw mulch free of weeds or other undesirable species, will be applied to the seeded area at 3,000 pounds per acre and crimped into the soil with a disk or other suitable machine.

### 6.8.6 Timing

The seeding of grasses will occur in early fall prior to the onset of the rainy season. Tree planting will occur in spring when field conditions permit.

### 1.12.1 Tailings

Static acid generation potential tests from batch tailings samples indicate the tailings are not acid generating. AGP in these comparisons was conservatively based on total sulfur. Not all sulfur forms generate acid drainage. Eight tests were done on both the total and fine fractions of tailings samples to represent the materials to be discharged in the surface tailings impoundment and underground. These showed no potential for acid generation. The results of the static testing is shown in Table 5.

**Table 5. Summary of ANP/AGP Testing**

| SAMPLE | TOTAL SULFUR (%) | AGP (T $CaCO_3$/KT) | ANP (T $CaCO_3$/KT) | ANP-AGP (T $CaCO_3$/KT) | ANP/AGP |
|---|---|---|---|---|---|
| 1 (fine) | 0.25 | 7.80 | 28.90 | 21.10 | 3.71 |
| 1 (coarse) | 0.03 | 0.90 | 22.60 | 21.70 | 25.11 |
| 3 (total) | 0.02 | 0.60 | 58.10 | 57.50 | 96.83 |
| 4 (total) | 0.32 | 10.00 | 44.00 | 34.00 | 4.40 |
| 5 (total) | 0.12 | 3.75 | 19.00 | 15.25 | 5.07 |
| 6 (total) | 0.03 | 0.94 | 37.00 | 36.06 | 39.47 |
| 7 (total) | 0.06 | 1.88 | 28.00 | 26.13 | 14.93 |
| 7 (fine) | 0.01 | 0.31 | 36.00 | 35.69 | 116.13 |

From EPA Method 1311 tests on tailings samples, the resulting leachate is well under maximum allowable concentrations, and tailings are therefore not hazardous. From EPA Method 1312 tests on batch tailings samples (representing precipitation leaching), the tailings leachate meets DEQ groundwater quality guidance levels. The EPA 1312 test leachate meets DEQ basin standards for all of the parameters analyzed, except for copper (WWL, 1992).

Tailings fluid analysis meets DEQ groundwater guidance levels for all parameters except iron and manganese. The tailings fluid meets basin standards for all parameters except copper, lead, iron, and silver. Comparing tailings fluid analysis results with Oregon DEQ basin standards, basin standards are exceeded by factors ranging from 1.7 to 8.4. This means if tailings fluid was discharged to surface water under permitted conditions, a dilution factor of 1.7 to 8.4 would be required to meet basin standards. Comparing the tailings fluid analysis results with DEQ groundwater guidance levels, guidance levels are exceeded by factors ranging from 3.8 to 8.3. This means that a dilution factor of 3.8 to 8.3 would be required for permitted discharge of tailings fluid before it is measured at a specific point of groundwater compliance (WWL, 1992).

100 feet beneath the terrace surface. Boulders of up to four-foot size were encountered during monitor well drilling. No significant variation with depth was seen in the percentage of fines. Coarser materials are generally found near to the outside and upper end of the terrace (WWL, 1992).

## 1.11 MINERALOGY AND GEOCHEMISTRY

The Bornite breccia pipe is related to a multiple phase intrusive diorite (Plexus, 1992). The breccia pipe consists of a fine-grained diorite border, a coarser-grained diorite interior, and an intrusive breccia (a mixture of the diorite and intruded andesites). Both the volcanic and intrusive rocks in the area have been subject to hydrothermal alteration, dominantly characterized by the copper sulfides bornite and chalcopyrite. Trace amounts of other sulfide minerals, including sphalerite and molybdenite, have been noted in some core specimens. Mineralogy of the Bornite deposit is listed in Table 4.

**Table 4. Bornite Mineralogy**

| Major Ore Minerals | | Minor Sulfide Minerals | | Major Gangue Minerals | |
|---|---|---|---|---|---|
| Bornite | $Cu_5FeS_4$ | Chalcocite | $Cu_2S$ | Sericite | $K_2Al_4(Si_2Al_6)O_{20}(OH)_4$ |
| Chalcopyrite | $CuFeS_2$ | Molybdenite | $MoS_2$ | Quartz | $SiO_2$ |
| Electrum | AuAg | Galena | PbS | Chlorite | $(Mg,Fe^{+2})_5(Al,Fe^{+3})_2Si_3O_{10}(OH)_8$ |
| | | Sphalerite | (Zn,Fe)S | Tourmaline | $(Na,Ca)(Mg,Fe^{+2},Fe^{+3})_3B_3Al_3(Al,Si_2,O_9)_3(O,OH,F)_4$ |
| | | Tennantite | $(Cu,Fe)_{12}As_4S_{13}$ | Calcite | $CaCO_3$ |
| | | Wittichenite | $Cu_3BiS_3$ | Dolomite | $CaMg(CO_3)_2$ |
| | | Pyrite | $FeS_2$ | Ankerite | $Ca(Mg,Fe)(CO_3)_2$ |
| | | | | Barite | $BaSO_4$ |
| | | | | Beryl | $Be_3Al_2(SiO_3)_6$ |

## 1.12 SUMMARY OF WASTE CHARACTERIZATION

Geochemical tests were performed on tailings, development rock, and tailings fluids. The objective was to characterize acid generating potential, leachability, and other parameters that may prove detrimental to the environment (WWL, 1992).

The ratio of acid neutralizing potential to acid generating potential (ANP/AGP) ranged from 3.7 to over 100 (WWL,1992). To be classified as acid generating, the material would exhibit an ANP/AGP ratio less than 3.0 (DEQ, 1992).

## SECTION 7.0
## WORK FORCE

The Bonite Project is planned to begin construction in the spring of 1993, depending upon receipt of permits and approvals. Construction of the surface facilities will occur over the following nine to eleven months. An average of 85 workers and a peak of 100 will be employed during this period.

Subsequent to completion of construction, the operating manpower requirements will drop to the range of 79 to 85 and continue at that level throughout the productive life of the project (see Table 7.1). Approximately 82 percent will be hired from the local Marion/Limn county labor pool.

Plexus will develop a training program to retrain local workers to work in a mining environment. Skills available from individuals with experience in agriculture, construction, and timber industries will be considered desirable. It is anticipated that hiring locally will allow for a more stable long-term work force.

**TABLE 7.1 Bornite Project Typical Manpower Requirements.**

| Mine | | Processing | | Administration | |
|---|---|---|---|---|---|
| Mine Superintendent | 1 | Mill Superintendent | 1 | General Manager | 1 |
| Mine Engineers | 2 | General Foreman | 1 | Secretary | 1 |
| Mine Geologists | 2 | Metallurgist | 1 | Accounting Clerks | 2 |
| Surveyors | 3 | Lab Technicians | 2 | Safety/Environmental Engineer | 1 |
| Mine Clerk | 1 | Shift Foremen | 4 | | |
| Shift Foremen | 3 | | | | |
| Mechanical Foreman | 1 | | | | |
| Maintenance | 7 | Maintenance | 5 | | |
| Equipment Operators | 7 | Mill Operator | 14 | | |
| Blasters | 3 | | | | |
| Miners | 16 | | | | |
| Subtotal | 46 | | 28 | | 5 |
| TOTAL | 79 employees | | | | |

## SECTION 8.0
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STATE PERMITTING BUDGET ESTIMATE FOR PLEXUS'S BORNITE PROJECT

I.D. No. 24-0076

DATE PREPARED: 07-Oct-91
DATE PRINTED: 03-Aug-92

PERSON DAYS FOR EACH ACTIVITY

| | DEQ | WRD | DOGAMI | ODFW | D of Ag & FORESTRY | |
|---|---|---|---|---|---|---|
| 1 State Participation in USFS IDT | | | | | | |
| Assume 2 days/month for 12 months | | | 24 | | | |
| 2 Baseline methodology review | | | | | | |
| Water - Ground & Surface, Air | 15 | 10 | | | | |
| Soils, Geol. & Hazards, Mineralogy | | | 10 | | | |
| Biological Resources (incl. T & E) | | | | 8 | 7 | |
| 3 Baseline data verification | 5 | 5 | 3 | 3 | 2 | |
| 4 Public meetings (informational) | 3 | 3 | 3 | 3 | | |
| 5 Completeness determination of consolidated application (DEQ portion will be done under their application) | | | | | | |
| Review for DOGAMI permit | | 15 | 22 | 10 | 5 | |
| Draft response for DOGAMI permit | | 3 | 5 | 3 | 2 | |
| Public hearing for DOGAMI permit | | 1 | 3 | 1 | | |
| Public comment hearing and final permit | | 15 | 22 | 15 | 10 | TOTAL STAFF DAYS: |
| Total number of staff days/agency | 23 | 52 | 92 | 43 | 26 | 236 |
| Agency billing rate | $57.00 | $34.00 | $32.00 | $30.00 | $31.00 | |
| Staff cost/agency (@ 8 hrs/day) | $10,488 | $14,144 | $23,552 | $10,320 | $6,448 | |
| Travel costs (@ 3%) | ** | $424 | $707 | $310 | $193 | |
| Individual agency permitting cost | $10,488 | $14,568 | $24,259 | $10,630 | $6,641 | |
| Total agency permitting cost | | | $66,586 | | | |
| Project administration (10%) | | | $6,659 | | | |
| Contingency (10%) | | | $7,324 | | | |
| Total cost estimate | | | $80,569 | | | |

* If the consolidated application is determined to be incomplete, the review process will be repeated.

** Travel cost built into DEQ hourly rate

# THE BORNITE PROJECT
# OPERATING AND RECLAMATION PERMIT
# TABLE OF CONTENTS

**Application for Reclamation Permit**





g:\bornite.drp

### 1.12.2 Development Rock and Ore

From static acid generation potential tests on rock core samples, about 3/4 of the development rock is not acid generating. This is based on ANP/AGP ratios greater than 3. AGP in these comparisons was conservatively based on total sulfur. The results of this testing is shown in Table 6.

**Table 6. Summary of Development Rock ANP/AGP Testing**

| SAMPLE | DRILL CORE SAMPLE | TOTAL SULFUR (%) | AGP (T $CaCO_3$/KT) | ANP (T $CaCO_3$/KT) | ANP-AGP (T $CaCO_3$/KT) | ANP/AGP |
|---|---|---|---|---|---|---|
| BNTD-1 | CC-18 190-250' | 0.23 | 7.20 | 50.70 | 43.50 | 7.04 |
| BNTD-2 | CC-18 583-612' | 0.09 | 2.80 | 18.40 | 15.60 | 6.57 |
| BNTD-3 | CC-11 840-890' | 0.14 | 4.40 | 31.70 | 27.30 | 7.20 |
| 1-300 | CC-13 299-300.8' | 0.04 | 1.25 | 4.00 | 2.75 | 3.20 |
| 1-600 | CC-13 599-601' | 0.32 | 10.00 | 5.00 | -5.00 | 0.50 |
| 1-900 | CC-13 899-900.6' | 0.42 | 13.13 | 50.00 | 36.88 | 3.81 |
| 2-300 | CC-14 298.5-300' | <0.01 | 0.31 | 7.00 | 6.69 | 22.58 |
| 2-600 | CC-14 599-600.8' | 0.04 | 1.25 | 4.00 | 2.75 | 3.20 |
| 2-900 | CC-14 899.2-901' | 0.21 | 6.56 | 11.00 | 4.44 | 1.68 |
| 3-300 | CC-15 298.5-300' | 0.10 | 3.13 | 10.00 | 6.88 | 3.20 |
| 3-600 | CC-15 598-600' | 0.08 | 2.50 | 26.00 | 23.50 | 10.40 |
| 3-900 | CC-15 898-900' | 0.04 | 1.25 | 4.00 | 2.75 | 3.20 |
| 4-300 | CC-12 299.3-300.8' | <0.01 | 0.31 | 11.00 | 10.69 | 35.48 |
| 4-600 | CC-12 599-600.8' | 0.06 | 1.88 | 21.00 | 19.13 | 11.20 |
| 4-900 | CC-12 899-900.8' | 0.04 | 1.25 | 26.00 | 24.75 | 20.80 |
| 5-300 | CC-8 299.3-300.8' | 0.11 | 3.44 | 45.00 | 41.56 | 13.09 |
| 5-600 | CC-8 594.5-596' | 0.24 | 7.50 | 11.00 | 3.50 | 1.47 |
| 6-300 | CC-16 299-300.5' | 0.04 | 1.25 | 34.00 | 32.75 | 27.20 |
| 6-600 | CC-16 599.3-600.8' | 0.60 | 18.75 | 39.00 | 20.25 | 2.08 |
| 6-900 | CC-16 899-900.5' | 0.42 | 13.13 | 9.00 | -4.13 | 0.69 |
| 7-300 | CC-19 299-301' | 0.15 | 4.69 | 34.00 | 29.31 | 7.25 |
| 8-300 | CC-10 299.5-300.5' | 0.02 | 0.63 | 37.00 | 36.38 | 59.20 |
| 8-600 | CC-10 599.3-600.8' | 0.32 | 10.00 | 17.00 | 7.00 | 1.70 |
| 8-900 | CC-10 899.5-901' | 0.01 | 0.31 | 9.00 | 8.69 | 28.80 |

More kinetic humidity cell testing was done on the samples that did not meet the ANP/AGP minimum standard. Kinetic testing simulates environmental weathering with alternating wet and dry periods. The resulting drainage is periodically tested for acid forming indicators. Humidity cell tests were performed on samples with low ANP/AGP

### 1.12.1 Tailings

Static acid generation potential tests from batch tailings samples indicate the tailings are not acid generating. AGP in these comparisons was conservatively based on total sulfur. Not all sulfur forms generate acid drainage. Eight tests were done on both the total and fine fractions of tailings samples to represent the materials to be discharged in the surface tailings impoundment and underground. These showed no potential for acid generation. The results of the static testing is shown in Table 5.

**Table 5. Summary of ANP/AGP Testing**

| SAMPLE | TOTAL SULFUR (%) | AGP ($T\ CaCO_3/KT$) | ANP ($T\ CaCO_3/KT$) | ANP-AGP ($T\ CaCO_3/KT$) | ANP/AGP |
|---|---|---|---|---|---|
| 1 (fine) | 0.25 | 7.80 | 28.90 | 21.10 | 3.71 |
| 1 (coarse) | 0.03 | 0.90 | 22.60 | 21.70 | 25.11 |
| 3 (total) | 0.02 | 0.60 | 58.10 | 57.50 | 96.83 |
| 4 (total) | 0.32 | 10.00 | 44.00 | 34.00 | 4.40 |
| 5 (total) | 0.12 | 3.75 | 19.00 | 15.25 | 5.07 |
| 6 (total) | 0.03 | 0.94 | 37.00 | 36.06 | 39.47 |
| 7 (total) | 0.06 | 1.88 | 28.00 | 26.13 | 14.93 |
| 7 (fine) | 0.01 | 0.31 | 36.00 | 35.69 | 116.13 |

From EPA Method 1311 tests on tailings samples, the resulting leachate is well under maximum allowable concentrations, and tailings are therefore not hazardous. From EPA Method 1312 tests on batch tailings samples (representing precipitation leaching), the tailings leachate meets DEQ groundwater quality guidance levels. The EPA 1312 test leachate meets DEQ basin standards for all of the parameters analyzed, except for copper (WWL, 1992).

Tailings fluid analysis meets DEQ groundwater guidance levels for all parameters except iron and manganese. The tailings fluid meets basin standards for all parameters except copper, lead, iron, and silver. Comparing tailings fluid analysis results with Oregon DEQ basin standards, basin standards are exceeded by factors ranging from 1.7 to 8.4. This means if tailings fluid was discharged to surface water under permitted conditions, a dilution factor of 1.7 to 8.4 would be required to meet basin standards. Comparing the tailings fluid analysis results with DEQ groundwater guidance levels, guidance levels are exceeded by factors ranging from 3.8 to 8.3. This means that a dilution factor of 3.8 to 8.3 would be required for permitted discharge of tailings fluid before it is measured at a specific point of groundwater compliance (WWL, 1992).

**DOGAMI ANALYSIS**
1991 – JUNE 1992

| INVOICE # | INVOICE AMOUNT | | DESCRIPTION |
|---|---|---|---|
| | | | 1991 |
| N/A | 80.60 | 80.60 | COPY FORMOSA'S RECLAMTION PLAN |
| | | | **DIRECT COSTS** |
| 342 | 763.74 | 318.25 | LYNCH 6 HRS |
| | | | THROOP 7 HRS / |
| | | | DISCUSSION W/ JANINE CLAYTON USFS |
| | | | PLEXUS PRESENTATION TO USFS EUGENE |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 187.49 | SUPERVISOR |
| | | 70.11 | RECLAMATIONIST |
| | | 81.98 | CLERICAL |
| | | 105.91 | INDIRECT COSTS/ 16.1 % MARKUP |
| | | | **DIRECT COSTS** |
| 365 | 1110.36 | 591.39 | LYNCH 4 HRS |
| | | | THROOP 14 HRS/ |
| | | | TALK W/M.HERNANDEZ/GOSSON /REVIEW BOND |
| | | | MEET WITH ENVIRONMENTAL GROUP |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 310.60 | SUPERVISOR |
| | | 29.43 | RECLAMATIONIST |
| | | 24.97 | CLERICAL |
| | | 153.97 | INDIRECT COSTS/ 16.1 % MARKUP |
| N/A | 5.00 | 5.00 | PUBLICATION |
| | | | **DIRECT COSTS** |
| 380 | 615.09 | 169.63 | LYNCH 2 HRS |
| | | | THROOP 5 HRS/ |
| | | | REVIEW PERMIT/MAILING LIST/TALK W/ J. CLAPTON & |

# DOGAMI ANALYSIS
1991 – JUNE 1992

| INVOICE # | INVOICE AMOUNT | | DESCRIPTION |
|---|---|---|---|
| | | | A. GORDON |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 213.77 | SUPERVISOR |
| | | 69.70 | RECLAMATIONIST |
| | | 58.20 | CLERICAL |
| | | 103.79 | INDIRECT COSTS/ 20.3 % MARKUP |
| 24–0076 | 300.00 | 300.00 | EXPLORATION PERMIT |
| | | | **DIRECT COSTS** |
| 423 | 1223.54 | 692.02 | LYNCH 16 HRS/ MEET W/ USFS THROOP 8 HRS / REVIEW BASELINE & DISCUSS W/USFS / TALK W/ DEQ HERNANEDEZ |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 83.64 | SUPERVISOR |
| | | 166.49 | RECLAMATIONIST |
| | | 74.92 | CLERICAL |
| | | 206.47 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 404 | 325.73 | 19.05 | THROOP 2 HRS / SET UP DISTRIB SHEET/ T.F. ON STATE GOVT. |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 111.10 | SUPERVISOR |
| | | 57.94 | RECLAMATIONIST |
| | | 82.67 | CLERICAL |
| | | 54.97 | INDIRECT COSTS/ 20.3 % MARKUP |

DOGAMI ANALYSIS
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| INVOICE # | INVOICE AMOUNT | | DESCRIPTION |
|---|---|---|---|
| | | | **DIRECT COSTS** |
| 437 | 3191.74 | 2290.34 | THROOP 78 HRS/ |
| | | | PUBLIC HEARING/ SITE VISIT/ TRT MTG/ IDT MTG/ |
| | | | BASELINE REVIEW W/ USFS/ SCOPING MTG |
| | | | LYNCH 1 HR / BUDGET DRAFT |
| | | | MARSHALL D. 5 HRS/ TYPING FOR THROOP |
| | | | SCHNITZER 3 HRS/ |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 146.72 | SUPERVISOR |
| | | 129.74 | RECLAMATIONIST |
| | | 86.35 | CLERICAL |
| | | 538.59 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | 1992 |
| | | | **DIRECT COSTS** |
| 452 | 1284.34 | 843.81 | THROOP 29 HRS/ |
| | | | REVIEW CONTRACT TERMS/USFS BD OF CONTRCT AWARDS/ |
| | | | USFS IDT MTG/REV. NEW BASELINE/ MEET |
| | | | W/CLAYTON, PULEO, NORTON, BARTO |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 98.43 | SUPERVISOR |
| | | 46.52 | RECLAMATIONIST |
| | | 78.86 | CLERICAL |
| | | 216.72 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 468 | 793.61 | 527.78 | LYNCH 2 HRS/ MTG W/A.GORDON / USFS W/CLAYTON |
| | | | THROOP 15 HRS/ |
| | | | REV. DEADLINE/ MEMOS/IDT MTG/ MEET W/PULEO, |
| | | | CLAYTON/ RESPONSE 90 IDT RE:BASELINE DATA |
| | | | MARSHALL 1 HR/ MENU |

DOGAMI ANALYSIS
1991 – JUNE 1992

| INVOICE # | INVOICE AMOUNT | | DESCRIPTION |
|---|---|---|---|
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 92.23 | SUPERVISOR |
| | | 38.76 | RECLAMATIONIST |
| | | 0.92 | CLERICAL |
| | | 133.92 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 489 | 1553.01 | 1180.15 | LYNCH 1 HR/ ADMIN & UPDATE |
| | | | SCHNITZER 6 HRS |
| | | | THROOP 36 HRS/ |
| | | | TRT MTG/REV. BASELINE & SOIL DATA/ MEET |
| | | | W/CLAYTON, TURNBAUGH, SHANK, DEQ, ETC. |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 106.69 | SUPERVISOR |
| | | 4.11 | RECLAMATIONIST |
| | | 0.00 | CLERICAL |
| | | 262.06 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 503 | 151.72 | 31.57 | LYNCH 1 HR/ |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 78.43 | SUPERVISOR |
| | | 16.12 | RECLAMATIONIST |
| | | 0.00 | CLERICAL |
| | | 25.60 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 517 | 2066.87 | 1588.05 | LYNCH 1 HR/ ADMIN |
| | | | SCHNITZER 8 HRS / CREDITED ON INV # 531 |
| | | | THROOP 34 HRS/ |

DOGAMI ANALYSIS
1991 -- JUNE 1992

| INVOICE # | INVOICE AMOUNT | | DESCRIPTION |
|---|---|---|---|
| | | | REV & DISCUS GRND WATER AMMDMTS W/CLAYTON & NORTON/ MTGS PLXS & DEQ/ DISCUSS 3RD PARTY CONTRACTING W/GWL CONTRCTRS/ IDT MTG/ REVIEW GEOL & SOIL DATA |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 95.79 | SUPERVISOR |
| | | 32.20 | RECLAMATIONIST |
| | | 2.06 | CLERICAL |
| | | 348.77 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 531 | 555.15 | 338.35 | LYNCH 2 HRS/ ACCT & STATUS REVIEW |
| | | | THROOP 19 HRS/ DISCUSS IDT MTG & GRNDWTR W/CLAYTON/ UNDERGROUND ENGNRG DATA/ EDIT GRNDWTR RESPONSE/ GROUND WATER MTG/ IDT MTG |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 86.29 | SUPERVISOR |
| | | 32.61 | RECLAMATIONIST |
| | | 4.22 | CLERICAL |
| | | 93.68 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 549 | 740.47 | 551.79 | LYNCH 2 HRS/ ADMINISTRATION |
| | | | THROOP 11 HRS/ REVIEW PRELIM DRAFT ALT. & APPENDIX 4/ TALK W/ NORTON, BARTO, BARB S., C. KERBY/ IDT MEETING |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 43.80 | SUPERVISOR |
| | | 19.93 | RECLAMATIONIST |

DOGAMI ANALYSIS
1991 – JUNE 1992

| INVOICE # | INVOICE AMOUNT | | DESCRIPTION |
|---|---|---|---|
| | | 0.00 | CLERICAL |
| | | 124.95 | INDIRECT COSTS/ 20.3 % MARKUP |
| | | | **DIRECT COSTS** |
| 563 | 454.90 | 258.42 | LYNCH 1 HR/ ADMINISTRATION |
| | | | THROOP 8 HRS/ REVIEW ISSUES & ALTERNATIVES/TALK W/HALEMEIER, PULEO, CLAYTON/ REVIEW & DISCUSS POSSIBLE SALES OF SAND IN VALLEY W/IDT, BARTO, MARIAH |
| | | | **NON SPECIFIC PROJECT DIVISION** |
| | | 104.65 | SUPERVISOR |
| | | 8.08 | RECLAMATIONIST |
| | | 6.99 | CLERICAL |
| | | 76.76 | INDIRECT COSTS/ 20.3 % MARKUP |
| | $15,215.87 | $15,215.87 | |

ratios. The humidity cell tests were performed for periods of 10 to 20 weeks, and indicate that the materials are not acid generating (WWL, 1992).

Static acid generation potential tests were also performed on samples within the breccia pipe, representing mineralized development rock and ore. These test results (with AGP conservatively based on total sulfur) indicate that the sheeted vein and interior pipe materials are not acid generating to marginally acid generating (11 of 13 samples with ANP/AGP ratios greater than 3). The highest grade ore material is potentially acid generating, but will be processed and the sulfide minerals removed in the concentrate product. No further acid generation testing was done on these samples. The results of this testing is shown in Table 7.

**Table 7. Ore ANP/AGP**

| SAMPLE | DRILL CORE SAMPLE | TOTAL SULFUR (%) | AGP (T $CaCO_3$/KT) | ANP (T $CaCO_3$/KT) | ANP-AGP (T $CaCO_3$/KT) | ANP/AGP |
|---|---|---|---|---|---|---|
| 9-160 | CC-28 160-170' | 0.50 | 15.6 | 37.7 | 22.1 | 2.4 |
| 9-330 | CC-28 250-261' | 1.48 | 46.2 | 28.7 | -17.5 | 0.6 |
| 9-273 | CC-28 273-280' | 0.81 | 25.3 | 31.6 | 6.3 | 1.2 |
| 6-230 | CC-35 230-240' | 0.19 | 5.9 | 50.1 | 44.2 | 8.5 |
| 6-250 | CC-35 250-260' | 2.01 | 62.8 | 58.2 | -4.6 | 0.9 |
| 6-390 | CC-35 390-400' | 0.71 | 22.2 | 90.1 | 67.9 | 4.1 |
| 6-410 | CC-24 410-420' | 0.31 | 9.7 | 38.6 | 28.9 | 4.0 |
| 6-720 | CC-24 720-730' | 1.71 | 53.4 | 65.3 | 11.9 | 1.2 |
| 6-670 | CC-24 670-680' | 0.09 | 2.8 | 22.4 | 19.6 | 8.0 |
| 5-420 | CC-37 420-430' | 0.36 | 11.2 | 50.8 | 39.6 | 4.5 |
| 5-433 | CC-37 433-440' | 2.65 | 82.8 | 33.5 | -49.3 | 0.4 |
| 5-590 | CC-37 590-600' | 0.37 | 11.6 | 136.0 | 124.4 | 11.7 |
| 8-638 | CC-32 638-650' | 0.04 | 1.2 | 98.5 | 97.3 | 82.1 |
| 7-786 | CC-29 786-790' | 1.00 | 31.2 | 98.5 | 67.3 | 3.2 |
| 7-780 | CC-29 780-786' | <0.01 | 0.3 | 124.0 | 123.7 | 413.3 |
| 10-847 | CC-42 847-857' | 0.41 | 12.8 | 52.2 | 0.0 | 4.1 |
| 1-480 | CC-27 476-490' | 0.49 | 15.3 | 82.8 | 67.5 | 5.4 |
| 1-494 | CC-27 494-500' | 3.94 | 123.0 | 50.5 | -72.5 | 0.4 |
| 1-680 | CC-27 680-690' | 0.03 | 0.9 | 88.6 | 87.7 | 98.4 |
| BNTD-4 | CC-32 310-410' | 0.04 | 1.20 | 33.90 | 32.70 | 28.25 |
| BNTD-5 | CC-32 510-610' | 0.19 | 5.90 | 16.80 | 10.90 | 2.85 |

From EPA Method 1311 tests on rock core samples, the resulting leachate is below maximum allowable concentrations, and are not hazardous. EPA Method 1312 tests on development rock and ore samples (representing materials stored on the surface and

## 1.12.2 Development Rock and Ore

From static acid generation potential tests on rock core samples, about 3/4 of the development rock is not acid generating. This is based on ANP/AGP ratios greater than 3. AGP in these comparisons was conservatively based on total sulfur. The results of this testing is shown in Table 6.

**Table 6. Summary of Development Rock ANP/AGP Testing**

| SAMPLE | DRILL CORE SAMPLE | TOTAL SULFUR (%) | AGP (T $CaCO_3$/KT) | ANP (T $CaCO_3$/KT) | ANP-AGP (T $CaCO_3$/KT) | ANP/AGP |
|---|---|---|---|---|---|---|
| BNTD-1 | CC-18 190-250' | 0.23 | 7.20 | 50.70 | 43.50 | 7.04 |
| BNTD-2 | CC-18 583-612' | 0.09 | 2.80 | 18.40 | 15.60 | 6.57 |
| BNTD-3 | CC-11 840-890' | 0.14 | 4.40 | 31.70 | 27.30 | 7.20 |
| 1-300 | CC-13 299-300.8' | 0.04 | 1.25 | 4.00 | 2.75 | 3.20 |
| 1-600 | CC-13 599-601' | 0.32 | 10.00 | 5.00 | -5.00 | 0.50 |
| 1-900 | CC-13 899-900.6' | 0.42 | 13.13 | 50.00 | 36.88 | 3.81 |
| 2-300 | CC-14 298.5-300' | <0.01 | 0.31 | 7.00 | 6.69 | 22.58 |
| 2-600 | CC-14 599-600.8' | 0.04 | 1.25 | 4.00 | 2.75 | 3.20 |
| 2-900 | CC-14 899.2-901' | 0.21 | 6.56 | 11.00 | 4.44 | 1.68 |
| 3-300 | CC-15 298.5-300' | 0.10 | 3.13 | 10.00 | 6.88 | 3.20 |
| 3-600 | CC-15 598-600' | 0.08 | 2.50 | 26.00 | 23.50 | 10.40 |
| 3-900 | CC-15 898-900' | 0.04 | 1.25 | 4.00 | 2.75 | 3.20 |
| 4-300 | CC-12 299.3-300.8' | <0.01 | 0.31 | 11.00 | 10.69 | 35.48 |
| 4-600 | CC-12 599-600.8' | 0.06 | 1.88 | 21.00 | 19.13 | 11.20 |
| 4-900 | CC-12 899-900.8' | 0.04 | 1.25 | 26.00 | 24.75 | 20.80 |
| 5-300 | CC-8 299.3-300.8' | 0.11 | 3.44 | 45.00 | 41.56 | 13.09 |
| 5-600 | CC-8 594.5-596' | 0.24 | 7.50 | 11.00 | 3.50 | 1.47 |
| 6-300 | CC-16 299-300.5' | 0.04 | 1.25 | 34.00 | 32.75 | 27.20 |
| 6-600 | CC-16 599.3-600.8' | 0.60 | 18.75 | 39.00 | 20.25 | 2.08 |
| 6-900 | CC-16 899-900.5' | 0.42 | 13.13 | 9.00 | -4.13 | 0.69 |
| 7-300 | CC-19 299-301' | 0.15 | 4.69 | 34.00 | 29.31 | 7.25 |
| 8-300 | CC-10 299.5-300.5' | 0.02 | 0.63 | 37.00 | 36.38 | 59.20 |
| 8-600 | CC-10 599.3-600.8' | 0.32 | 10.00 | 17.00 | 7.00 | 1.70 |
| 8-900 | CC-10 899.5-901' | 0.01 | 0.31 | 9.00 | 8.69 | 28.80 |

More kinetic humidity cell testing was done on the samples that did not meet the ANP/AGP minimum standard. Kinetic testing simulates environmental weathering with alternating wet and dry periods. The resulting drainage is periodically tested for acid forming indicators. Humidity cell tests were performed on samples with low ANP/AGP

12/17/91

Plexus

Separate state & Fed processes

USFS feels state requirements are more stringent

DOGAMI permit appl. expected Feb - March '92

Problem w/ EIS contractor

subject to precipitation leaching) indicate that leachate meets DEQ groundwater guidance levels and surface water quality standards for all of the parameters analyzed except mercury and zinc (WWL, 1992). The results of 1311 and 1312 testing is shown in Tables 8 and 9, respectively.

**Table 8. Summary of Initial Batch Leach Testing, EPA Method 1311**

| SAMPLE (mg/l) | BNTD-1 | BNTD-2 | BNTD-3 | BNTD-4 | BNTD-5 | 1-600 | 6-900 | 10-694 | CONCENTRATION ALLOWED |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.03 | <0.02 | <0.02 | <0.02 | <0.02 | <0.1 | <0.1 | <0.1 | 5 |
| Barium | 0.39 | 0.17 | 0.27 | 0.14 | 0.24 | 0.22 | 0.40 | 0.82 | 100 |
| Cadmium | 0.03 | 0.02 | 0.05 | <0.02 | <0.02 | 0.00 | <0.005 | 0.005 | 1 |
| Chromium | 0.27 | 0.22 | 0.27 | 0.05 | 0.03 | 5 | 0.03 | <0.01 | 5 |
| Copper | <0.02 | <0.02 | <0.02 | 0.18 | 0.28 | 0.07 | --- | --- | 1 |
| Lead | <0.01 | <0.10 | <0.10 | <0.10 | <0.10 | --- | 0.02 | <0.02 | 5 |
| Mercury | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.02 | --- | --- | 0.2 |
| Selenium | 0.06 | <0.02 | <0.02 | <0.02 | <0.02 | --- | <0.1 | <0.1 | 1 |
| Silver | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.1 | <0.01 | <0.01 | 5 |
| Zinc | 0.12 | 0.10 | 0.11 | 0.14 | 0.15 | <0.01 | --- | --- | 1 |

**Table 9. Summary of Batch Leach Testing, EPA Method 1312**

| SAMPLE (mg/l) | 1-600 | 2-900 | 3-900 | 4-900 | 6-900 |
|---|---|---|---|---|---|
| Arsenic | <0.10 | <0.10 | <0.10 | <0.10 | <0.01 |
| Barium | 0.01 | 0.05 | 0.01 | 0.09 | 0.54 |
| Cadmium | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Chromium | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Copper | --- | --- | --- | --- | --- |
| Lead | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Mercury | 0.012 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Selenium | <0.1 | <0.1 | <0.01 | <0.01 | <0.01 |
| Silver | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Zinc | <0.01 | 0.04 | <0.01 | 0.05 | 0.39 |

## 1.13 NOISE

Noise levels in the Bornite project area are expected to be typical of unoccupied forests, and will range from a low of about 15-20 dB A, to 75-85 dB A during severe wind or storms. Birds, wind, flowing water and other sources will result in daytime levels typically between 45 and 55 dB A. Noise levels measured at the site ranged from 37-43 dB. The locations and noise levels are shown in Table 10.

ratios. The humidity cell tests were performed for periods of 10 to 20 weeks, and indicate that the materials are not acid generating (WWL, 1992).

Static acid generation potential tests were also performed on samples within the breccia pipe, representing mineralized development rock and ore. These test results (with AGP conservatively based on total sulfur) indicate that the sheeted vein and interior pipe materials are not acid generating to marginally acid generating (11 of 13 samples with ANP/AGP ratios greater than 3). The highest grade ore material is potentially acid generating, but will be processed and the sulfide minerals removed in the concentrate product. No further acid generation testing was done on these samples. The results of this testing is shown in Table 7.

**Table 7. Ore ANP/AGP**

| SAMPLE | DRILL CORE SAMPLE | TOTAL SULFUR (%) | AGP (T $CaCO_3$/KT) | ANP (T $CaCO_3$/KT) | ANP-AGP (T $CaCO_3$/KT) | ANP/AGP |
|---|---|---|---|---|---|---|
| 9-160 | CC-28 160-170' | 0.50 | 15.6 | 37.7 | 22.1 | 2.4 |
| 9-330 | CC-28 250-261' | 1.48 | 46.2 | 28.7 | -17.5 | 0.6 |
| 9-273 | CC-28 273-280' | 0.81 | 25.3 | 31.6 | 6.3 | 1.2 |
| 6-230 | CC-35 230-240' | 0.19 | 5.9 | 50.1 | 44.2 | 8.5 |
| 6-250 | CC-35 250-260' | 2.01 | 62.8 | 58.2 | -4.6 | 0.9 |
| 6-390 | CC-35 390-400' | 0.71 | 22.2 | 90.1 | 67.9 | 4.1 |
| 6-410 | CC-24 410-420' | 0.31 | 9.7 | 38.6 | 28.9 | 4.0 |
| 6-720 | CC-24 720-730' | 1.71 | 53.4 | 65.3 | 11.9 | 1.2 |
| 6-670 | CC-24 670-680' | 0.09 | 2.8 | 22.4 | 19.6 | 8.0 |
| 5-420 | CC-37 420-430' | 0.36 | 11.2 | 50.8 | 39.6 | 4.5 |
| 5-433 | CC-37 433-440' | 2.65 | 82.8 | 33.5 | -49.3 | 0.4 |
| 5-590 | CC-37 590-600' | 0.37 | 11.6 | 136.0 | 124.4 | 11.7 |
| 8-638 | CC-32 638-650' | 0.04 | 1.2 | 98.5 | 97.3 | 82.1 |
| 7-786 | CC-29 786-790' | 1.00 | 31.2 | 98.5 | 67.3 | 3.2 |
| 7-780 | CC-29 780-786' | <0.01 | 0.3 | 124.0 | 123.7 | 413.3 |
| 10-847 | CC-42 847-857' | 0.41 | 12.8 | 52.2 | 0.0 | 4.1 |
| 1-480 | CC-27 476-490' | 0.49 | 15.3 | 82.8 | 67.5 | 5.4 |
| 1-494 | CC-27 494-500' | 3.94 | 123.0 | 50.5 | -72.5 | 0.4 |
| 1-680 | CC-27 680-690' | 0.03 | 0.9 | 88.6 | 87.7 | 98.4 |
| BNTD-4 | CC-32 310-410' | 0.04 | 1.20 | 33.90 | 32.70 | 28.25 |
| BNTD-5 | CC-32 510-610' | 0.19 | 5.90 | 16.80 | 10.90 | 2.85 |

From EPA Method 1311 tests on rock core samples, the resulting leachate is below maximum allowable concentrations, and are not hazardous. EPA Method 1312 tests on development rock and ore samples (representing materials stored on the surface and

**Table 10. Short-Term Noise Measurements of the Bornite Project Area**
(Brown-Buntin Associates, Inc., 1992)

| SITE | DESCRIPTION | DISTANCE FROM ROADWAY (ft) | $L_{eq}$, dB | NOISE SOURCE |
|---|---|---|---|---|
| 1 | Shady Cove Camp Area | 100-200 | 47 | Little N. Santiam River |
| 2 | FS Road 2207-214 Camp/Picnic Area | 150 | 40 | River |
| 3 | FS Road 2207-211 Camp/Picnic Area | 300+ | 31 | Birds, River |
| 4 | Intersection of FS roads 2207 & 2209 | 100 | 28 | Birds |
| 5 | Residences on North Fork Road near entrance to WNF | 50-100 | 32 | River in the distance |
| 6 | Evans Creek Retreat | 300+ | 31 | Birds |
| 7 | Elkhorn Corporation Vacation Homes - 34885 N. Fork Road | 50-300 | 42 | River |
| 8 | Salmon Falls Picnic Grounds | 100 | 47 | River |
| 9 | Camp Cascade - 33806 N. Fork Road | 100+ | 40 | River |
| 10 | Residences - 33535 N. Fork Road | 200 | 34 | River in the distance |
| 11 | Residence - 33435 N. Fork Road | 75 | 32 | Birds |
| 12 | Residence - 33155 N. Fork Road | 100+ | 34 | Birds |
| 13 | Residence - 33016 N. Fork Road | 300+ | 28 | Wind |
| 14 | Elkhorn Woods & Fire Station | 200 | 31 | Wind, Birds |
| 15 | Residence - 32325 N. Fork Road | 300 | 28 | Wind |
| 16 | Elkhorn Valley Golf Club | 50+ | 46 | Traffic |
| 17 | Residence - 32246 N. Fork Road | 50 | 33 | Wind |
| 18 | Elkhorn Valley Recreation Area | 100+ | 42 | Wind, Traffic |
| 19 | Canyon Creek Recreation Area | 100+ | 37 | River |
| 20 | Residences - 23611 N. Fork Road | 100 | 39 | Traffic, River |
| 21 | Residence - 28495 N. Fork Road | 100 | 38 | River |
| 22 | Residence - 26865 N. Fork Road | 50 | 41 | River |
| 23 | Residence - 24245 N. Fork Road | 50 | 36 | Traffic |
| 24 | Residence - 24115 N. Fork Road | 100 | 42 | River |
| 25 | Residence - 23265 N. Fork Road | 100 | 49 | Traffic |
| 26 | Residence - 23245 N. Fork Road | 100 | 36 | River |
| 27 | Residence - 23149 N. Fork Road | 100 | 37 | River |
| 28 | Residence - 26965 N. Fork Road | 75 | 52 | Traffic |
| 29 | Little North Fork Picnic Area | 150+ | 51 | River |
| 30 | Taylor Park Road & N. Fork Road | 50 | 50 | Traffic |
| 31 | FS Road 2207 - Opal Lake Area | 50 | 43 | Distant river |

An Environmental Noise Model was used to predict noise levels in the vicinity of the mine. Variables used to simulate the operation included topographic data and information from mine equipment sources and measured existing noise levels. The modeling indicates that due to the effects of dense vegetation, intervening topography, and normal spreading of sound waves with distance, noise generated by activities at the subject to precipitation leaching) indicate that leachate meets DEQ groundwater guidance levels and surface water quality standards for all of the parameters analyzed except mercury and zinc (WWL, 1992). The results of 1311 and 1312 testing is shown in Tables 8 and 9, respectively.

**Table 8. Summary of Initial Batch Leach Testing, EPA Method 1311**

| SAMPLE (mg/l) | BNTD-1 | BNTD-2 | BNTD-3 | BNTD-4 | BNTD-5 | 1-600 | 6-900 | 10-694 | CONCENTRATION ALLOWED |
|---|---|---|---|---|---|---|---|---|---|
| Arsenic | 0.03 | <0.02 | <0.02 | <0.02 | <0.02 | <0.1 | <0.1 | <0.1 | 5 |
| Barium | 0.39 | 0.17 | 0.27 | 0.14 | 0.24 | 0.22 | 0.40 | 0.82 | 100 |
| Cadmium | 0.03 | 0.02 | 0.05 | <0.02 | <0.02 | 0.00 | <0.005 | 0.005 | 1 |
| Chromium | 0.27 | 0.22 | 0.27 | 0.05 | 0.03 | 5 | 0.03 | <0.01 | 5 |
| Copper | <0.02 | <0.02 | <0.02 | 0.18 | 0.28 | 0.07 | --- | --- | 1 |
| Lead | <0.01 | <0.10 | <0.10 | <0.10 | <0.10 | --- | 0.02 | <0.02 | 5 |
| Mercury | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.02 | --- | --- | 0.2 |
| Selenium | 0.06 | <0.02 | <0.02 | <0.02 | <0.02 | --- | <0.1 | <0.1 | 1 |
| Silver | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.1 | <0.01 | <0.01 | 5 |
| Zinc | 0.12 | 0.10 | 0.11 | 0.14 | 0.15 | <0.01 | --- | --- | 1 |

**Table 9. Summary of Batch Leach Testing, EPA Method 1312**

| SAMPLE (mg/l) | 1-600 | 2-900 | 3-900 | 4-900 | 6-900 |
|---|---|---|---|---|---|
| Arsenic | <0.10 | <0.10 | <0.10 | <0.10 | <0.01 |
| Barium | 0.01 | 0.05 | 0.01 | 0.09 | 0.54 |
| Cadmium | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Chromium | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Copper | --- | --- | --- | --- | --- |
| Lead | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Mercury | 0.012 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Selenium | <0.1 | <0.1 | <0.01 | <0.01 | <0.01 |
| Silver | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Zinc | <0.01 | 0.04 | <0.01 | 0.05 | 0.39 |

## 1.13 NOISE

Noise levels in the Bornite project area are expected to be typical of unoccupied forests, and will range from a low of about 15-20 dB A, to 75-85 dB A during severe wind or storms. Birds, wind, flowing water and other sources will result in daytime levels typically between 45 and 55 dB A. Noise levels measured at the site ranged from 37-43 dB. The locations and noise levels are shown in Table 10.

Bornite will not be audible at either of the nearest recreation sites of Opal Lake or the Shady Cove Campground.

Noise generated at the mine site would be audible to persons travelling on Forest Service road 2207 within one-half to one mile of the operation, depending on atmospheric conditions and intervening topography. Persons traveling immediately adjacent to the plant site would be exposed to plant noise levels ranging from 60-70 dB. This would be an increase over existing background levels, but would not constitute a significant impact (Bornite DEIS, 1992).

A computer model predicted increases in traffic noise on roadways used by Bornite Project traffic. Project generated traffic would increase existing noise levels by 3 to 16 dB on the project transportation corridor during peak hour traffic flows. The areas that would be affected by an increase in road noise would be the Shady Cove Campground and picnic areas off Forest Service roads 2207 and 2209. Because these activity areas are located 100 to 300 feet from the roadway, the peak hour traffic noise levels would range from 43-50 dB. Traffic noise levels in this range are not expected to adversely affect persons. An increase in peak traffic noise levels on the North Fork road resulting from project generated traffic is predicted to be approximately 3 dB, a barely perceptible change in noise levels (Bornite DEIS, 1992) .

Construction activities would generate noise levels ranging from 85 to 90 dB at a distance of 50 feet. Construction, however, would be temporary in nature and occur for the most part during normal daytime working hours. Due to the lack of noise- sensitive public use areas in the immediate project area, construction of facilities is not expected to cause annoyance or sleep disruption.

**Table 10. Short-Term Noise Measurements of the Bornite Project Area**
(Brown-Buntin Associates, Inc., 1992)

| SITE | DESCRIPTION | DISTANCE FROM ROADWAY (ft) | $L_{eq}$, dB | NOISE SOURCE |
|---|---|---|---|---|
| 1 | Shady Cove Camp Area | 100-200 | 47 | Little N. Santiam River |
| 2 | FS Road 2207-214 Camp/Picnic Area | 150 | 40 | River |
| 3 | FS Road 2207-211 Camp/Picnic Area | 300+ | 31 | Birds, River |
| 4 | Intersection of FS roads 2207 & 2209 | 100 | 28 | Birds |
| 5 | Residences on North Fork Road near entrance to WNF | 50-100 | 32 | River in the distance |
| 6 | Evans Creek Retreat | 300+ | 31 | Birds |
| 7 | Elkhorn Corporation Vacation Homes - 34885 N. Fork Road | 50-300 | 42 | River |
| 8 | Salmon Falls Picnic Grounds | 100 | 47 | River |
| 9 | Camp Cascade - 33806 N. Fork Road | 100+ | 40 | River |
| 10 | Residences - 33535 N. Fork Road | 200 | 34 | River in the distance |
| 11 | Residence - 33435 N. Fork Road | 75 | 32 | Birds |
| 12 | Residence - 33155 N. Fork Road | 100+ | 34 | Birds |
| 13 | Residence - 33016 N. Fork Road | 300+ | 28 | Wind |
| 14 | Elkhorn Woods & Fire Station | 200 | 31 | Wind, Birds |
| 15 | Residence - 32325 N. Fork Road | 300 | 28 | Wind |
| 16 | Elkhorn Valley Golf Club | 50+ | 46 | Traffic |
| 17 | Residence - 32246 N. Fork Road | 50 | 33 | Wind |
| 18 | Elkhorn Valley Recreation Area | 100+ | 42 | Wind, Traffic |
| 19 | Canyon Creek Recreation Area | 100+ | 37 | River |
| 20 | Residences - 23611 N. Fork Road | 100 | 39 | Traffic, River |
| 21 | Residence - 28495 N. Fork Road | 100 | 38 | River |
| 22 | Residence - 26865 N. Fork Road | 50 | 41 | River |
| 23 | Residence - 24245 N. Fork Road | 50 | 36 | Traffic |
| 24 | Residence - 24115 N. Fork Road | 100 | 42 | River |
| 25 | Residence - 23265 N. Fork Road | 100 | 49 | Traffic |
| 26 | Residence - 23245 N. Fork Road | 100 | 36 | River |
| 27 | Residence - 23149 N. Fork Road | 100 | 37 | River |
| 28 | Residence - 26965 N. Fork Road | 75 | 52 | Traffic |
| 29 | Little North Fork Picnic Area | 150+ | 51 | River |
| 30 | Taylor Park Road & N. Fork Road | 50 | 50 | Traffic |
| 31 | FS Road 2207 - Opal Lake Area | 50 | 43 | Distant river |

An Environmental Noise Model was used to predict noise levels in the vicinity of the mine. Variables used to simulate the operation included topographic data and information from mine equipment sources and measured existing noise levels. The modeling indicates that due to the effects of dense vegetation, intervening topography, and normal spreading of sound waves with distance, noise generated by activities at the

# THE BORNITE PROJECT
# 2.0 GENERAL INFORMATION

## 2.1 PROJECT LOCATION

The Bornite Project site is about 50 miles east of Salem, Oregon, in the western Cascades (Figure 1). The project area is contained within a broad valley in the Cedar Creek drainage. Cedar Creek is a tributary of the Little North Santiam River. The property consists of unpatented lode claims, held under a lease from Cyprus Minerals Corporation and Plexus, Inc. The claims are within Sections 30 and 31, T8S, R5E and Sections 6 and 7,T9S, R5E, W.M. The powerline servicing the project will be routed adjacent to F-2207 and F-2233 to a location near Detroit, Oregon. All project facilities will be within Willamette National Forest boundaries. The project area is within the southern portion of the Lester Mining District, also known as the North Santiam Mining District.

The Bornite Breccia Pipe is in the southwest 1/4 of Section 31, T8S, R5E. Limited exposure of the breccia pipe occurs approximately at the 2250 foot elevation near the bottom of the Cedar Creek drainage.

## 2.2 LAND STATUS AND OWNERSHIP

Plexus, Inc. holds 105 unpatented lode mining claims under long term lease from Cyprus Minerals Company of Denver, Colorado. Figure 7 indicates the location of the claims.

The Bornite Project is in an area managed as general forest by The Willamette National Forest. The area is under jurisdiction of the Detroit Ranger District.

## 2.3 STRUCTURE OF PLEXUS, INC.

### 2.3.1 Name and Mailing Address

Plexus, Incorporated
185 South State Street, Suite 400
Salt Lake City, Utah 84111
Telephone (801)-363-9152
Fax (801)-363-8747

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### 2.3.2 Company Profile and Responsible Personnel

Plexus Resources Corporation is a Canadian company headquartered in Salt Lake City, Utah. The Company conducts business in the United States through its wholly-owned U.S. subsidiary, Plexus, Inc. The Company has been successfully involved in mineral development since 1980.

Plexus acquires and develops mineral resource properties to produce both precious and base metals. The Company structures its operations to quickly evaluate existing and potential reserve expansions that can be developed in a timely, cost-efficient manner. The Company holds property interests and conducts activities through a variety of business arrangements. These include joint ventures, leasehold rights, equity investments, financing contracts, royalty interests, and fee ownership.

Currently, Plexus participates in a joint venture at the operating Denton-Rawhide gold/silver mine, located in western Nevada. Plexus also operates the Western World Mining Company, a joint venture developing a copper mining and milling operation in north central California.

**Corporate Officers**

ARTHUR H. DITTO, President, Chief Executive Officer, and Director

Mr. Ditto has more than 30 years in the mining and construction business. He can be considered the founder of Plexus Resources Corporation. As an Anaconda Company executive, he was responsible for development of a $217 million mining and processing project. Mr. Ditto is a professional engineer and a graduate of Montana College of Mineral Sciences and Technology in Mining Engineering.

ALLEN S. GORDON, Vice President, Technical Services

Prior to joining Plexus in January 1991, Mr. Gordon headed operations management, mine development and engineering, exploration and environmental planning at Western States Minerals Corporation. He has worked 18 years in the mining industry and holds a Master's Degree in Mining Engineering from the University of Idaho.

J. MICHAEL G. WASHINGTON, Vice President, Chief Financial Officer

A former Vice President and Chief Financial Officer of CoCa Mines, Inc., and previously Vice President of Finance and Director of Wharf Resources, Ltd.,

## 2.4 SUMMARY OF PROJECT ACTIVITIES AND SCHEDULES

Figure 8 is a summary of the major project activities over the life of the mining project.

## 2.5 PROJECT PERMIT BOUNDARY

Figure 9 is an outline of the project boundaries. The permit area is larger than the affected area because the surface disturbance does not encompass the area above the underground decline. Forty-six acres may be disturbed by the mining operation.

## 2.6 DESCRIPTION OF EXISTING LAND USE

The existing land use is designated as general forest by the Willamette National Forest Plan. Mining has historically occurred in the Little North Santiam area, and timber management is the major use today. Commercial timber was harvested from the 1950's through the 1970's.

### 2.6.1 Proposed Post-Mine Land Use

The Bornite project lies entirely within the Willamette National Forest. The Forest Management Plan requires mitigation measures for disturbed areas to avoid or repair direct, indirect, and cumulative effects of disturbance.

The Forest Service requires reclamation both during and after mining. Based on resource mitigation, reclamation is intended to return the mine site to a forest character. This forms the basis of the reclamation plan, and is the reclamation goal set by the Willamette National Forest.

The area is now designated as general forest by the Willamette National Forest. Reclamation will return the area to a general forest designation. The Willamette National Forest may eventually propose the area be developed as a recreational site. This alternative is addressed in Section 4.2.1.

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A land use compatibility statement from Marion county is included in the appendix.

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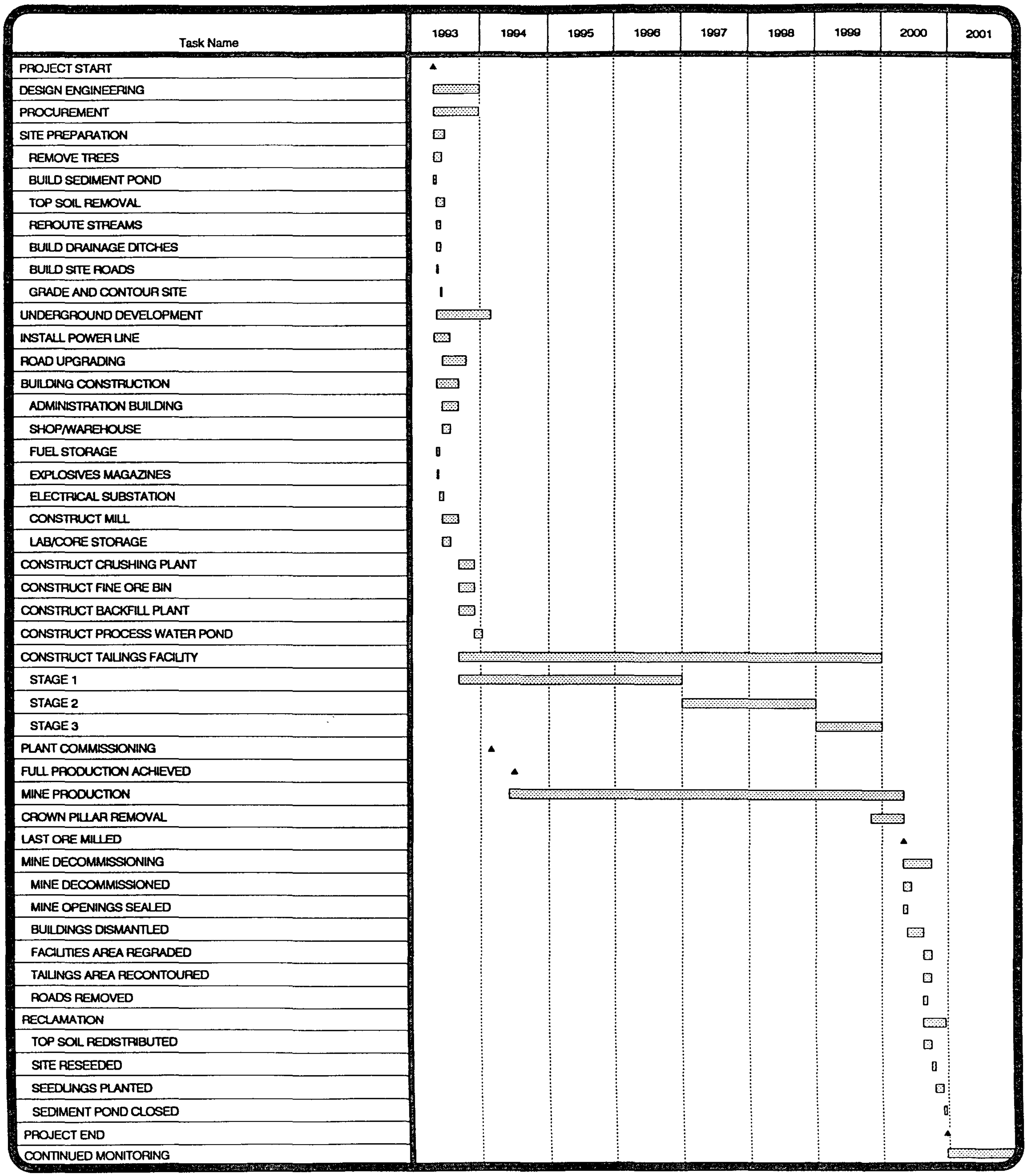
FIGURE 8

BORNITE PROJECT

PROVISIONAL CONSTRUCTION, OPERATING, RECLAMATION, AND MONITORING SCHEDULE




AS OF NOVEMBER 12, 1992

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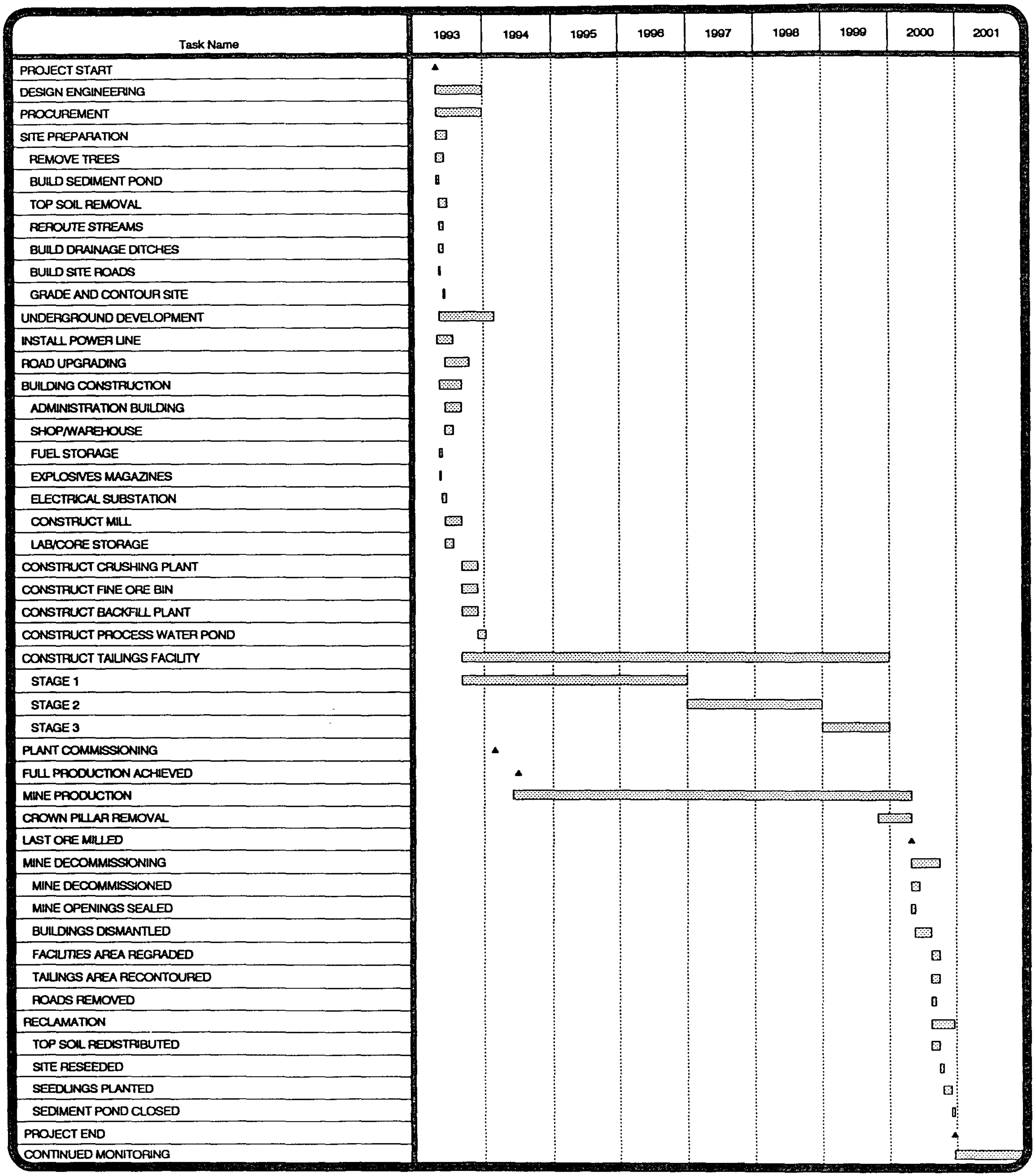
## FIGURE 8
### BORNITE PROJECT
### PROVISIONAL CONSTRUCTION, OPERATING, RECLAMATION, AND MONITORING SCHEDULE




AS OF NOVEMBER 12, 1992

# THE BORNITE PROJECT
# 3.0 OPERATING PLAN

## 3.1 PHYSICAL DESCRIPTION OF THE ORE BODY

The Bornite ore body is a breccia pipe deposit, cylindrical in shape, extending from surface to a depth beyond 1200 feet. It is associated with a Tertiary diorite/quartz diorite body intruding Tertiary andesitic volcanic rocks.

The Bornite breccia pipe has a maximum diameter of 400 to 450 feet. It narrows toward the surface and is relatively intact. Contacts with the country rock are typically sharp and locally characterized by sheeted faults. The pipe cuts both the lower member of the Sardine Formation and the Cedar Creek stock.

A cross section of the ore body is shown in Figure 6 and a typical plan section are illustrated in Figure 10. The outer contact of the high grade shell is a sharply defined geological contact between outermost breccia and the enclosing wall rock of sheeted vein.

In the high grade shell, the ground preparation developed during the early genesis of the breccia pipe, along the margin and cap, was the preferred conduit for mineralizing fluids. The copper ore occurs as veinlets, disseminations, or complete replacement of the breccia matrix. Copper mineralization is weakly disseminated through the breccia clasts.

The Breccia pipe interior contains higher grade zones within generally low grade copper breccia. Areas of higher or lower permeability may have caused pooling to the mineralizing fluids.

## 3.2 SITE CLEARING AND CONSTRUCTION

When permits and approvals have been obtained, site clearing and construction will begin. All steps will be taken to minimize the area of disturbance and environmental impacts.

Trees with commercial value will be harvested and taken to a local timber mill. Small trees with no commercial value will be removed and combined with the surface soil stockpile. Tree harvesting will occur in stages, with clearing to occur as surface facilities expand. Harvest of Yew trees would be coordinated with the Willamette National Forest following Pacific Yew guidelines.

Buffer areas of trees will be strategically left to mitigate visual impacts. A visual barrier would be left in place between the existing road and mine operation. A barrier of existing and new trees will be located around the relocated Bornite Brook.

Impacts to forest vegetation by tree removal will be mitigated by reclamation. A Douglas fir and white pine forest would be created to replace existing vegetation. New wetlands will be created on a one-to-one ratio to replace any displaced wetlands. New wetlands will be revegetated with indigenous native species.

Selective clearing along the Cedar Creek road will be required to allow road widening and repair to bring the access route to necessary standards. Some tree clearing would also be required along the power route.

## 3.3 CONSTRUCTION SCHEDULE

As soon as possible after project permits and approvals are obtained, construction of the power line will begin. Simultaneously, clearing of the mine site area and upgrading of the transportation corridor will also begin.

Once the site is cleared, Bornite Brook would be relocated and reestablished. A sediment pond would be built to capture surface run off. A monitoring program would be instituted to monitor discharge from the pond.

Removal of surface top soil will being next. Suitable top soil will be removed to stock piles for later use in reclamation. Top soil stock piles would be seeded to prevent erosion during the mine life.

The site will then be graded and contoured to allow facilities construction. A drainage system will be established to direct run off to the sediment pond and prevent discharge into Bornite Brook or Cedar Creek. Access roads and culverts will be installed to allow access by motor vehicles on the property.

Facilities construction would then begin.First priority will be to complete the administration building, shop/warehouse/dry, fuel storage building, explosives storage building, mine water pond, and development stock pile pad. Then mine development and construction of the tailings management system will begin. Work would then begin on the crushing plant, fine ore storage bin, mill, lab, and backfill plant. A proposed construction schedule is illustrated in Figure 8.

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## 3.4 DESCRIPTION OF UNDERGROUND OPERATIONS

The Bornite Project will include a modern, safe, underground mine that will yield 1,400 tons of ore daily, five days per week. Equipment used underground will be rubber-tired diesel powered drilling, loading, and hauling vehicles. Underground equipment is configured differently, but accomplishes many of the same tasks as surface heavy equipment.

Access to the ore body will be through a declining tunnel-like ramp. Eventually, the underground mine will reach depths of more than 900 feet. Ore will be extracted from underground excavations called stopes. The ore will be trammed up the ramp in haulage trucks to the surface for processing. An isometric projection of the ore body and ramp is illustrated in Figure 11.

### 3.4.1 Mine Production Schedule

The underground mine will produce about 360,000 tons of ore annually for its productive life. There will be sufficient capacity to boost the mining rate in response to changing economic conditions. Initially, mine operations will be scheduled for two eight hour shifts daily, five days a week. As the mining depth increases, a third shift may be necessary to keep production levels.

### 3.4.2 General Mine Arrangement

Underground extraction methods will allow for optimum recovery of the Bornite ore body. There will be minimal surface disturbance. Only two small openings to the underground workings will be visible on the surface: The mine portal, and the collar of the ventilation raise, as shown in Plate 2.

A ramp, with a 12.5 percent downward grade, will provide access to the ore body. From the ramp, all material, personnel, and equipment will enter and exit the mine. All of the ore and development rock will also be transported on the ramp system.

The size and shape of the ore body lends itself particularly well to low-cost modern bulk mining methods. Extraction of ore from the stoping areas will be continuous. As now planned, there will be several stopes in the ore body, with one to three operating at any given time. The number of active working areas may change due to prevailing economic conditions.

After ore extraction, the stopes will be filled with cemented mill tailings. Backfilling will provide structural support for later pillar extraction and eliminate subsidence. In this way, the extraction of the ore body will be maximized.

### 3.4.3 Underground Mining Methods

Development use mechanized rubber tired drill jumbos and haul trucks. Waste will be trucked to surface and, if suitable, will be used for road building, contouring, dam construction and backfill. Ore development will be stock piled initially, until mill start up. The ore stock pile will then provide mill feed during the first month of operation.

Surrounding country rock units at Bornite will support sublevel blasthole stoping. Use of delayed backfill is a stable and appropriate mining method. Initially, a mucking level would be developed. A series of drilling levels would then be developed above the mucking level, as shown in Figure 12. Ore would be drilled vertically, using conventional longhole drills. Then it would be blasted, causing the ore to collapse into the mucking level below. The rubbilized ore would scooped up by load-haul-dump machines and loaded into haul trucks for transport to surface.

Other mining methods may be used to recover interior pipe ore, sheeted vein ore, remnants of the high grade shell, or presently undetected ore zones. These include shrinkage, cut-and-fill, vertical retreat, and room-and-pillar mining. Increased knowledge of the orebody in wake of after development will indicate choice of secondary methods.

### 3.4.4 Pillar Extraction

Stopes will be mined in sequence, to minimize the area of opening to decrease dilution and improve safety. Initially, a primary stope will be mined and backfilled with cemented tailings. After a series of primary stopes have been extracted and filled, adjacent secondary stopes will be mined.

A single sill pillar will be left to divide the ore body into two mining zones. A sill pillar is rock left to support two mine openings located one above the other. After backfilling the top stope, the sill pillar will be recovered by blasting it into the open stope below. The ore will be removed, and the bottom stope backfilled.

Ore left between surface and the first mining level is known as the crown pillar of a mine. After filling the stopes below the crown pillar, the pillar will be drilled from surface and blasted to complete maximum recovery of the ore body. Mucking of the crown pillar will be done from underground, with ore being transported to surface for processing.

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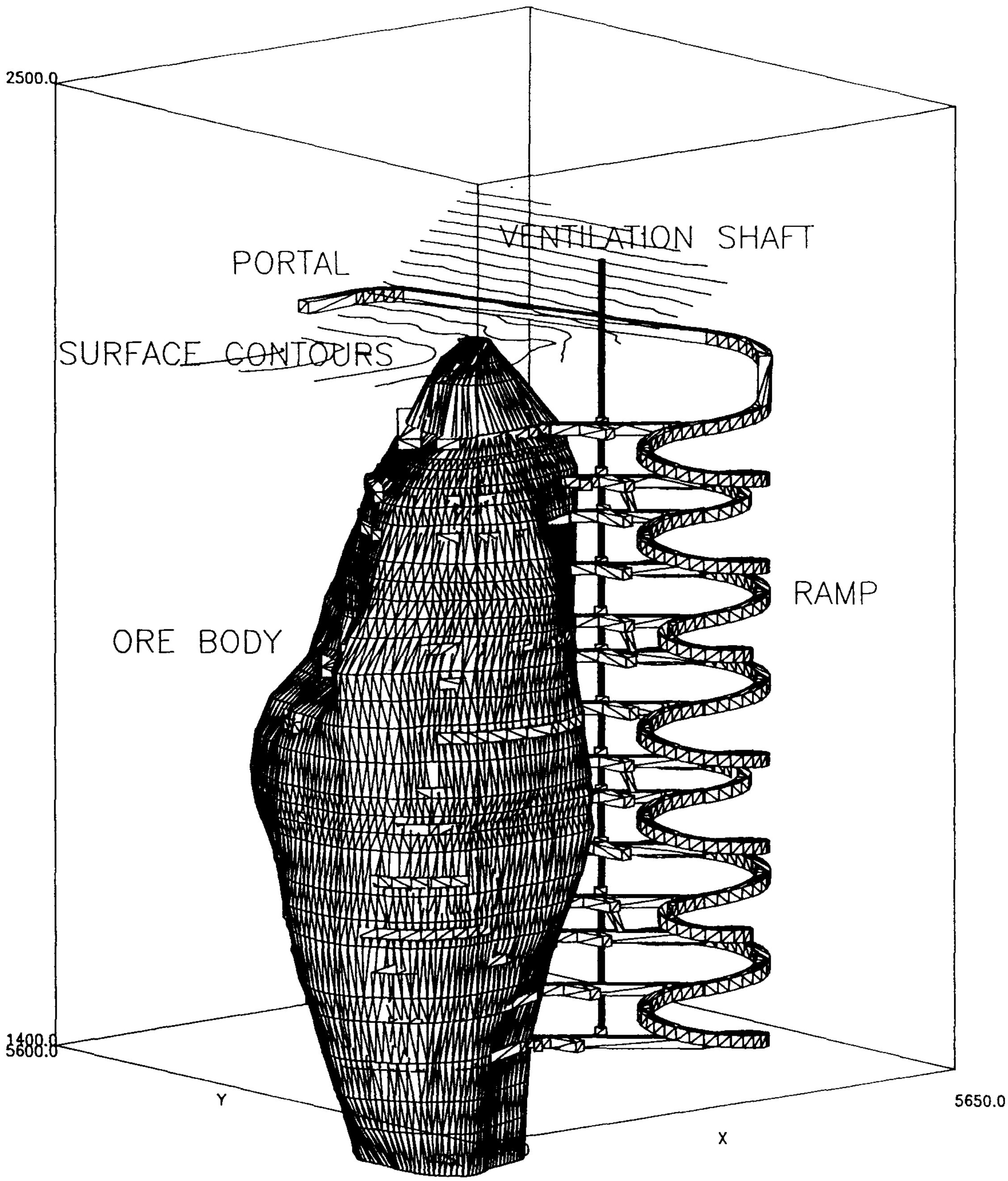



*PLEXUS, INC.*

***BORNITE PROJECT***
***MARION COUNTY, OREGON***

OREBODY AND PROVISIONAL RAMP ISOMETRIC

PREPARED BY PLEXUS, INC.

FIGURE 11 | NOV., 1992

After ore extraction, the stopes will be filled with cemented mill tailings. Backfilling will provide structural support for later pillar extraction and eliminate subsidence. In this way, the extraction of the ore body will be maximized.

### 3.4.3 Underground Mining Methods

Development use mechanized rubber tired drill jumbos and haul trucks. Waste will be trucked to surface and, if suitable, will be used for road building, contouring, dam construction and backfill. Ore development will be stock piled initially, until mill start up. The ore stock pile will then provide mill feed during the first month of operation.

Surrounding country rock units at Bornite will support sublevel blasthole stoping. Use of delayed backfill is a stable and appropriate mining method. Initially, a mucking level would be developed. A series of drilling levels would then be developed above the mucking level, as shown in Figure 12. Ore would be drilled vertically, using conventional longhole drills. Then it would be blasted, causing the ore to collapse into the mucking level below. The rubbilized ore would scooped up by load-haul-dump machines and loaded into haul trucks for transport to surface.

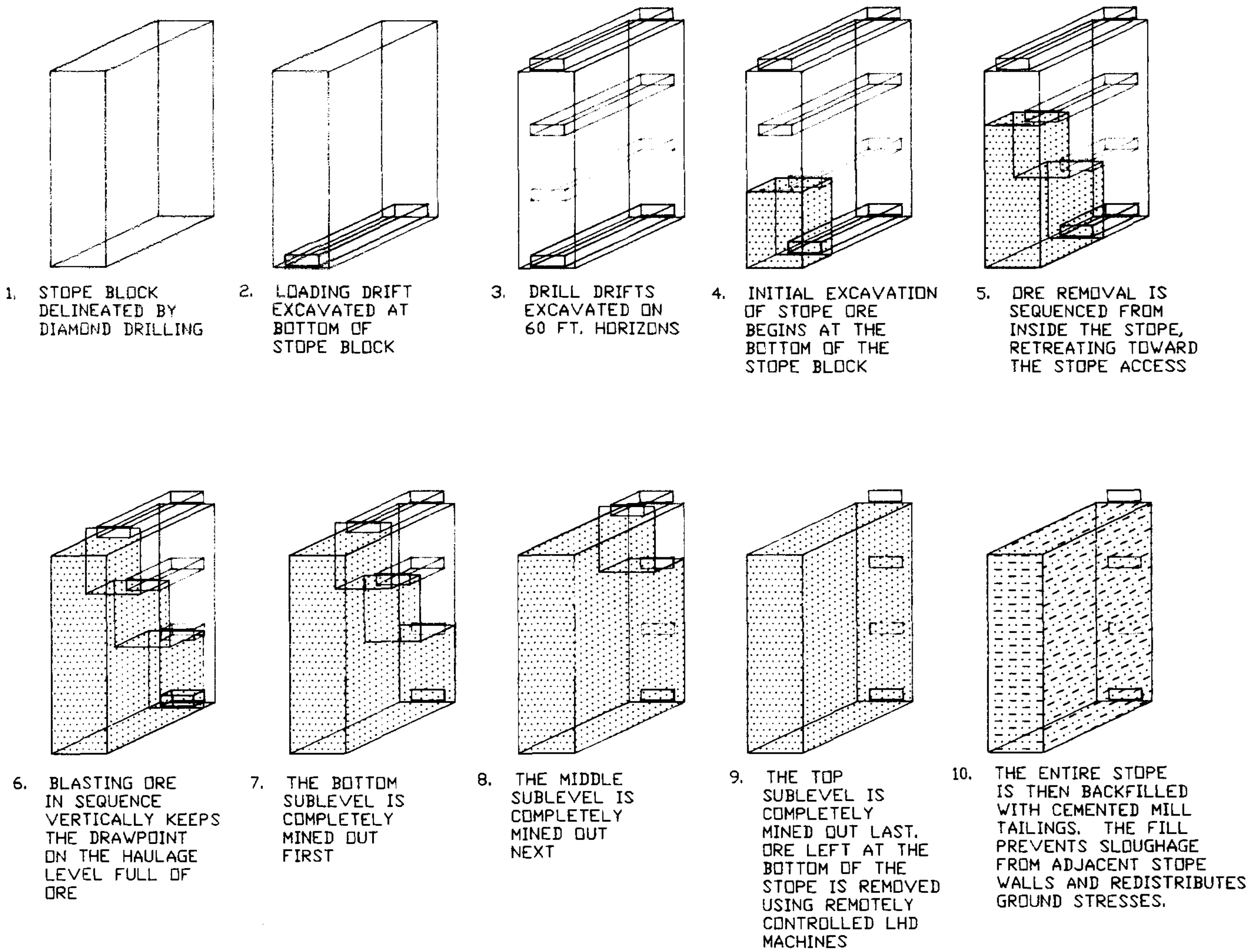
Other mining methods may be used to recover interior pipe ore, sheeted vein ore, remnants of the high grade shell, or presently undetected ore zones. These include shrinkage, cut-and-fill, vertical retreat, and room-and-pillar mining. Increased knowledge of the orebody in wake of after development will indicate choice of secondary methods.

### 3.4.4 Pillar Extraction

Stopes will be mined in sequence, to minimize the area of opening to decrease dilution and improve safety. Initially, a primary stope will be mined and backfilled with cemented tailings. After a series of primary stopes have been extracted and filled, adjacent secondary stopes will be mined.

A single sill pillar will be left to divide the ore body into two mining zones. A sill pillar is rock left to support two mine openings located one above the other. After backfilling the top stope, the sill pillar will be recovered by blasting it into the open stope below. The ore will be removed, and the bottom stope backfilled.

Ore left between surface and the first mining level is known as the crown pillar of a mine. After filling the stopes below the crown pillar, the pillar will be drilled from surface and blasted to complete maximum recovery of the ore body. Mucking of the crown pillar will be done from underground, with ore being transported to surface for processing.




*PLEXUS, INC.*

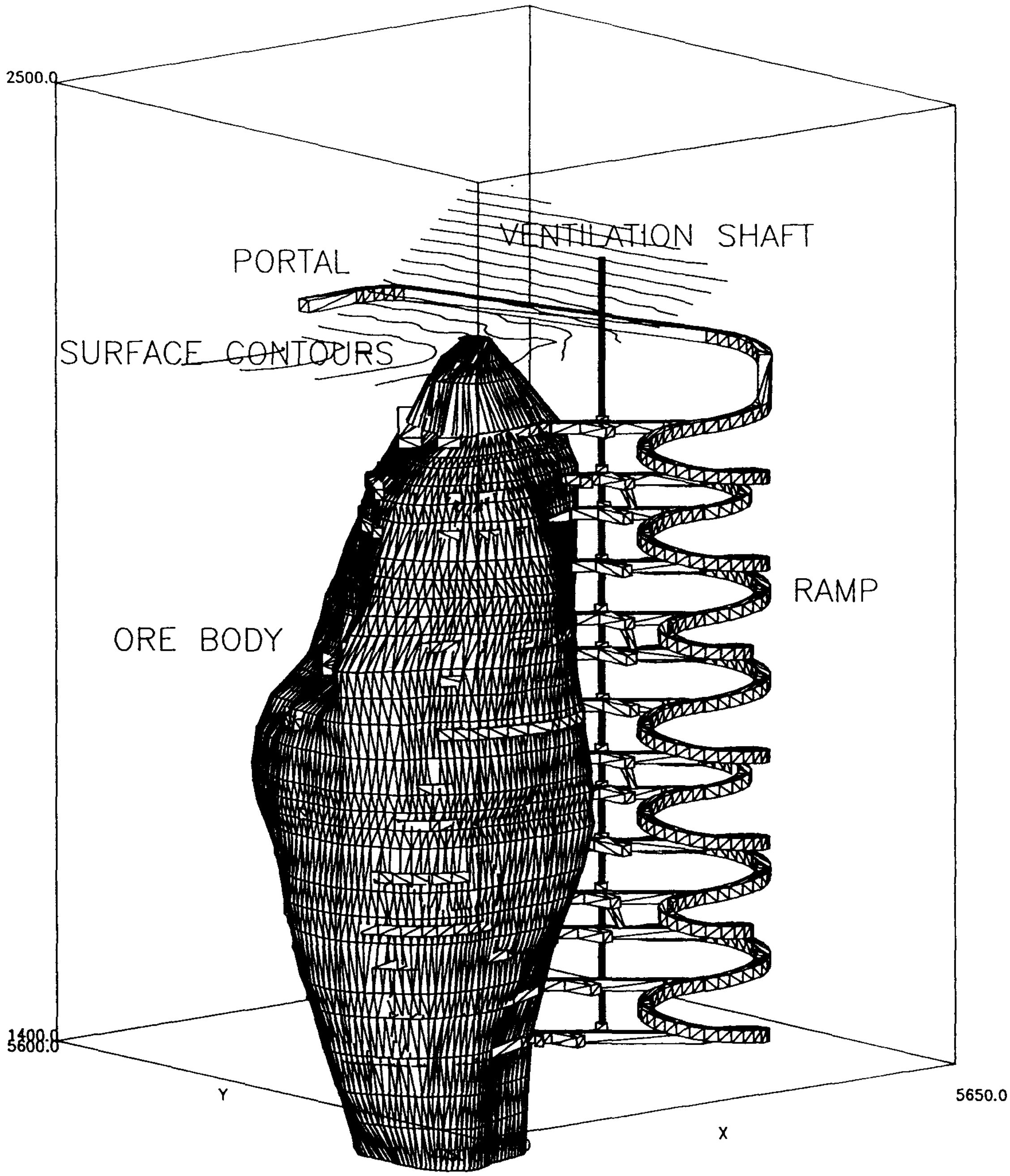
*BORNITE PROJECT*

***MARION COUNTY, OREGON***

PROVISIONAL MINING METHOD SCHEMATIC

PREPARED BY PLEXUS, INC.

FIGURE 12 | NOV., 1992




| | |
|---|---|
| *PLEXUS, INC.* | |
| ***BORNITE PROJECT*** ***MARION COUNTY, OREGON*** | |
| OREBODY AND PROVISIONAL RAMP ISOMETRIC | |
| PREPARED BY PLEXUS, INC. | |
| FIGURE 11 | NOV., 1992 |

Removal of the crown pillar will not increase the area of surface disturbance. The potential for subsidence will be reduced, allowing complete filling of the mine excavations.

Removal of the crown pillar will be staged. Small stopes will be removed in sequence, as shown in Figure 13, to minimize the size of the surface opening. As each stope is excavated it will be backfilled immediately with cemented tailings.

Excess ore will be stockpiled on the surface during this period. Once the crown pillar is fully removed, the mill will continue operating using stockpiled ore as feed for the mill. This will allow complete filling of the crown pillar area with cemented tailings.

Colluvium excavated from the top of the crown pillar area to establish a drilling area and to prevent dilution would also be used for backfill. When the ore has been removed and the mine backfilled, the surface would be graded and reclaimed.

The planned mining sequence is shown by blocks for the Bornite ore body in Figure 14. The crown and sill pillars based on the Mining Plan are also illustrated.

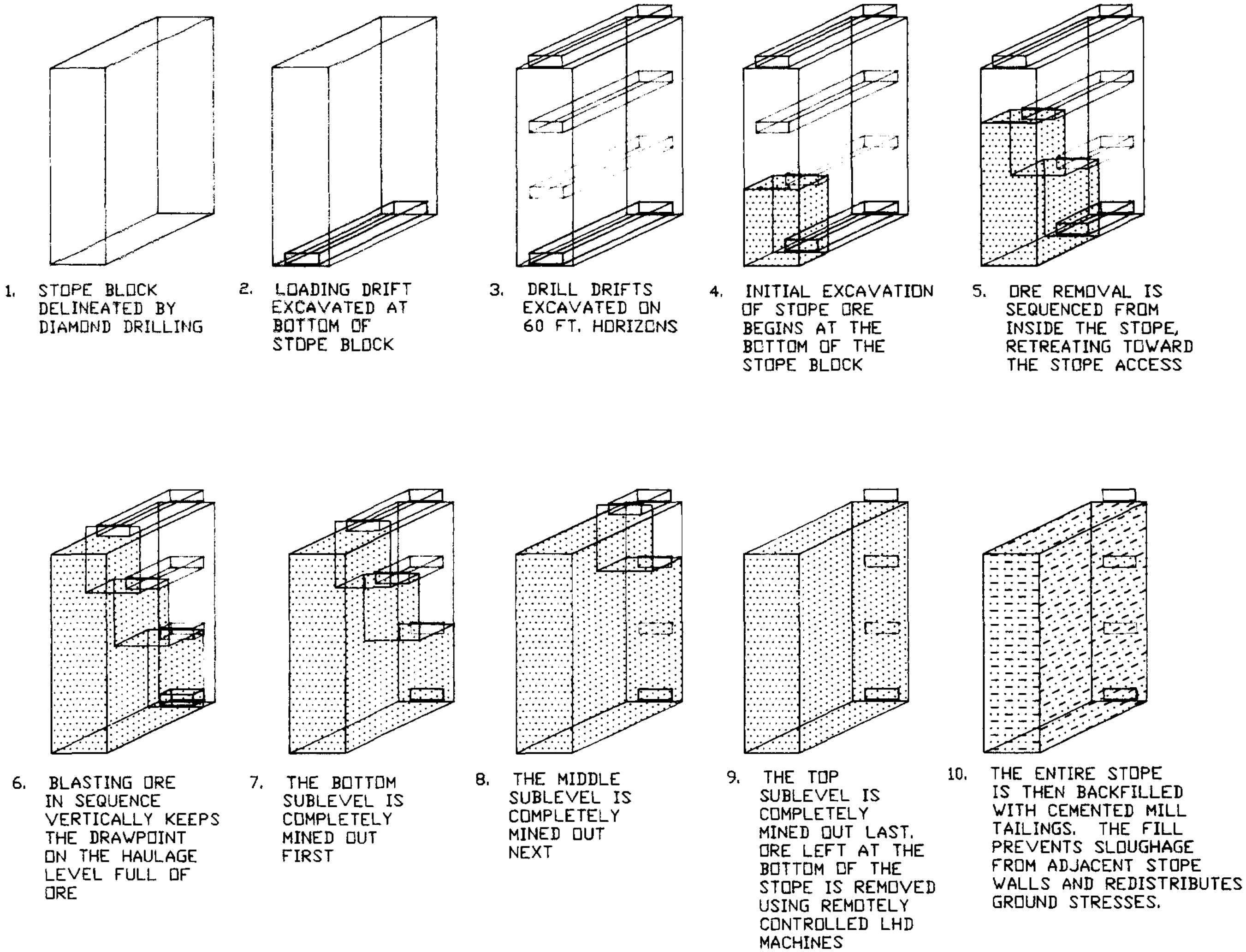
The crown pillar contains 36,000 tons of ore-grade material, with an average 2.4 percent copper equivalent. A cross-section of the excavated area of the crown pillar is shown in Figure 15. A minor amount of colluvium would be needed to be removed for drilling. The area of surface disturbance is illustrated in Figure 16.

Removal of the crown pillar will not increase surface disturbance, because the area will used during the mine life to store development material. It will reduce acid generating potential caused by leaving unrecovered ore, reduce subsidence potential by allowing total filling of the ore body, and add major economic benefits to the project.

### 3.4.5 Mine Water Control

Mine water control will be completed in a series of stages. For ramp development to the 1750 level, a series of tanks will be staged on the main mucking levels to pump water to the recycle process water tank on the surface. A typical pump tank is shown in Figure 17. Once on the 1750 level, a settling tank, based on the design illustrated in Figure 18, will be established.

After development of sublevels above the 1750 level, the ramp will be driven to the 1430 level. Pump tanks will be used to pump water to the settling tanks on the 1750 level during development. Once the ramp has reached the 1430 level, a second settling tank system will be established.




*PLEXUS, INC.*

*BORNITE PROJECT*
***MARION COUNTY, OREGON***

PROVISIONAL MINING METHOD SCHEMATIC

PREPARED BY PLEXUS, INC.

| | | |
|---|---|---|
| | FIGURE 12 | NOV., 1992 |

Figure 18 illustrates the stages of the pumping system development. Use of settling tanks will allow removal of suspended solids underground. This material will be transported to the mill or dumped into backfilled stopes underground. Tank and main pump sizes will be selected based on actual water flows experienced in the operation.

Groundwater flowing into the mine has been estimated to be 100 gallons per minute. Use of drill water and water decanted from backfilling pours is expected to increase pumping requirements to just over 200 gallons per minute.

If unexpected water flows are encountered, grouting will be used to reduce or eliminate flows. Pumping design is based on flexibility, allowing a quick change to larger pumps if required.

Underground sumps will be designed based on water flows encountered during operation. A typical sump is expected to be 20 feet long and five feet deep.

### 3.4.6 Subsidence Control

Surface subsidence and underground sloughage will be eliminated by backfilling underground voids. All voids, except those required for post mining access, will be filled with cemented tailings or waste rock.

### 3.4.7 Mine Equipment Requirements

The Bornite Project underground mine will be developed as a trackless operation, utilizing diesel powered rubber-tired equipment. Underground drilling, loading, and hauling unit operations will use specially designed equipment for underground use. While similar to surface equipment, underground vehicles are generally lower profile and more rugged. Primary underground mobile development and production equipment requirements will be:

**Table 5. Mine Equipment**

| Equipment | Number |
|---|---|
| Load-Haul-Dump | 3 |
| Drill Jumbo | 1 |
| Haulage Trucks | 3 |
| Service Trucks | 1 |
| Longhole Trucks | 3 |
| Supervisor/Transportation Vehicles | 3 |

Removal of the crown pillar will not increase the area of surface disturbance. The potential for subsidence will be reduced, allowing complete filling of the mine excavations.

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| Service Trucks | 1 |
| Longhole Trucks | 3 |
| Supervisor/Transportation Vehicles | 3 |

SURFACE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BLOCK 6 | 41A | 45A | 42B | 46B | 43B | 47B | 44B | 48B | CROWN PILLAR |
| | 41A | 45A | 42A | 46A | 43A | 47A | 44A | 48A | FORTH DEVELOPED LEVEL |
| BLOCK 1 | 13C | 25C | 14C | 26C | 15C | 27C | 16C | 28C | |
| | 13B | 25B | 14B | 26B | 15B | 27B | 16B | 28B | |
| | 13A | 25A | 14A | 26A | 15A | 27A | 16A | 28A | THIRD DEVELOPED LEVEL |
| BLOCK 2 | 5C | 17C | 6C | 18C | 7C | 19C | 8C | 20C | |
| | 5B | 17B | 6B | 18B | 7B | 19B | 8B | 20B | |
| | 5A | 17A | 6A | 18A | 7A | 19A | 8A | 20A | SECOND DEVELOPED LEVEL |
| BLOCK 3 | 1C | 9C | 2C | 10C | 3C | 11C | 4C | 12C | |
| | 1B | 9B | 2B | 10B | 3B | 11B | 4B | 12B | |
| | 1A | 9A | 2A | 10A | 3A | 11A | 4A | 12A | FIRST LEVEL DEVELOPED |
| SILL PILLAR | 29D | 37D | 30D | 38D | 31D | 39D | 32D | 40D | |
| BLOCK 4 | 29C | 37C | 30C | 38C | 31C | 39C | 32C | 40C | |
| | 29B | 37B | 30B | 38B | 31B | 39B | 32B | 40B | |
| | 29A | 37A | 30A | 38A | 31A | 39A | 32A | 40A | SIXTH DEVELOPED LEVEL |
| BLOCK 5 | 21C | 33C | 22B | 34C | 23C | 35C | 24C | 36C | |
| | 21B | 33B | 22B | 34B | 23B | 35B | 24B | 36B | |
| | 21A | 33A | 22A | 34A | 23A | 35A | 24A | 36A | FIFTH DEVELOPED LEVEL |

NOTE: RAMP DEVELOPMENT WILL INITIALLY BE COMPLETED TO THE BOTTOM OF THE THIRD MINING BLOCK. SUBLEVELS WILL THEN BE DEVELOPED TO SURFACE. NEXT, THE RAMP WILL BE DRIVEN TO THE BOTTOM OF THE FIFTH MINING BLOCK. DEVELOPMENT WILL THEN BE COMPLETED UP TO THE SILL PILLAR. PRODUCTION MINING WILL OCCUR IN A TYPICAL STOPE SEQUENCING, AS OUTLINED ABOVE. IN PRACTICE, THE STOPE SEQUENCE WILL OCCUR THREE DIMENSIONALLY.

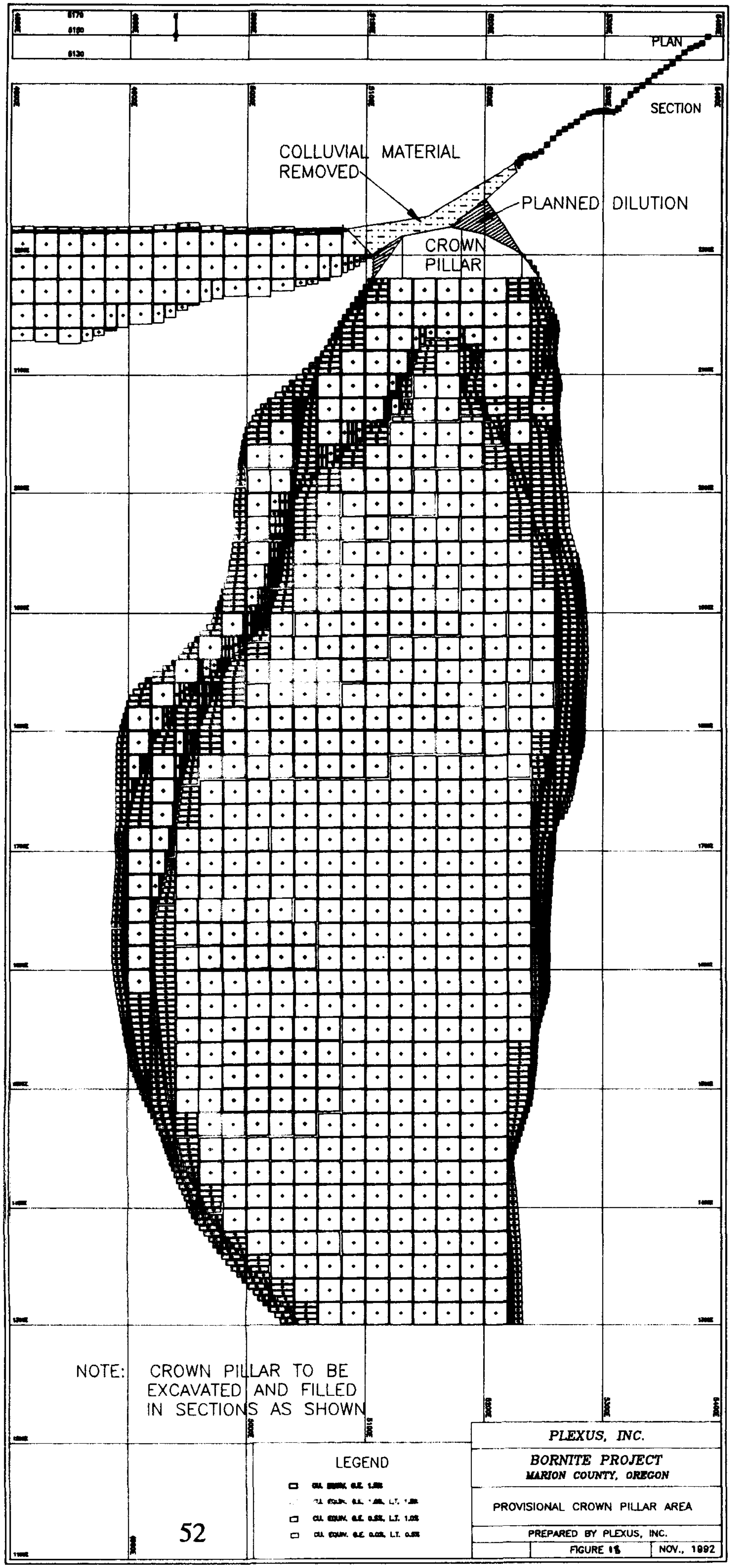
*PLEXUS, INC.*

*BORNITE PROJECT*
*MARION COUNTY, OREGON*

PROVISIONAL 2–D STOPING SEQUENCE

PREPARED BY PLEXUS, INC.

FIGURE 14 | NOV., 1992

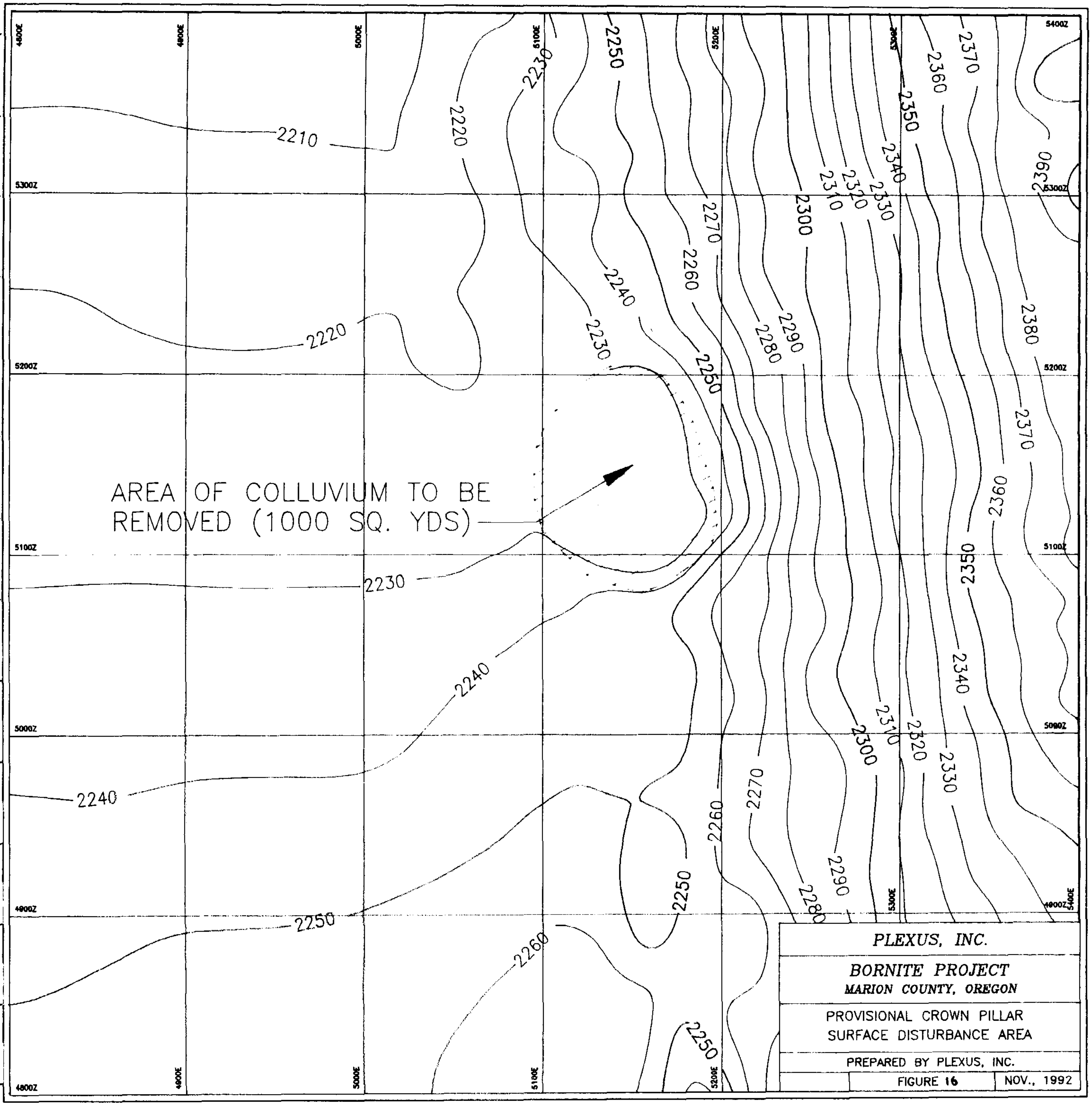

PLAN
SECTION
COLLUVIAL MATERIAL REMOVED
PLANNED DILUTION
CROWN PILLAR
NOTE: CROWN PILLAR TO BE EXCAVATED AND FILLED IN SECTIONS AS SHOWN
LEGEND
CU. EQUIV. G.E. 0.5%, L.T. 1.0%
PLEXUS, INC.
BORNITE PROJECT
MARION COUNTY, OREGON
PROVISIONAL CROWN PILLAR AREA
PREPARED BY PLEXUS, INC.
NOV., 1992

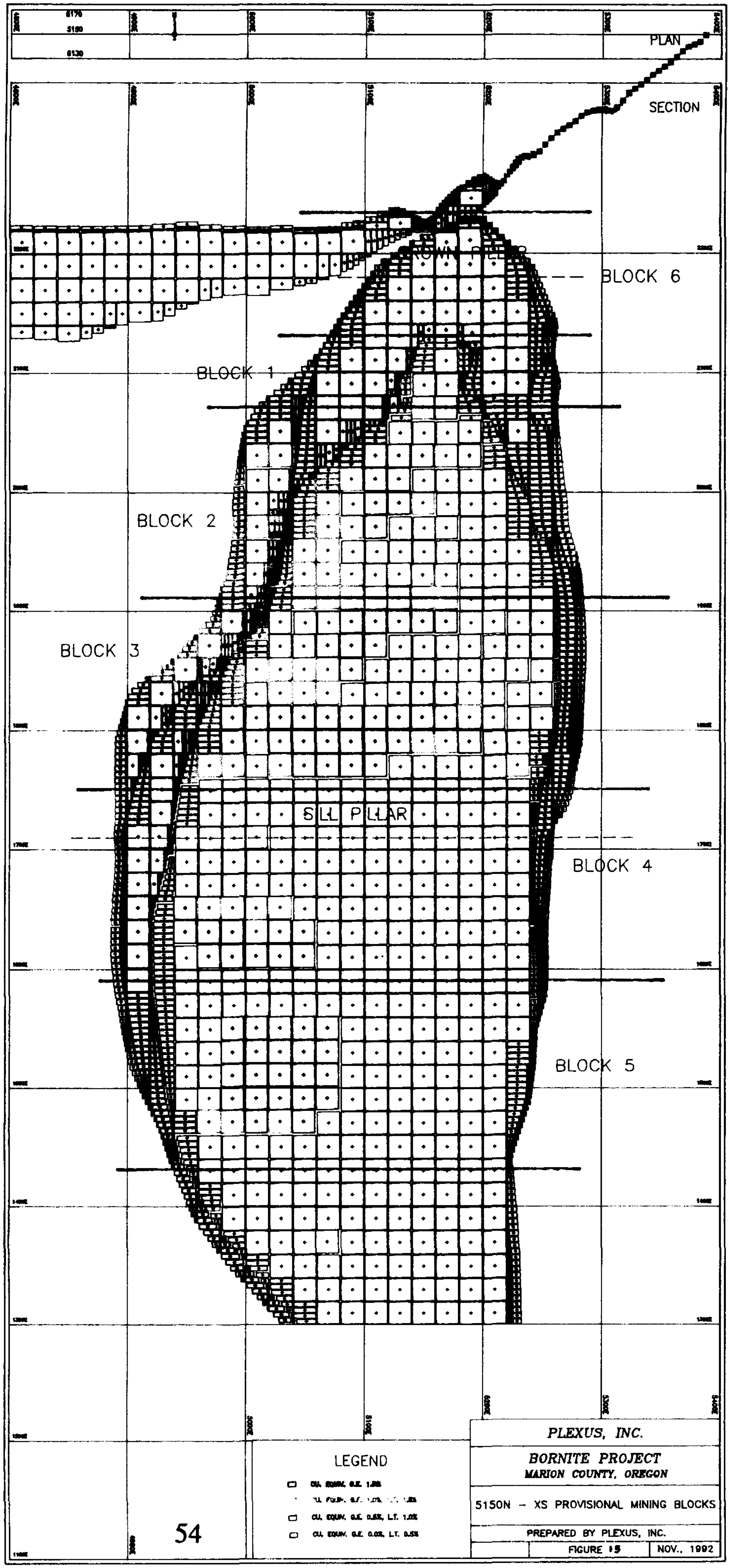
SURFACE

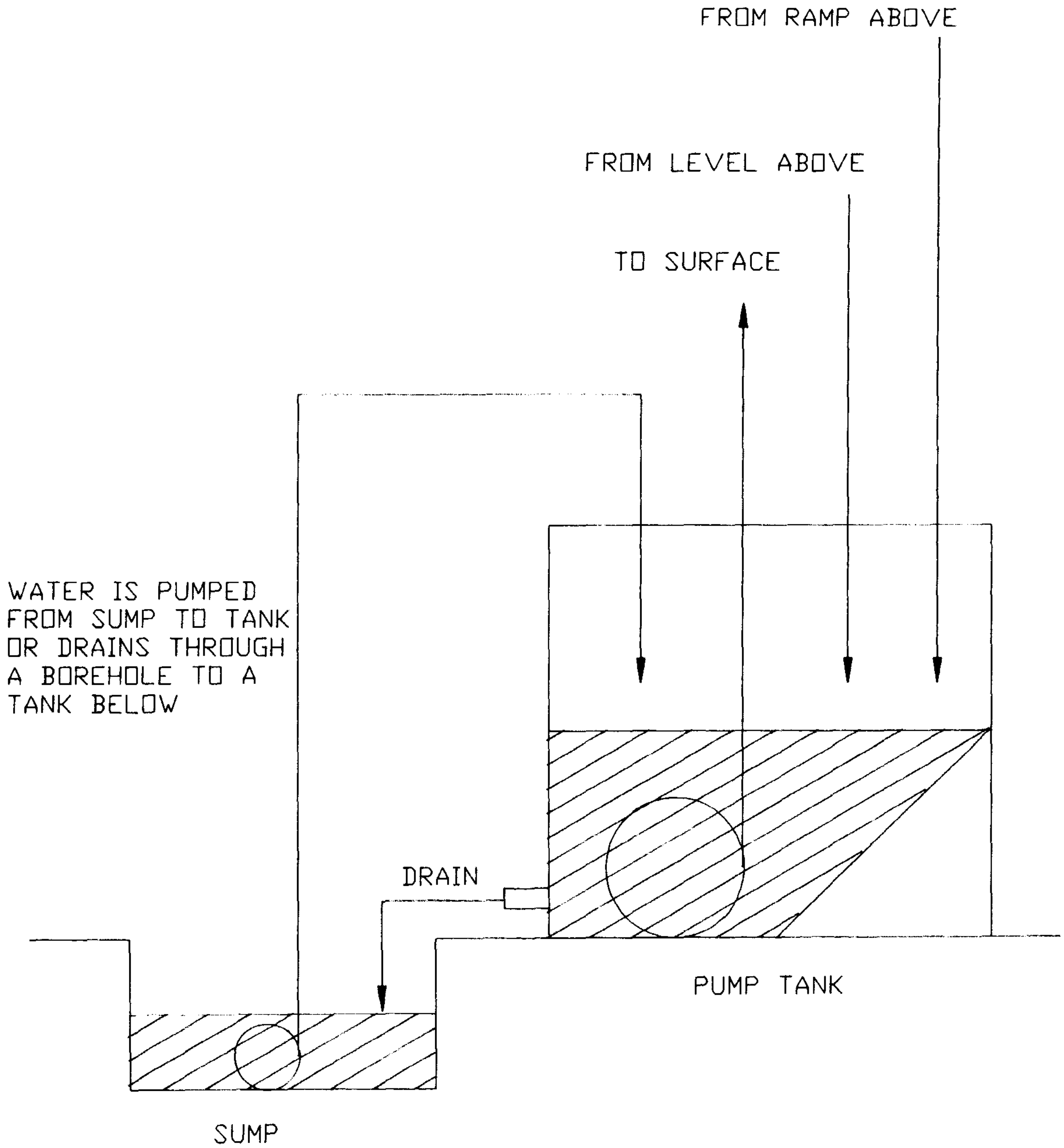
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BLOCK 6 | 41A | 45A | 42B | 46B | 43B | 47B | 44B | 48B | CROWN PILLAR |
| | 41A | 45A | 42A | 46A | 43A | 47A | 44A | 48A | FORTH DEVELOPED LEVEL |
| BLOCK 1 | 13C | 25C | 14C | 26C | 15C | 27C | 16C | 28C | |
| | 13B | 25B | 14B | 26B | 15B | 27B | 16B | 28B | |
| | 13A | 25A | 14A | 26A | 15A | 27A | 16A | 28A | THIRD DEVELOPED LEVEL |
| BLOCK 2 | 5C | 17C | 6C | 18C | 7C | 19C | 8C | 20C | |
| | 5B | 17B | 6B | 18B | 7B | 19B | 8B | 20B | |
| | 5A | 17A | 6A | 18A | 7A | 19A | 8A | 20A | SECOND DEVELOPED LEVEL |
| BLOCK 3 | 1C | 9C | 2C | 10C | 3C | 11C | 4C | 12C | |
| | 1B | 9B | 2B | 10B | 3B | 11B | 4B | 12B | |
| | 1A | 9A | 2A | 10A | 3A | 11A | 4A | 12A | FIRST LEVEL DEVELOPED |
| SILL PILLAR | 29D | 37D | 30D | 38D | 31D | 39D | 32D | 40D | |
| BLOCK 4 | 29C | 37C | 30C | 38C | 31C | 39C | 32C | 40C | |
| | 29B | 37B | 30B | 38B | 31B | 39B | 32B | 40B | |
| | 29A | 37A | 30A | 38A | 31A | 39A | 32A | 40A | SIXTH DEVELOPED LEVEL |
| BLOCK 5 | 21C | 33C | 22B | 34C | 23C | 35C | 24C | 36C | |
| | 21B | 33B | 22B | 34B | 23B | 35B | 24B | 36B | |
| | 21A | 33A | 22A | 34A | 23A | 35A | 24A | 36A | FIFTH DEVELOPED LEVEL |

NOTE: RAMP DEVELOPMENT WILL INITIALLY BE COMPLETED TO THE BOTTOM OF THE THIRD MINING BLOCK. SUBLEVELS WILL THEN BE DEVELOPED TO SURFACE. NEXT, THE RAMP WILL BE DRIVEN TO THE BOTTOM OF THE FIFTH MINING BLOCK. DEVELOPMENT WILL THEN BE COMPLETED UP TO THE SILL PILLAR. PRODUCTION MINING WILL OCCUR IN A TYPICAL STOPE SEQUENCING, AS OUTLINED ABOVE. IN PRACTICE, THE STOPE SEQUENCE WILL OCCUR THREE DIMENSIONALLY.

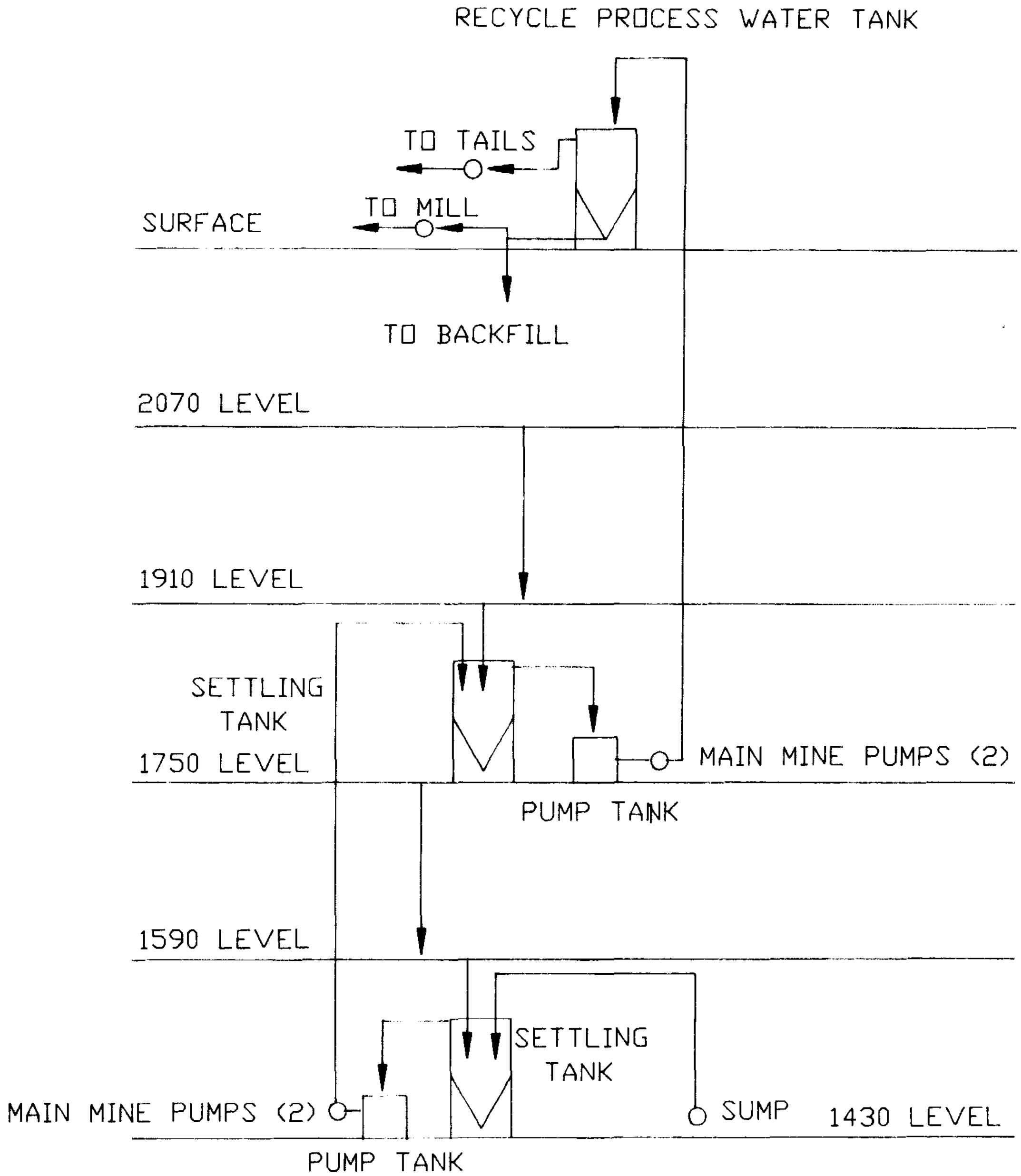
| |
|---|
| *PLEXUS, INC.* |
| *BORNITE PROJECT*<br>***MARION COUNTY, OREGON*** |
| PROVISIONAL 2-D STOPING SEQUENCE |
| PREPARED BY PLEXUS, INC. |
| FIGURE 14 — NOV., 1992 |


AREA OF COLLUVIUM TO BE REMOVED (1000 SQ. YDS)
PLEXUS, INC.
BORNITE PROJECT
MARION COUNTY, OREGON
PROVISIONAL CROWN PILLAR SURFACE DISTURBANCE AREA
PREPARED BY PLEXUS, INC.
FIGURE 16
NOV., 1992


PLAN
SECTION
CROWN PILLAR
BLOCK 6
BLOCK 1
BLOCK 2
BLOCK 3
SILL PILLAR
BLOCK 4
BLOCK 5
LEGEND
CU. EQUIV. G.E. 0.5%, LT. 1.0%
PLEXUS, INC.
BORNITE PROJECT
MARION COUNTY, OREGON
5150N – XS PROVISIONAL MINING BLOCKS
PREPARED BY PLEXUS, INC.
NOV., 1992

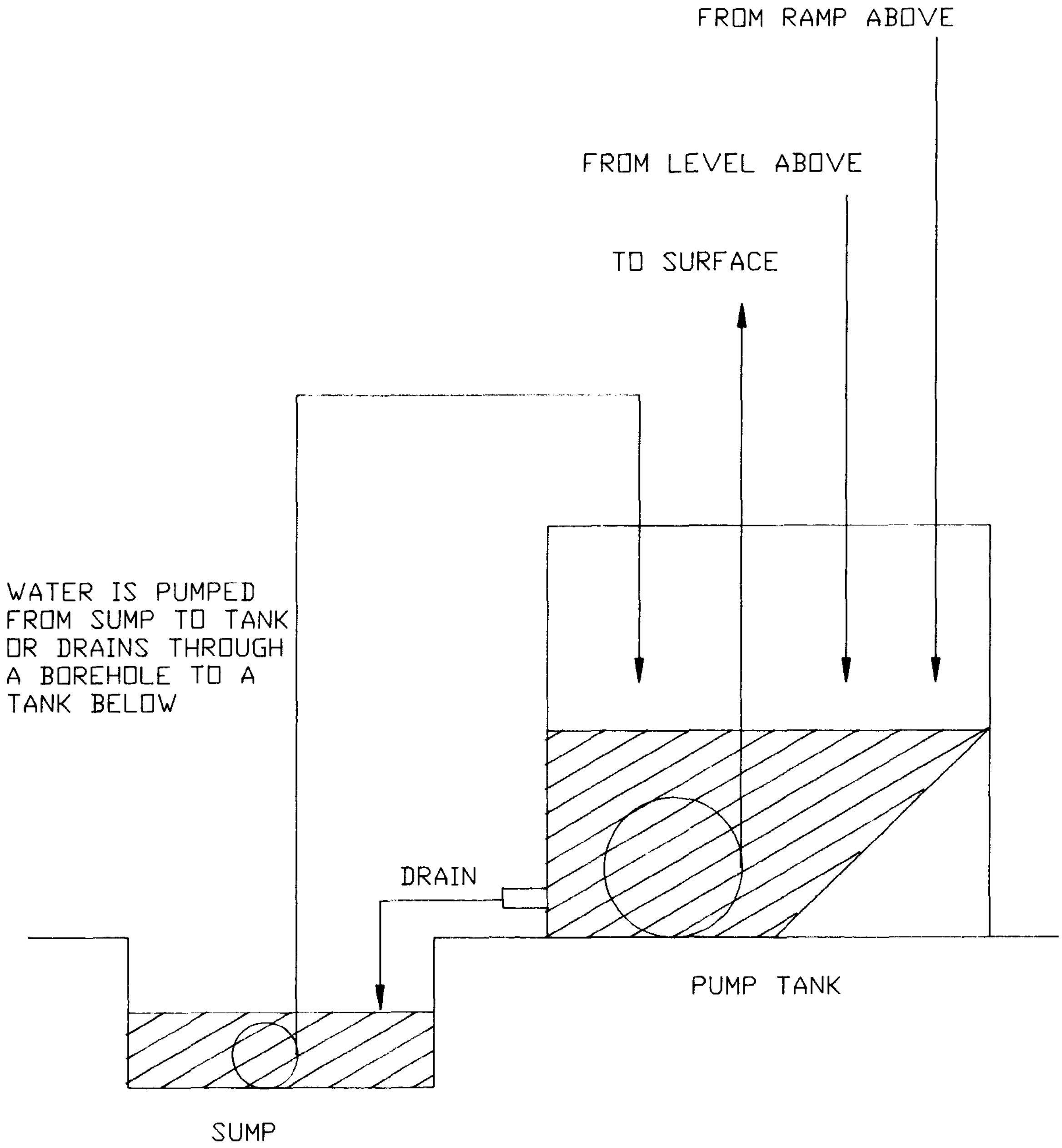



| | | |
|---|---|---|
| *PLEXUS, INC.* | | |
| ***BORNITE PROJECT*** ***MARION COUNTY, OREGON*** | | |
| PROVISIONAL PUMP TANK ARRANGEMENT | | |
| PREPARED BY PLEXUS, INC. | | |
| | FIGURE 17 | JULY, 1992 |




STAGE 4: RAMP DEVELOPMENT TO 1430 LEVEL
PRODUCTION ABOVE 1430 LEVEL

| |
|---|
| *PLEXUS, INC.* |
| ***BORNITE PROJECT*** ***MARION COUNTY, OREGON*** |
| PROVISIONAL FINAL PUMPING SYSTEM |
| PREPARED BY PLEXUS, INC. |
| FIGURE 18 — NOV., 1992 |




*PLEXUS, INC.*

***BORNITE PROJECT***
***MARION COUNTY, OREGON***

PROVISIONAL PUMP TANK ARRANGEMENT

PREPARED BY PLEXUS, INC.

FIGURE 17 | JULY, 1992

Underground equipment also will include small hand tools, small pneumatic rock drills, a variety of pumps, compressors, and auxiliary ventilation fans. As the mine deepens and the equipment ages, additional load haul dumps (LHD's) and haulage trucks may be brought in.

## 3.5 METALLURGICAL PROCESS DESCRIPTION

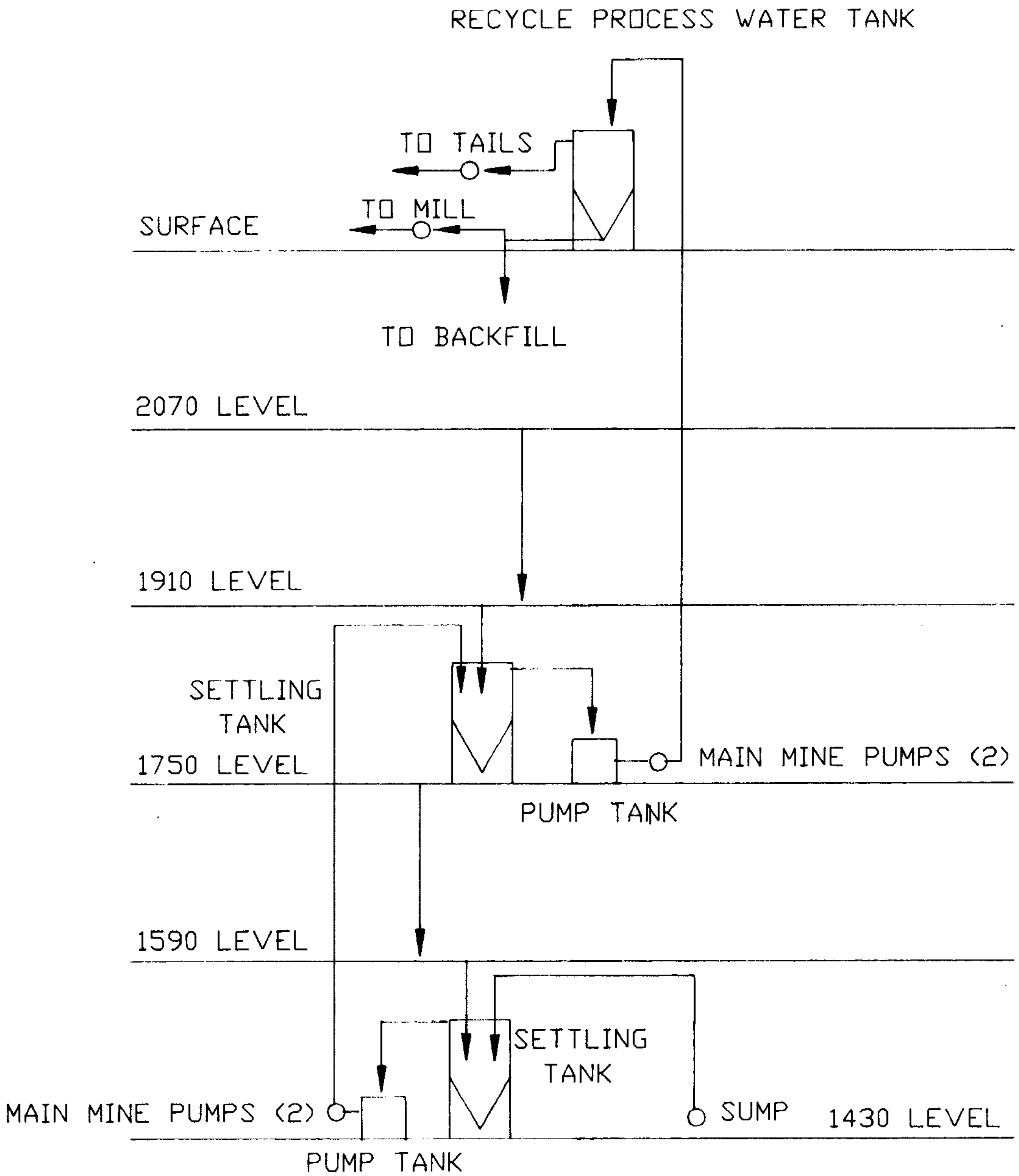
The Bornite process plant (mill) will be designed to treat 1,000 tons of ore a day from underground mining operations to produce a flotation concentrate for sale and further treatment. The concentrate will contain a higher percentage of the copper, gold, and silver than originally present in the ore. The provisional process flowsheet is shown in Figure 19.

Flotation, or froth flotation, is a widely-used process for separation and concentration of valuable minerals from finely ground ores. Nearly a century old, the process is employed worldwide for treating a variety of metallic and non-metallic mineral ores.

Flotation is a mechanical process based on the differences in wettability among minerals when their surfaces are properly conditioned. A suspension of ore particles in water is exposed to finely divided air bubbles, to which the non-wettable (usually valuable) minerals become attached. The air bubbles carry the selected minerals to the surface of the slurry and form a stabilized froth which is skimmed off (rougher), while the other usually valueless minerals remain in the slurry. The separation may be enhanced by refloating the concentrate to increase its grade (cleaner) or refloating the tailing to recover remaining traces of valuable minerals (scavenger).

At present, the Bornite flotation process will consist of several steps. Run-of-mine ore will be crushed in two stages at a rate of 120 tons hourly to a size of less than 5/8 inch. The crushed ore will be conveyed to a fine ore storage bin with a capacity of 3,000 tons. Ore withdrawn from the storage bin will be further reduced in a ball mill at a rate of 44 tons hourly. Water will be added in the grinding process to produce a slurry of coarsely-ground ore.

The slurry will be conditioned to prepare it for flotation, which will separate the copper minerals as a concentrate. After thickening, the copper concentrate will be filtered to produce a dewatered product suitable for shipping. The tailing will be thickened and pumped to the tailings impoundment or backfilled underground.




STAGE 4: RAMP DEVELOPMENT TO 1430 LEVEL
PRODUCTION ABOVE 1430 LEVEL

| |
|---|
| *PLEXUS, INC.* |
| *BORNITE PROJECT*<br>*MARION COUNTY, OREGON* |
| PROVISIONAL FINAL PUMPING SYSTEM |
| PREPARED BY PLEXUS, INC. |
| FIGURE 1[illegible] NOV., 1992 |

Geochemical testing of the flotation products for Bornite ores confirms the success of the flotation process to remove metal-bearing minerals. The flotation process tailings are classified as non-toxic. They do not generate acid, and do not leach toxic metals. These samples indicate that the tailings meet DEQ draft requirements for tailings-solids treatment criteria (WWL, 1992).

### 3.5.1 Crushing and Screening

Run-of-mine underground ore from will be delivered to the primary crusher dump hopper by trucks. Alternatively, ore from the mine development stockpile can be fed to the crusher by a front-end loader.

The crushing circuit will consist of a primary jaw crusher and a secondary cone crusher in closed circuit with a screen. Product size will be minus 5/8-inch.

Ore withdrawn from the dump hopper will be fed to the primary jaw crusher by a reciprocating plate feeder. The primary crusher will reduce the run-of-mine ore to nominally minus 4 inches.

The primary crusher product will be conveyed to a double-deck vibrating screen, fitted with a 3-inch upper deck and 5/8-inch lower deck. The combined plus 5/8-inch oversize will be fed to the secondary cone crusher for further reduction. Secondary crusher product will join the discharge from the primary crusher and be returned to the screen. Screen undersize will be conveyed to the 3,000-ton capacity fine ore bin.

Conveyor transfer and discharge points in the crushing area will be hooded and vented via a baghouse and fan. Dust collected in the baghouse will be dumped or returned manually to the grinding circuit.

### 3.5.2 Temporary Ore Storage

Before and shortly after mill startup, ore must be stored outside the mine. During this initial period, ore will be stored in the stockpile area south of the mine portal. As mine development proceeds and the mill is in full operation, the ore stockpile volume will be significantly reduced. The stockpile will be used for temporary storage of ore as required by unplanned mill mechanical problems. During normal planned operations, ore hauled from underground in the trucks will be dumped directly into a hopper ahead of the primary crusher.

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### 3.5.3 Primary Grinding

Crushed ore will be reclaimed from the fine ore bin by two belt feeders, either one of which is capable of feeding the grinding circuit at 44 tons hourly. The belt feeders will discharge onto a belt conveyor that transfers the ore into the mill building and discharge into the ball or rod mill feed chute.

The 10.5-foot diameter by 14-foot long ball or rod mill will operate in closed circuit with hydrocyclones to produce feed to the flotation circuit with a particle size of 80 percent passing 297 microns (48 mesh). Mill discharge will be pumped to the cyclones, the underflow returning to the mill, and the overflow passing to a stationary screen to remove trash. Screen undersize will be pumped to the flotation circuit.

### 3.5.4 Flotation and Regrind

Three stages of conventional mechanical flotation cells in a rougher-scavenger-cleaner arrangement will produce concentrate with optimum grade and recovery. A ball mill will regrind the cleaner tailings for reflotation.

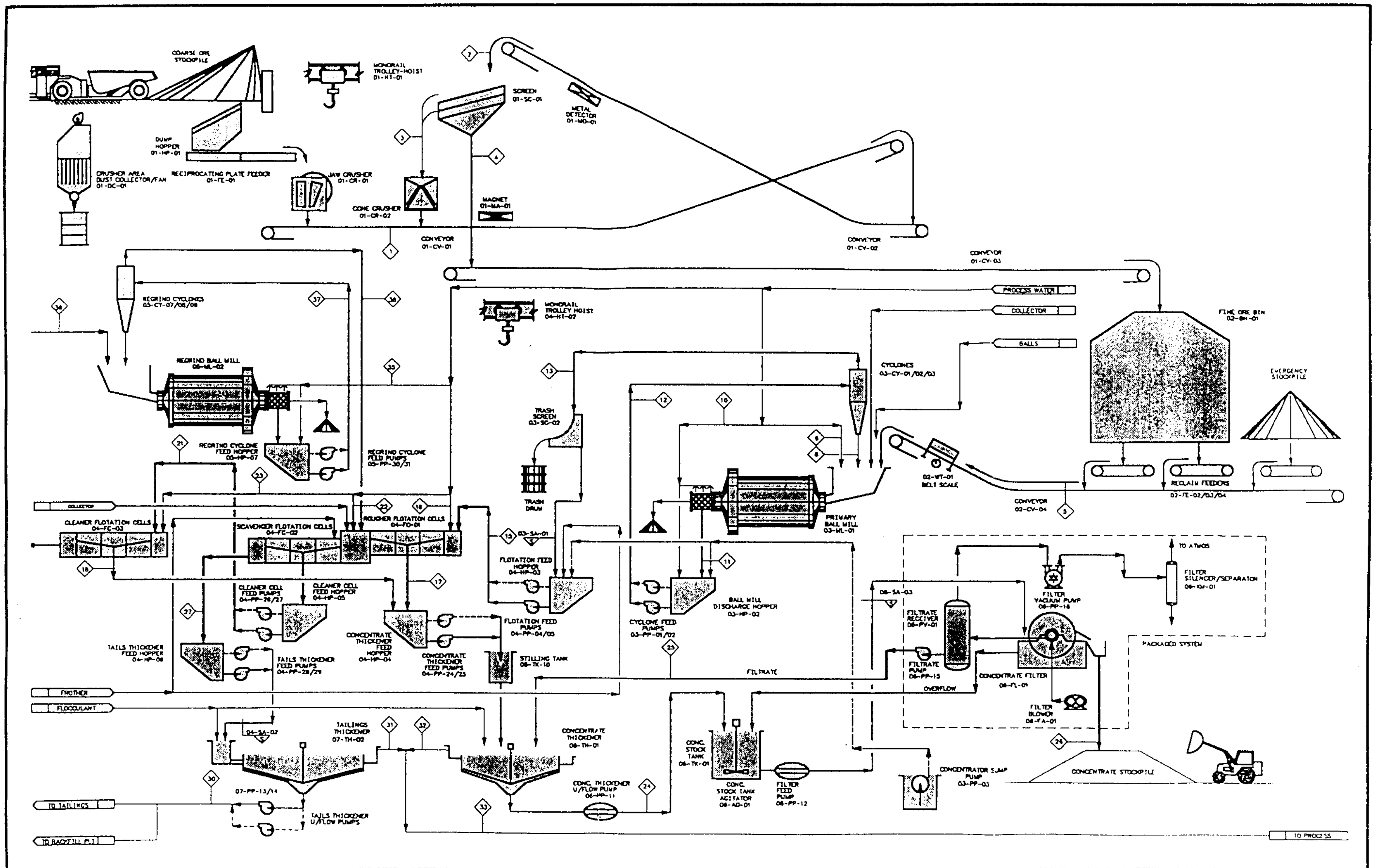
Screened cyclone overflow will be pumped to the rougher cells, which produce a final concentrate. Rougher tailings will flow directly to the scavenger cells. The tailing from these cells will be pumped to the thickener for disposal. The concentrate will be pumped to the cleaner cells, which produce a final concentrate and an intermediate-grade tailing. This tailing will be reground in a ball mill operating in closed circuit with a cyclone. Cyclone overflow will flow by gravity to the scavenger circuit. The concentrates from the rougher and cleaner cells will be combined in a hopper and pumped to the concentrate thickener.

### 3.5.5 Concentrate Dewatering

The concentrate thickener underflow will be pumped to an agitated stock tank with 24-hour storage capacity. The thickened concentrate will be pumped to a vacuum filter. The concentrate filter cake will fall to a confined storage area below the filter. Concentrate is reclaimed by a front-end loader and loaded into highway trucks for shipment and eventual sale.

### 3.5.6 Concentrate Characteristics

In the flotation process used at the Bornite Project, a premium copper concentrate will be produced. Maximization of the concentrate grade and reduction of the total quantities of concentrates produced will reduce transportation costs and smelter changes.




| | | |
|---|---|---|
| PLEXUS, INC. | | |
| BORNITE PROJECT<br>MARION COUNTY, OREGON | | |
| 1000 TPD COPPER CONC. PLANT<br>PROCESS FLOW SHEET | | |
| PREPARED BY MINPROC ENGINEERS, INC. | | |
| | FIGURE 19 | MAY, 1991 |

## FIGURES



## PLATES

g:\bornite.drp

Daily production of concentrate from the 1,000 ton per day Bornite Project mill would be about 78 to 100 tons. Grade of the concentrate will be roughly 32 to 39 percent copper, or about 15 times that of the mill feed ore grade. Some typical assay results determined during testwork by Dawson Metallurgical Laboratories are shown below in Table 11.

**Table 11. Typical Concentrate Analysis**

| Element | Percentage |
|---|---|
| Cu | 35.7 |
| Fe | 21.4 |
| Zn | <0.01 |
| Mo | 0.13 |
| As | <0.01 |
| Total S | 32.5 |
| $SiO_2$ | 7.67 |
| Pb | 0.10 |
| Cr | <0.005 |
| Cd | <0.005 |
| F | 0.049 |
| Sb | <0.01 |
| Bi | 0.132 |
| Se | <0.01 |
| Hg | 745 ppb |

### 3.5.7 Reagents

Reagents will be used to condition the ore slurry to promote the flotation process. Due to unique ore characteristics, minor quantities of reagents will be used at the Bornite Project. Typical reagents used in processes similar to that at the Bornite Project will be delivered in dry or liquid form. Even though the reagents are considered non-hazardous, they will be stored in a confined area so that leaks or spills can be easily contained and recovered. Details of the purpose, handling and storage of reagents likely to be used at the Bornite Project are provided below.

#### Collector

A collector will be added to the ore slurry before flotation to render the ore mineral surfaces non-wettable and ease their attachment to the air bubbles for removal as a concentrate froth. A variety of collectors are used in the mining industry. A proprietary

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dithiophosphate collector (American Cyanamid A3477) or the equivalent will be used at the Bornite Project.

The collector will be delivered as a liquid in 55-gallon drums. These will be stored under cover in a curbed containment area. As needed, a drum will be brought into the flotation area of the plant, and contents will be pumped into the collector mixing tank and diluted with water to a concentration of 5 to 25 percent. The prepared batch will then be transferred into the collector storage tank, from where it will be fed at a controlled rate into the ball mill feed chute and the scavenger flotation cells or column. Expected collector use is 7,000 lbs. yearly.

**Frother**

The term "frother" refers to a variety of chemicals used to help the flotation process by producing a stable froth to strengthen the bubbles in the flotation cells. One frother, MIBC (methyl isobutyl carbinol) or the equivalent, will be used at the Bornite Project. The reagent will be delivered in 55-gallon drums and stored under cover in a curbed containment area. Drums will be brought into the flotation area, and the contents pumped into the frother tank as needed. The mixture will be fed at a controlled rate to the rougher and scavenger flotation cells or columns. Total frother usage is expected to range between 20,000 and 25,000 lbs. yearly.

**Flocculent**

The Bornite Project may employ a flocculent from time to time to assist settling and thickening of concentrate and tailings slurries in their respective thickeners. Flocculents are generally high molecular weight organic polymers. They are added to mineral slurries in very small quantities to cause flocculation (agglomeration) of fine particles. Because of their increased mass, the flocculated particles settle readily, producing a thickened slurry and a clear supernatant solution.

Flocculent will be delivered as a dry granular solid in 50-lb fiber drums or plastic-lined paper sacks. The drums or sacks will be stored under cover. The flocculent will be dispersed in water and allowed to become fully wetted while being gently agitated. After the solids have dissolved, the stock solution will be drained to a storage tank. The solution will be metered into an in-line mixing device for continuous dilution by a stream of water. The diluted flocculent solution will be fed into the concentrate and tailings slurry streams as it enter the thickeners. Flocculent use will be minimal and only when needed for process water clarification. Expected consumption will be 15,000 to 20,000 lbs. per year.

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Tailings solution were produced from a simulated froth flotation process. The solution was then used to determine the toxicity to aquatic life according to standardized tests as prescribed by EPA protocol. Three life forms representing a food chain were used in the testing. Two tests were conducted, an acute test and a chronic or long term test. In both of the tests tailings solutions were added to actual site surface water with the organisms. The acute tests had no mortalities at three times the proposed reagent strength proposed to be used in the Bornite milling process. The long-term test showed no mortalities in the original organisms.

## 3.6 PROCESS FACILITIES DESCRIPTION

Process facilities, based on present design, will consist of three major structures with interconnecting belt conveyors. The first, the crushing and screening building, will be located adjacent to the mine portal. The elevation of the mine portal bench will be about 25 feet above the process plant bench to facilitate direct dumping of the loaded mine trucks into the primary crusher feed hopper. The second structure, the fine ore storage bin and reclaim tunnel, will be 150 feet northwest of the crushing and screening building. This facility will have a minimum storage capacity of 3,000 tons of crushed ore to provide an uninterrupted flow of material to the concentrator. Third and largest of the structures will be the concentrator/mill building. This facility, 100 feet southwest, will contain the grinding, flotation, concentration, tailings thickener, and reagent sections.

### 3.6.1 General

The process facilities will be designed and constructed in accordance with the latest federal, state and local codes to prevent the release of process materials to the environment and to minimize the overall project impact on the surroundings. A general arrangement of mine facilities is shown in Figure 13.

The site will be finished and graded with local materials, following the natural land contours as much as possible. The top layer will be a compacted, all-weather road base gravel with a chemical agent used for dust control. Plant site surface runoff will be directed to a sediment pond prior to discharge.

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Buildings and process structures such as conveyors, bins, tanks and thickeners will be supported on steel reinforced concrete foundations. Concrete slabs and curb walls will be provided under all process areas to contain spillage and facilitate clean-up. Concrete will conform to local codes.

Belt conveyors, transfer chutes, hoppers and other bulk material handling devices will be designed and constructed to minimize dust generation and release. All belt conveyors, hoppers, bins and transfer chutes will be covered. Both bag-type dust collection systems and water spray dust suppression systems will be used. All mechanical equipment with drives and rotating parts will be equipped with safety guards in accordance with industry standards.

The entire process facility/mine portal area will be surrounded by a five foot high metallic chain-link fence to provide personnel security and prohibit entry of wildlife. Fenced areas needing additional security, such as electrical substations, will topped with barbed wire. A security booth within the administration building will control main gate access. Control rooms in the concentrator/mill building and the crushing and screening building will continuously monitor processing.

### 3.6.2 Crushing and Screening Facility

The crushing and screening building will receive run-of-mine ore by direct dumping of the mine haul trucks into a 50-ton capacity hopper in the structure. A 42-inch wide reciprocating plate feeder meters the ore into the first stage of crushing. The primary crusher will be a 36-inch by 48-inch jaw mounted on an independent concrete foundation. A series of two 36-inch wide belt conveyors will transfer crusher discharge product to a 8-foot wide by 18-foot long vibrating screen. Screen oversize material will feed the secondary shorthead cone crusher. The plate feeder, the cone crusher and the sizing screen will be mounted on structural steel. Platforms and stairways complete with grating and handrail will be provided for equipment access. A 24-inch wide belt conveyor will transfer screen undersize product to the fine ore bin. The crushers and screen will be serviced using a 5-ton monorail with electric trolley-hoist.

The crushing and screening building will be approximately 30 feet wide by 70 feet long with a tentative peak height of 40 feet. It will be provided with insulation, translucent paneling for natural light, high pressure sodium electric lighting, powered roof

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ventilators and heaters. The transfer tower located to the southwest of the crushing building will be an open structure about 16 feet wide by 20 feet long by 20 feet high. A combination control room and motor control center will be on the upper level of the crushing building with a clear line of sight to dumping, crushing and screening operations.

### 3.6.3 Fine Ore Storage and Reclamation Facility

A 24-inch wide belt conveyor will deliver crushed material to the top of the fine ore bin. The 3,000-ton live capacity bin will be designed and constructed of mild steel plate with a concentrate ring beam foundation. It will be 50 feet in diameter and 66 feet in overall height. A 10-foot diameter corrugated steel pipe will form the reclaim tunnel. Within the tunnel, two 24-inch wide by 13-foot long belt feeders with steel reclaim hoppers will extract ore from the bin and meter it onto a 24-inch wide mill feed belt conveyor. Access into the tunnel from opposite sides of the bin will be provided. Lighting will be installed at the top of the bin and inside the reclaim tunnel, however, no powered ventilation or heating will be provided.

### 3.6.4 Grinding, Flotation and Concentration Facility

The concentrator/mill building will be about 60 feet wide by 88 feet long with tentative roof peak height at 35 feet. This building will contain the following process unit operations:

- grinding and classification
- flotation
- flotation regrinding
- concentrate thickening
- concentrate filtering and storage
- reagent storage and plant services

The grinding circuit will consist of a 10.5-foot diameter by 14-foot long rod or ball mill in closed circuit with a cluster of three 10-inch diameter cyclones. The mill and its 800 hp drive will be supported by independent concrete foundations. Access around the perimeter of the mill will be provided by structural steel platforms. The cyclones will be located above the feed end of the mill supported by structural steel. Cyclone

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The crushing and screening building will be approximately 30 feet wide by 70 feet long with a tentative peak height of 40 feet. It will be provided with insulation, translucent paneling for natural light, high pressure sodium electric lighting, powered roof underflow product returns to the mill while cyclone overflow product is pumped to the flotation section of the plant. The mill will be located in the northernmost corner of the building.

The flotation circuit will consist of a series of conventional 100-cubic-foot and 40-cubic-foot mechanically agitated flotation tanks. Structural steel supports and access platforms will be provided around the cells. The top of the cells and the cyclones will be serviced by a 2-ton monorail with an electric trolley-hoist.

The tailings from the scavenger cells will flow by gravity to an 80-hp ball mill for regrinding and then return to the flotation feed section. The concentrate from the rougher cells will gravity flow to a nominal 15-foot diameter conventional thickener. The thickened concentrate will be pumped to a 6,000-gallon capacity agitated stock tank. The regrind mill, concentrate thickener and stock tank are supported by independent concentrate foundations. A common structural steel access platform services the top of this equipment, which is located inside the southwest side of the building.

The concentrate filtration, storage and load-out circuit will be located in the southernmost corner of the building. It will consist of a 4-foot diameter by 6-foot long vacuum drum filter supported by a steel platform and will be located directly above a concrete bunker. The concrete bunker has storage for 5 days production of concentrate and will have its own exterior door for loadout by front-end loader.

The control room and motor control center room below are located inside the eastern most corner of the building. Both will be constructed out of concrete block and will be separately heated and ventilated.

The tailings thickener will be a 20-foot diameter, high-rate type and will be located outside the concentrator building. The concrete slab and curb under the thickener will divert spills onto the slab within the building. All spillage in the building will go to a central sump and be pumped back into the process.

The reagents mixing and storage section of the plant will be located in a "lean-to" next to the southeast side of the building. A concrete containment slab, curbing and a sump will be provided for spillage. The largest reagent tank is 500 gallons.

The concentrator/mill building have insulation, translucent paneling, high bay, high pressure sodium lighting, powered roof ventilators and propane fired unit heaters.

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### 3.7 TAILINGS IMPOUNDMENT FACILITY

The tailings impoundment site will be just above the mine site. The impoundment will be utilized to store coarse and fine mill tailings. Design also will allow storage of water to maximize recycle and minimize disturbance to aquifers in the area.

Flotation tailings will be thickened at the mill to a solids content averaging 55 to 60 percent. During most mill operations, tailings will be pumped to the backfill plant for cement addition, when required, and placement to designated areas as mine backfill.

The density of the backfilled tailings will be optimized to get as much tailings back underground as possible. The milled tailings will not be as dense as the rock that was mined. Therefore, surface disposal of about 990,000 tons of tailings not backfilled is required.

Tailings will be conveyed to either the mine or tailings impoundment as a thickened slurry. The tailings pipeline will be laid above ground in a shallow channel or buried beneath access roads. The tailings will be of a relatively coarse grind, with most of the coarse fraction being separated by cyclones in the backfill plant, to produce a high quality backfill. The remaining coarse and fines fraction will be stored in the tailings impoundment area. Water in the tailings slurry will be decanted, collected in the process water pond, and recycled or discharged.

The facility will be built in three stages over the mine life. Excavation of the hillside, in addition to suitable mine development rock, will be used for construction. Plates 2, 3, 4 and Figure 22 indicate the three stages.

The tailings impoundment has been designed as an unlined structure. The tailings are non-acid generating. The effluent will meet drinking water standards in almost all circumstances.

Sixty percent of the mill tailings produced during the mine life will be used underground for backfill. The remaining 40 percent will be stored on surface in the impoundment. At the end of the mine life, the impoundment area will be reclaimed.

Final design will be completed based subsequent to the stipulations in the EIS and permitting process.

underflow product returns to the mill while cyclone overflow product is pumped to the flotation section of the plant. The mill will be located in the northernmost corner of the building.

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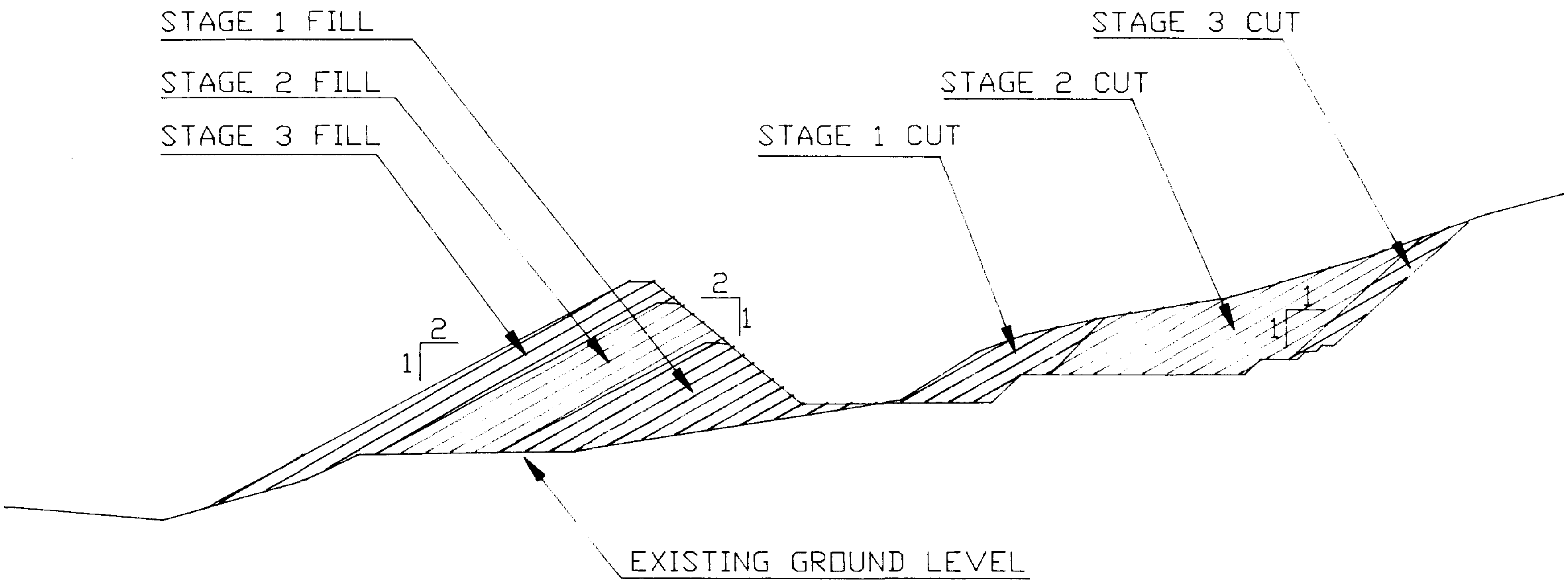


PLEXUS, INC.

BORNITE PROJECT
MARION COUNTY, OREGON

CONCEPTUAL IMPOUNDMENT X-SECTION

PREPARED BY PLEXUS, INC.

FIGURE 20 | NOV., 1992

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The tailings impoundment site will be just above the mine site. The impoundment will be utilized to store coarse and fine mill tailings. Design also will allow storage of water to maximize recycle and minimize disturbance to aquifers in the area.

Flotation tailings will be thickened at the mill to a solids content averaging 55 to 60 percent. During most mill operations, tailings will be pumped to the backfill plant for cement addition, when required, and placement to designated areas as mine backfill.

The density of the backfilled tailings will be optimized to get as much tailings back underground as possible. The milled tailings will not be as dense as the rock that was mined. Therefore, surface disposal of about 990,000 tons of tailings not backfilled is required.

Tailings will be conveyed to either the mine or tailings impoundment as a thickened slurry. The tailings pipeline will be laid above ground in a shallow channel or buried beneath access roads. The tailings will be of a relatively coarse grind, with most of the coarse fraction being separated by cyclones in the backfill plant, to produce a high quality backfill. The remaining coarse and fines fraction will be stored in the tailings impoundment area. Water in the tailings slurry will be decanted, collected in the process water pond, and recycled or discharged.

The facility will be built in three stages over the mine life. Excavation of the hillside, in addition to suitable mine development rock, will be used for construction. Plates 2, 3, 4 and Figure 22 indicate the three stages.

The tailings impoundment has been designed as an unlined structure. The tailings are non-acid generating. The effluent will meet drinking water standards in almost all circumstances.

Sixty percent of the mill tailings produced during the mine life will be used underground for backfill. The remaining 40 percent will be stored on surface in the impoundment. At the end of the mine life, the impoundment area will be reclaimed.

Final design will be completed based subsequent to the stipulations in the EIS and permitting process.

## 3.8 TOPSOIL SALVAGE AND STOCKPILE

Baseline studies of the project area indicate that the topsoil contains a large percentage of boulder size material. If all of the course rock material were removed from the topsoil before it is stored, 142,900 cubic yards of material would be salvaged. If the course material were not removed, 220,400 cubic yards would be salvaged. Topsoil will be salvaged and course material that will fit into the excavation equipment will be loaded and stored in stockpiles. If areas of large boulders are identified the soil will be screened to remove the course material. This material will be stripped using front end loaders and scrapers, screened, and sorted. Suitable material will be placed stable configuration, and seeded until required for reclamation. Topsoil stockpiles are shown in Plate 2.

As timber is cleared from the site and adequate area exists, topsoil stripping will begin. Areas to be stripped will be identified in the field to enable correct depths of each soil type to be recovered. The equipment will then remove the topsoil and remaining vegetation.

## 3.9 DEVELOPMENT ROCK USE AND STORAGE

Approximately 40,000 tons of ore will be mined and stock piled on surface prior to mill startup. Non-ore development material will be used for tailings dam construction, road building, and backfill.

The ore stockpile will be lined to collect runoff. Runoff will be collected and used in the mill or pumped to the tailings impoundment area.

## 3.10 DRAINAGE AND SEDIMENT CONTROL

The permit area will be sloped and ditched to collect runoff water in the sediment pond. Surface disturbance will be minimized to eliminate sediment sources. Erosion practices will be implemented on an ongoing basis to minimize the potential for sediment generation. Ditch locations are shown in Plates 2 to 4.

Diversion channels and ditches will be designed to channel runoff during 100-year storm events and to maximize long-term erosional stability. The sediment pond will be sized to contain mine site runoff from a 100-year storm event, as well as provide sufficient residence time for settlement of suspended particles. The pond will be unlined to facilitate cleanout during operations. Storage capacity will be 333,000 cubic feet, and the pond size will be 200 feet by 200 feet by 10 feet deep, as shown in Figure 21. Water from the sediment pond will be pumped to the process water pond or the tailings impoundment.

## 3.11 ANCILLARY FACILITIES

### 3.11.1 Electrical Power

Electrical power for the project will be provided by Consumer's Power Tumble Creek Substation near Detroit. An overhead 24.9-kV line will be routed along existing U.S. Forest Service roads about 14 miles. The line will end in a main substation at the west side of the plant perimeter.

The metering point for electric service will be at the Tumble Creek substation. Total annual energy use is estimated at 15,034,000 kWhr.

A primary transformer will reduce line voltage to 4160 V. The 4160 V power will be distributed to the underground mine, ball mill, crushing and screening plant and the concentrator/mill motor control center. There will be motors with an estimated 600 kW maximum load in the mine, 630 kW maximum load in the crushing plant, 508 kW in the concentrator, 537 kW in the primary ball mill and approximately 100 kW elsewhere in various applications.

### 3.11.2 Access Road

Primary access to the Bornite Project (Figure 2) will be the existing roads system from Mehama and Gates via County Roads 960 (North Fork Road) and 967 (Gates Hill Road) respectively, past Elkhorn to the Forest Service western boundary and road F-2209. It is about 13 miles from Mehama to the Forest boundary. Access on F-2209 continues for about one mile where it intersects with F-2207 and continues past the Bornite property, about four miles. Total access from Mehama to the property boundary is approximately 18 miles.

Alternative access to the property can be gained by French Creek road from Detroit, F-2223, and on F-2207 to the property. This alternative route consists of about 14 miles of rugged gravel road.

Traffic routing, load limitations and maintenance would be coordinated with the U.S. Forest Service and Marion County to minimize impacts to the existing road system. Truck traffic required for facilities operations would be similar to that used for timber hauling.

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# TABLES

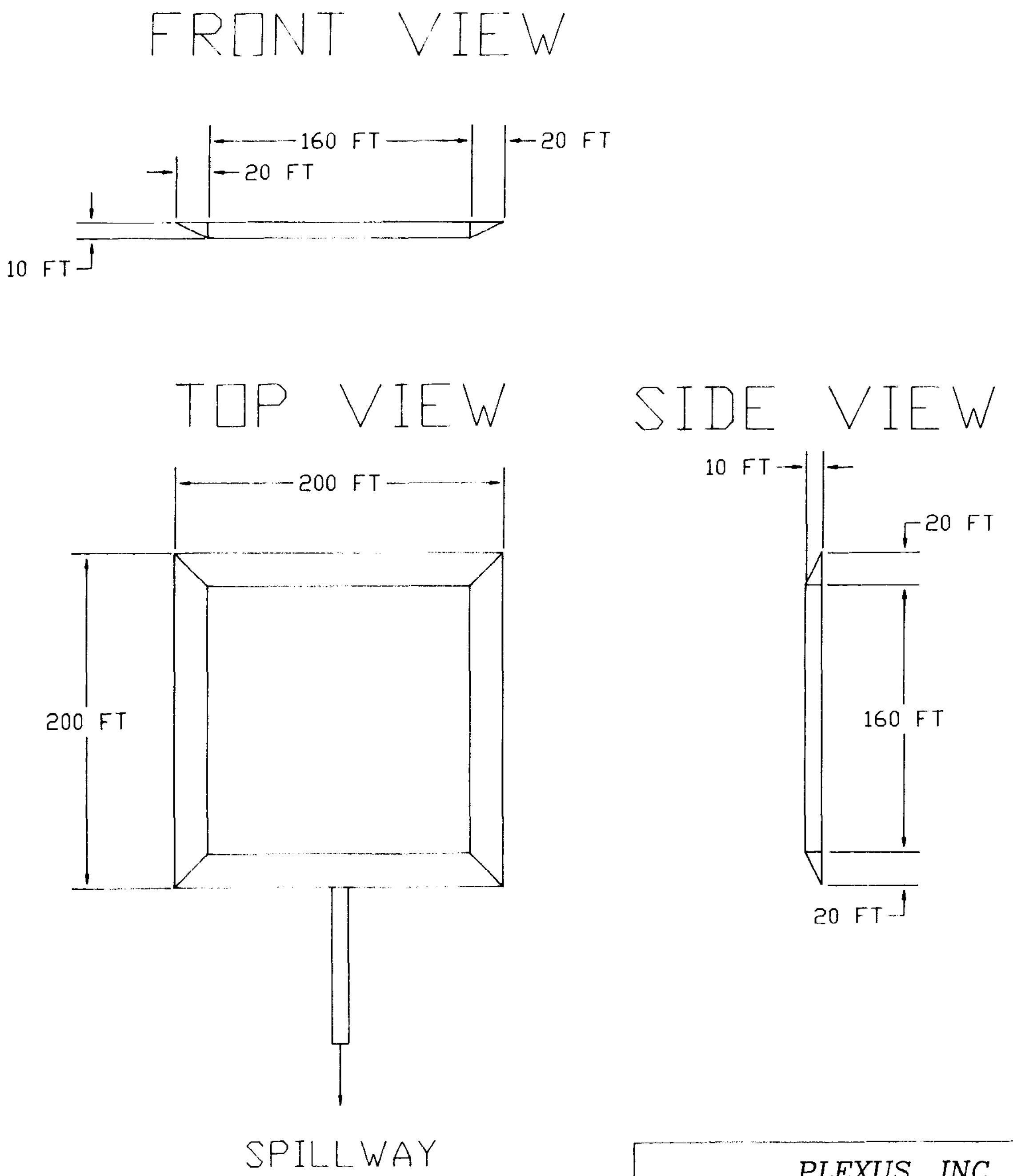


# APPENDIX

## FIGURES



## PLATES




*PLEXUS, INC.*

*BORNITE PROJECT*
***MARION COUNTY, OREGON***

CONCEPTUAL SEDIMENT POND LAYOUT

PREPARED BY PLEXUS, INC.

| | FIGURE 21 | SEPT, 1992 |
|---|---|---|

from the sediment pond will be pumped to the process water pond or the tailings impoundment.

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Traffic routing, load limitations and maintenance would be coordinated with the U.S. Forest Service and Marion County to minimize impacts to the existing road system. Truck traffic required for facilities operations would be similar to that used for timber hauling.

Trucks will deliver fuel, cement, process reagents and supplies to the mine site at three to four times daily. During construction phase, equipment would be delivered on multi-axle low boy trailers. All trucks would be sized for use on the existing roads and bridges. Delivery of the copper concentrate produced by the Bornite Project will be in covered trucks suitable for highway travel at the rate of five trips daily. In addition, some miscellaneous traffic will be occur for services such as the pick-up of solid waste and sanitary waste.

It is envisioned that most of mine/mill personnel would be brought to work by van pool from Mehama to minimize the impact of traffic on the road system. Some management personnel would need their vehicles on the property because of the nature of their work.

Plexus would be required to obtain a road use permit from the U.S. Forest Service. As part of the permit, the Company will provide a fee or services to cover the increased maintenance cost of forest roads. Increased use of the County road will be small and will be paid for by the increased tax base from the mine.

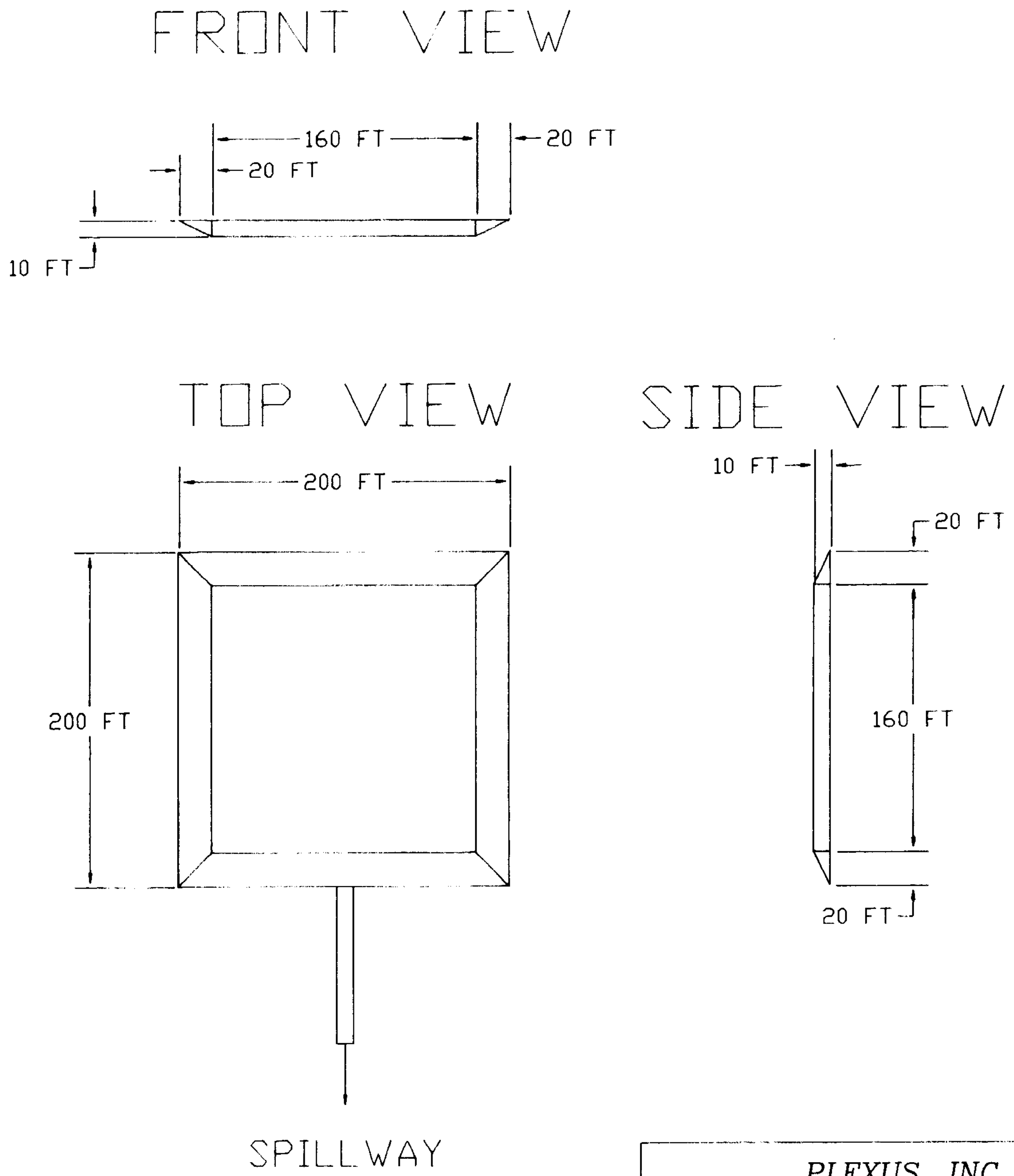
### 3.11.3 Water Supply and Storage

Water supply for the project will be from wells on the site, precipitation, and groundwater flow into the mine workings. The well water will be pumped to the water storage tank above the tailings impoundment facility, and will be used for drinking water, wash water, and emergency supply, such as fire protection. The well water will be separate from other water used on the project site.

Most of the mill makeup water will be recycled from the tailings facility underground, and pumped from the process water pond. Precipitation will be captured on the project site and stored for use as makeup water. Additional mill makeup water will be supplied from the wells only as needed.

### 3.11.4 Ammonium Nitrate/Explosive Storage

Ammonium nitrate will be delivered as bulk prill (i.e. small solid grains). The prill will be stored in an approved 20-ton silo. As required for usage, the ammonium nitrate will be mixed with diesel fuel to provide the desired explosive characteristics to be used underground. Ammonium nitrate and other explosives will be purchased and delivered to the mine site by the manufacturer in approved vehicles with trained personnel. Explosives will be stored in licensed magazines. Magazines will conform to all regulations concerning storage of explosives.




*PLEXUS, INC.*

***BORNITE PROJECT***
***MARION COUNTY, OREGON***

CONCEPTUAL SEDIMENT POND LAYOUT

PREPARED BY PLEXUS, INC.

FIGURE 21 | SEPT, 1992

These magazines will be located at an appropriate distance from the ammonium nitrate storage silo and buildings. All employees responsible for explosives will be trained and certified by government agencies.

### 3.11.5 Cement Storage

Cement for mine backfilling will be stored in a silo near the mine portal or other location above the underground workings to allow for efficient backfill placement. When backfill operations needed more cement, deliveries will be arranged. A typical arrangement for the backfill plant is shown in Figures 22 and 23. Tailings and cement will be mixed together and distributed underground through boreholes and piping.

### 3.11.6 Fuel Storage

Diesel fuel will be stored on the surface in a vertical steel tank with a 7,500 gallon capacity. Gasoline will be stored in a surface horizontal tank with a 500 gallon capacity. Both fuel tanks and dispensing pumps will be located in an covered containment with an impervious synthetic liner. The containment can hold 110 percent of the largest tank plus a 25-year, 24-hour rainfall event. A detection system will be provided to spot any leakage of fuels into the secondary containment. A fire suppression system will be installed to automatically discharge in the event of a fire at the storage site. The fuel storage arrangement is shown in Figure 24.

### 3.11.7 Sanitary and Solid Waste Disposal

Waste produced on-site will be handled and disposed according to County and State requirements. Trash will be temporarily stored in a receptacle at the mine site and hauled off site to a municipal waste disposal facility. Sewage will be temporarily stored in a holding tank at the mine site and hauled off-site to designated sewage treatment plant or disposed of in a conventional septic system, as appropriate and approved by the State of Oregon and the U.S. Forest Service.

Vegetation stripped during site preparation and construction that cannot be salvaged for lumber or incorporated into mulch or topsoil for reclamation will be disposed of as directed by applicable U.S. Forest Service standards.

### 3.11.8 Maintenance and Warehouse Facilities

The workshop/warehouse will be located next to the mine portal. These facilities will be sized to provide the following:

Trucks will deliver fuel, cement, process reagents and supplies to the mine site at three to four times daily. During construction phase, equipment would be delivered on multi-axle low boy trailers. All trucks would be sized for use on the existing roads and bridges. Delivery of the copper concentrate produced by the Bornite Project will be in covered trucks suitable for highway travel at the rate of five trips daily. In addition, some miscellaneous traffic will be occur for services such as the pick-up of solid waste and sanitary waste.

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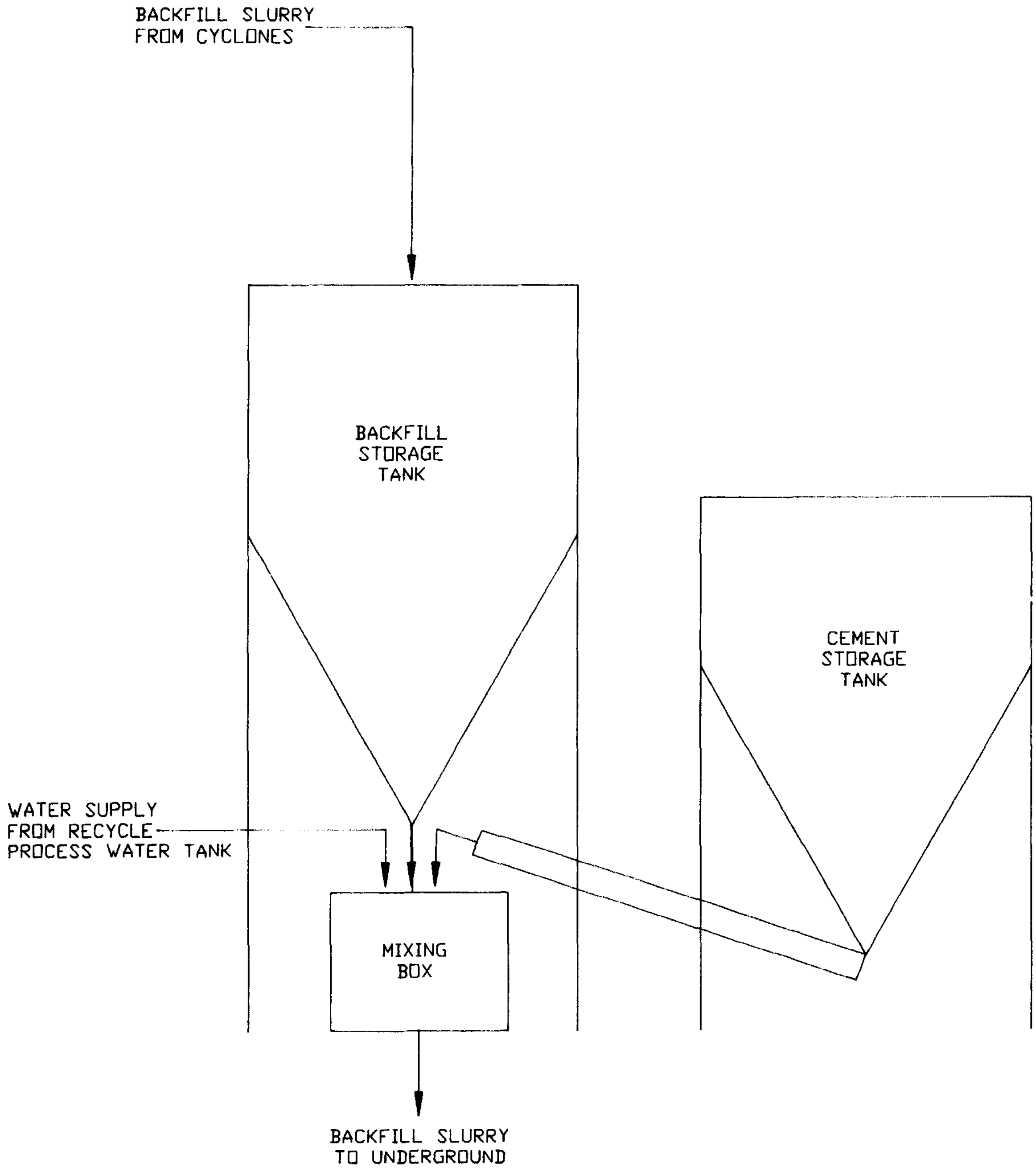


*PLEXUS, INC.*

*BORNITE PROJECT*
***MARION COUNTY, OREGON***

CONCEPTUAL BACKFILL STORAGE SYSTEM

PREPARED BY PLEXUS, INC.

FIGURE 22 NOV., 1992

These magazines will be located at an appropriate distance from the ammonium nitrate storage silo and buildings. All employees responsible for explosives will be trained and certified by government agencies.

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Vegetation stripped during site preparation and construction that cannot be salvaged for lumber or incorporated into mulch or topsoil for reclamation will be disposed of as directed by applicable U.S. Forest Service standards.

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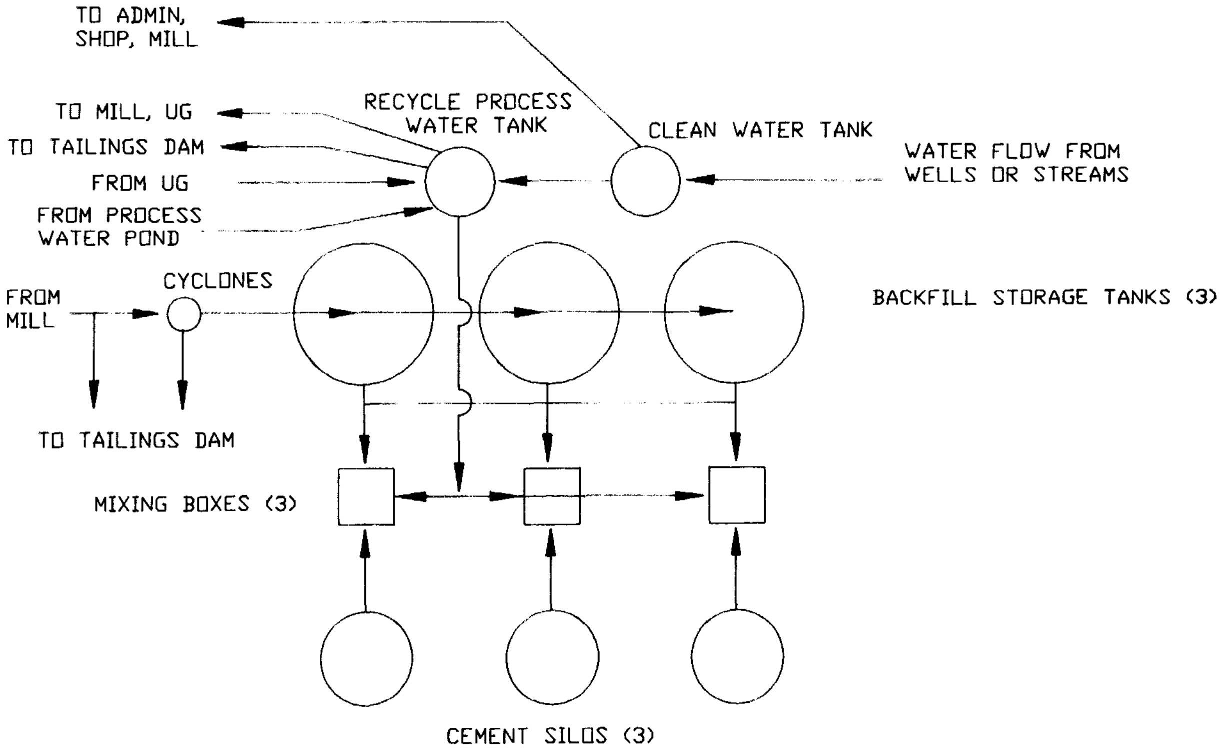


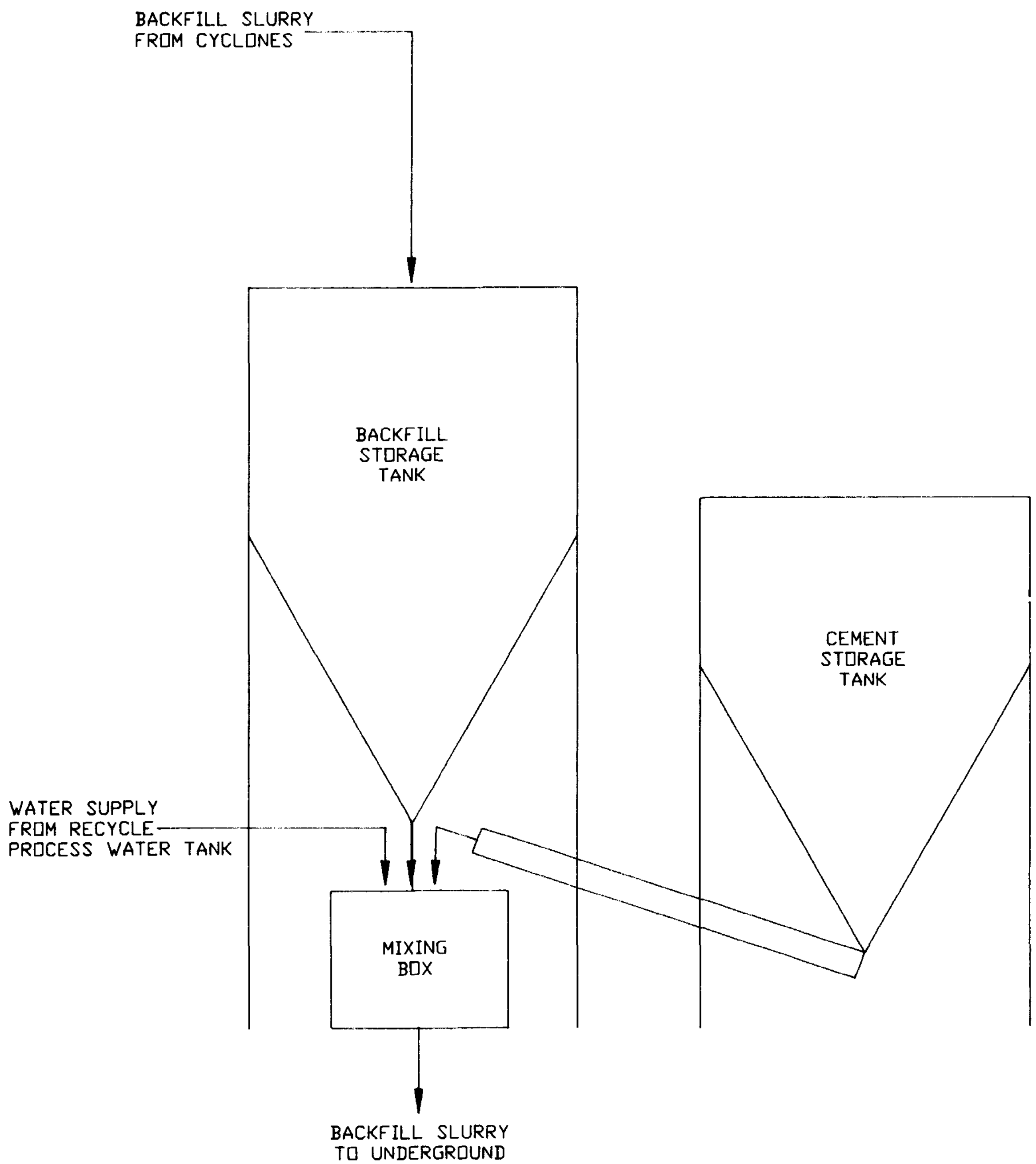

PLEXUS, INC.

BORNITE PROJECT
MARION COUNTY, OREGON

BACKFILL PLANT CONCEPTUAL SCHEMATIC

PREPARED BY PLEXUS, INC.

FIGURE 23 | NOV., 1992

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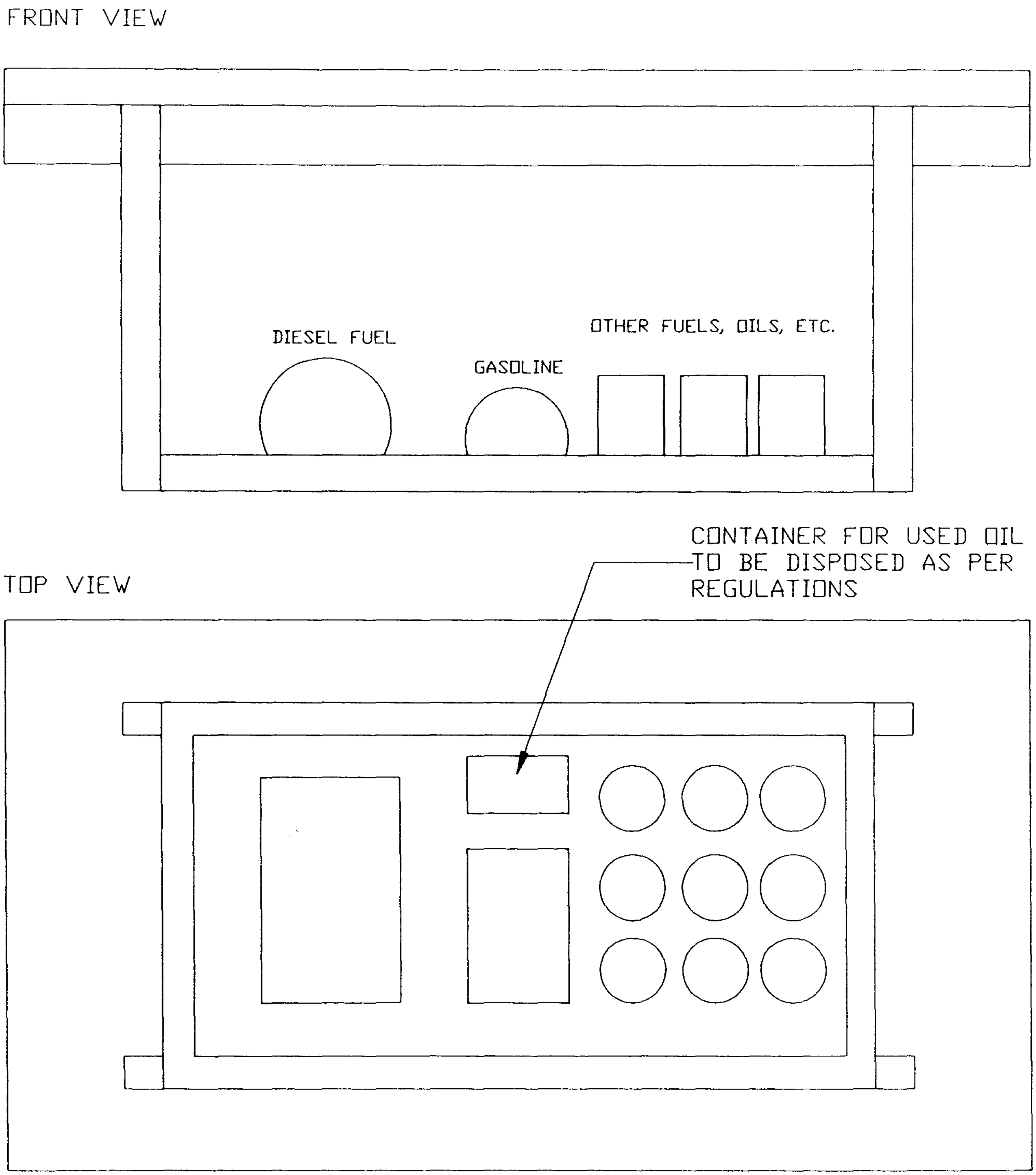
|---|
| *PLEXUS, INC.* |
| *BORNITE PROJECT*<br>***MARION COUNTY, OREGON*** |
| CONCEPTUAL BACKFILL STORAGE SYSTEM |
| PREPARED BY PLEXUS, INC. |
| FIGURE 22 — NOV., 1992 |



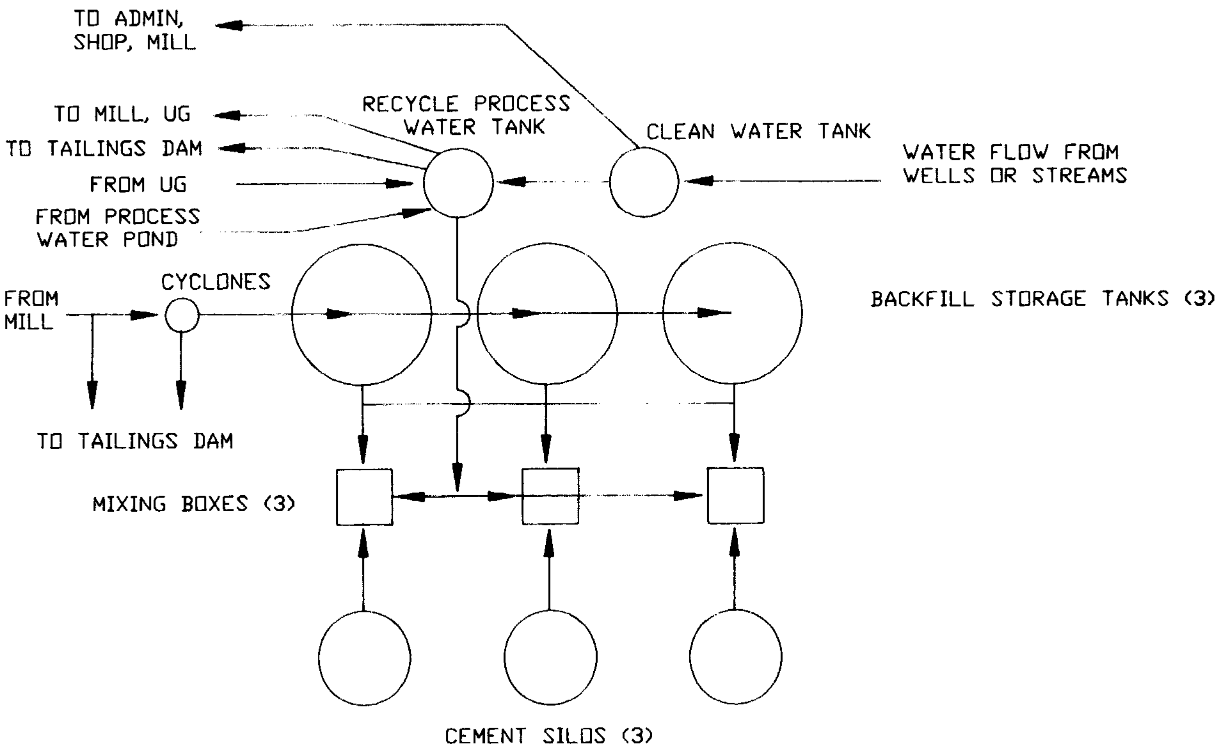

*PLEXUS, INC.*

*BORNITE PROJECT*
*MARION COUNTY, OREGON*

CONCEPTUAL FUEL STORAGE AREA

PREPARED BY PLEXUS, INC.

FIGURE 24 | NOV., 1992




*PLEXUS, INC.*

*BORNITE PROJECT*

***MARION COUNTY, OREGON***

BACKFILL PLANT CONCEPTUAL SCHEMATIC

PREPARED BY PLEXUS, INC.

FIGURE 23 | NOV., 1992

- service/maintenance bays for long term maintenance requirements
- service/maintenance bays for short term maintenance requirements
- warehouse facilities for mine and plant operations;
- workshop facilities for mine and plant operations;
- offices for senior maintenance and warehouse personnel;
- electrical shop

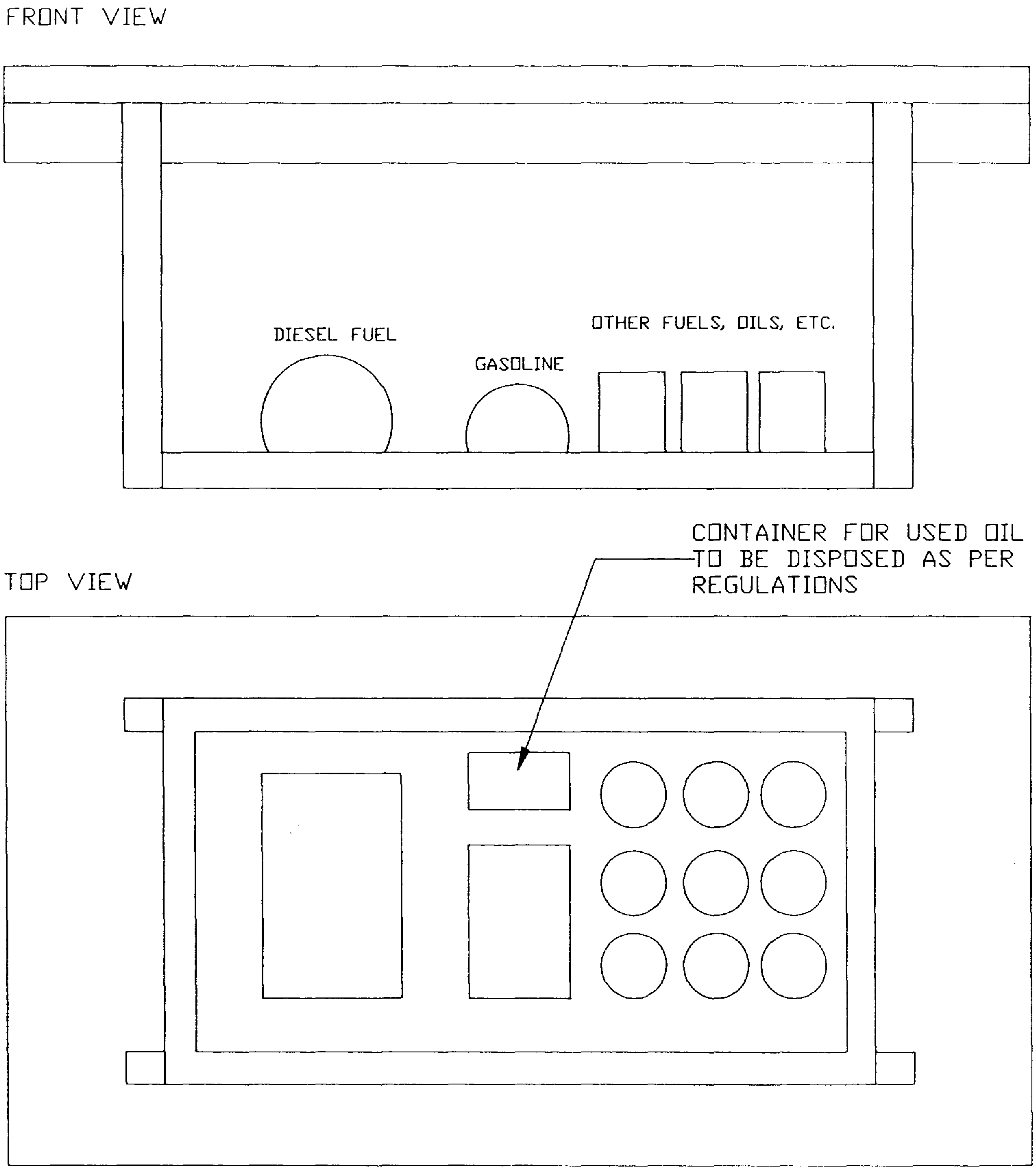
The building will be about 36 feet wide and 64 feet long with a 25-foot eave height as shown in Figure 27.

### 3.11.9 Administration Building

An office building will be located just inside the main gate to conduct administrative activities and monitor gate traffic. This building will accommodate the following

In addition to individual offices, the building will contain a:

- administrative office
- engineering and geology offices
- security
- reception area
- mine rescue/training room
- conference/lunchroom
- fireproof vault
- mine management
- mine lamproom




PLEXUS, INC.

BORNITE PROJECT
MARION COUNTY, OREGON

CONCEPTUAL FUEL STORAGE AREA

PREPARED BY PLEXUS, INC.

FIGURE 24 NOV., 1992

- shower facilities

The building will be about 60 feet wide and 108 feet long with a 15-foot eave height as shown in Figure 25.

### 3.11.10 Laboratory and Core Storage

The sample preparation, assay, and analytical laboratory will be located adjacent to the administration building. The laboratory facilities will be equipped to perform daily analyses of mine and mill samples used for operations control. The building will be provided with laboratory crushing, screening, separation, and drying equipment. The laboratory will be equipped with fire assay facilities. Additionally, the laboratory will contain an A.A. spectrometer, pH meter, sinks, and sample handling equipment. The building will be approximately 40 feet wide and 60 feet long with a 15-foot eave height as shown in Figure 27.

### 3.11.11 Security and Fencing

The mine and mill area will be fenced with one gate at the mine entrance from the U.S. Forest Service road. The gate will be manned by security personnel or office staff. A five-foot chain-link fence will be installed around the mine area, diversion channels, the mill area, and all water storage ponds and the tailings impoundment as shown in Plate 4.

### 3.11.12 Outdoor Lighting

Exterior lighting will be required at several facilities to allow for safe operations after dark. Lighting is expected to be required at the crusher, mill, shop, and the portal area. This lighting will be hooded and directional to avoid unnecessary glare.

## 3.12 VISUAL SCREENING

Care would be taken during the life of the project to minimize the unnecessary elimination of vegetation, particularly along the project permit boundary with border Forest Service roads. A buffer of coniferous forest along the roadway would be retained sufficient to screen the facilities and the disturbed areas. To minimize visibility, buildings would be set back from the roadway.

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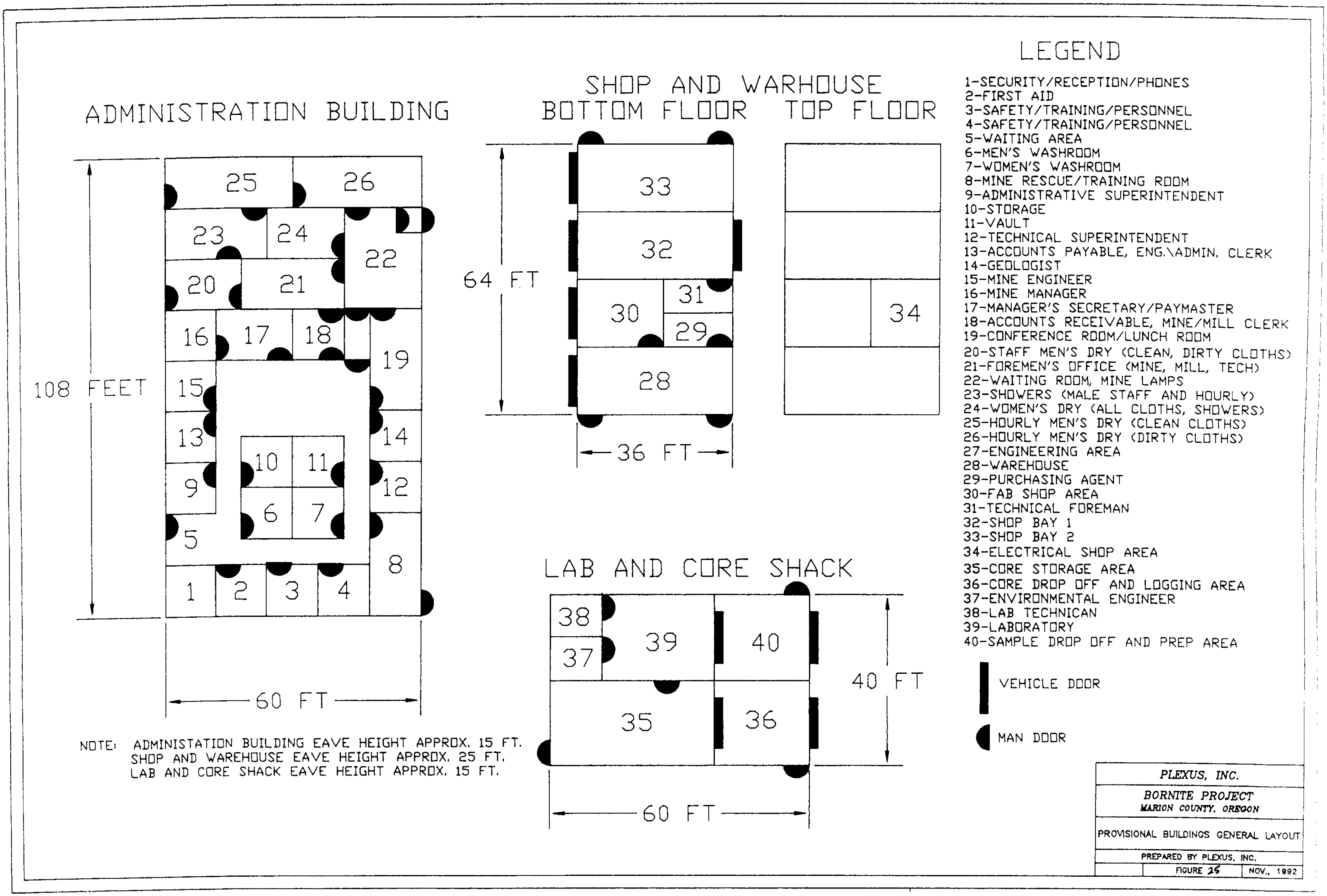
ADMINISTRATION BUILDING
108 FEET
60 FT
25
26
23
24
22
20
21
16
17
18
19
15
13
14
10
11
9
12
6
7
5
8
1
2
3
4
SHOP AND WARHOUSE
BOTTOM FLOOR TOP FLOOR
64 FT
36 FT
33
32
31
30
29
28
34
LAB AND CORE SHACK
40 FT
60 FT
38
37
39
40
35
36
NOTE: ADMINISTATION BUILDING EAVE HEIGHT APPROX. 15 FT.
SHOP AND WAREHOUSE EAVE HEIGHT APPROX. 25 FT.
LAB AND CORE SHACK EAVE HEIGHT APPROX. 15 FT.
LEGEND
1-SECURITY/RECEPTION/PHONES
2-FIRST AID
3-SAFETY/TRAINING/PERSONNEL
4-SAFETY/TRAINING/PERSONNEL
5-WAITING AREA
6-MEN'S WASHROOM
7-WOMEN'S WASHROOM
8-MINE RESCUE/TRAINING ROOM
9-ADMINISTRATIVE SUPERINTENDENT
10-STORAGE
11-VAULT
12-TECHNICAL SUPERINTENDENT
13-ACCOUNTS PAYABLE, ENG.\ADMIN. CLERK
14-GEOLOGIST
15-MINE ENGINEER
16-MINE MANAGER
17-MANAGER'S SECRETARY/PAYMASTER
18-ACCOUNTS RECEIVABLE, MINE/MILL CLERK
19-CONFERENCE ROOM/LUNCH ROOM
20-STAFF MEN'S DRY (CLEAN, DIRTY CLOTHS)
21-FOREMEN'S OFFICE (MINE, MILL, TECH)
22-WAITING ROOM, MINE LAMPS
23-SHOWERS (MALE STAFF AND HOURLY)
24-WOMEN'S DRY (ALL CLOTHS, SHOWERS)
25-HOURLY MEN'S DRY (CLEAN CLOTHS)
26-HOURLY MEN'S DRY (DIRTY CLOTHS)
27-ENGINEERING AREA
28-WAREHOUSE
29-PURCHASING AGENT
30-FAB SHOP AREA
31-TECHNICAL FOREMAN
32-SHOP BAY 1
33-SHOP BAY 2
34-ELECTRICAL SHOP AREA
35-CORE STORAGE AREA
36-CORE DROP OFF AND LOGGING AREA
37-ENVIRONMENTAL ENGINEER
38-LAB TECHNICAN
39-LABORATORY
40-SAMPLE DROP OFF AND PREP AREA
VEHICLE DOOR
MAN DOOR
PLEXUS, INC.
BORNITE PROJECT
MARION COUNTY, OREGON
PROVISIONAL BUILDINGS GENERAL LAYOUT
PREPARED BY PLEXUS, INC.
FIGURE 25
NOV., 1992

- shower facilities

The building will be about 60 feet wide and 108 feet long with a 15-foot eave height as shown in Figure 25.

### 3.11.10 Laboratory and Core Storage

The sample preparation, assay, and analytical laboratory will be located adjacent to the administration building. The laboratory facilities will be equipped to perform daily analyses of mine and mill samples used for operations control. The building will be provided with laboratory crushing, screening, separation, and drying equipment. The laboratory will be equipped with fire assay facilities. Additionally, the laboratory will contain an A.A. spectrometer, pH meter, sinks, and sample handling equipment. The building will be approximately 40 feet wide and 60 feet long with a 15-foot eave height as shown in Figure 27.

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## 3.12 VISUAL SCREENING

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To lessen the visual impact, buildings will be constructed using colors and materials selected to be harmonious with the natural surroundings. Perimeter fencing will be colored to blend with the landscape.

## 3.13 WATER MANAGEMENT PLAN

A water management plan was completed (Plexus, 1992) to determine the impact of the mine on the permit area. The plan is based on the following three concepts:

- Recycling of project water to minimize disturbance to the aquifers on the project site.
- Capture and storage of precipitation during wet periods for use in dry seasons. This minimizes the need to withdraw water from the aquifers unless absolutely necessary.
- Maximizing recharge of the aquifers by allowing seepage from the tailings impoundment area and water ponds.

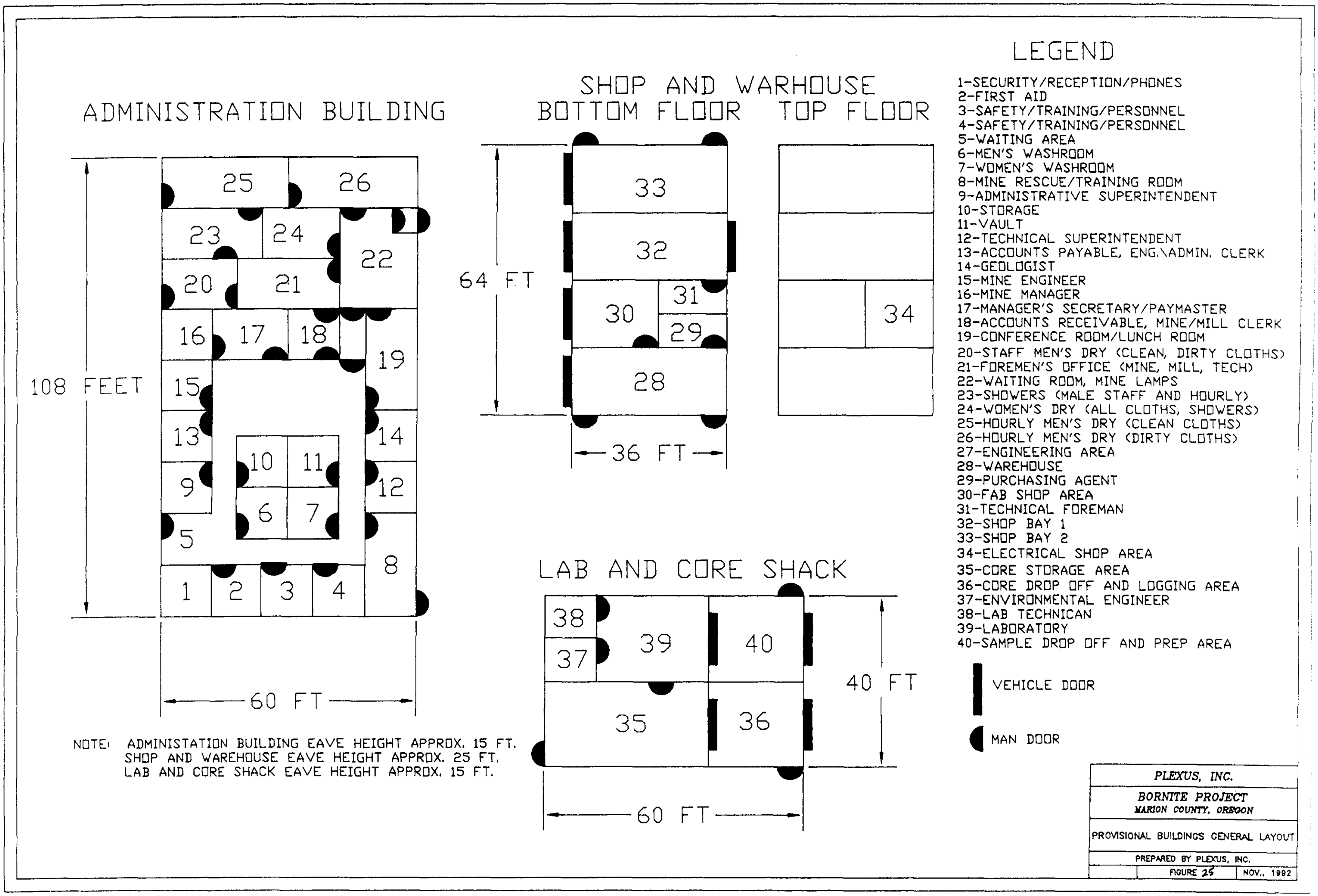
Discharge to surface waters would occur from the process water pond. Discharge water would be treated, if necessary, to allow it to meet drinking water quality standards.

## 3.14 ENVIRONMENTAL CONSEQUENCES AND MITIGATION

The Bornite Project will be designed to minimize the risks of environmental disturbance. Mitigation steps include design, training, procedure implementation, prevention, and control countermeasures.

### 3.14.1 On-Site Spill Prevention and Contingency Plan

An On-Site Spill Prevention and Counter-measure Plan (SPCC) will define procedures to deal with any emergency situation associated with a spill of substances with significant contaminant potential. The SPCC's primary purpose is to define and describe basic management responses to spills and to provide an emergency operational handbook for emergencies, such as an accidental release of process chemicals or fuel. Potential spill sources at the site will include petroleum products and chemical reagents. The SPCC addresses emergency responses to spills of each of these materials. The SPCC plan is developed in accordance with Oregon Revised Statutes, Chapter 468 (1986 and 1987).


ADMINISTRATION BUILDING
108 FEET
60 FT
25 26 23 24 22 20 21 16 17 18 19 15 13 14 9 12 10 11 6 7 5 8 1 2 3 4
SHOP AND WARHOUSE
BOTTOM FLOOR
TOP FLOOR
64 FT
36 FT
33 32 30 31 29 28 34
LAB AND CORE SHACK
40 FT
60 FT
38 37 39 40 35 36
NOTE: ADMINISTATION BUILDING EAVE HEIGHT APPROX. 15 FT.
SHOP AND WAREHOUSE EAVE HEIGHT APPROX. 25 FT.
LAB AND CORE SHACK EAVE HEIGHT APPROX. 15 FT.
LEGEND
1-SECURITY/RECEPTION/PHONES
2-FIRST AID
3-SAFETY/TRAINING/PERSONNEL
4-SAFETY/TRAINING/PERSONNEL
5-WAITING AREA
6-MEN'S WASHROOM
7-WOMEN'S WASHROOM
8-MINE RESCUE/TRAINING ROOM
9-ADMINISTRATIVE SUPERINTENDENT
10-STORAGE
11-VAULT
12-TECHNICAL SUPERINTENDENT
13-ACCOUNTS PAYABLE, ENG.\ADMIN. CLERK
14-GEOLOGIST
15-MINE ENGINEER
16-MINE MANAGER
17-MANAGER'S SECRETARY/PAYMASTER
18-ACCOUNTS RECEIVABLE, MINE/MILL CLERK
19-CONFERENCE ROOM/LUNCH ROOM
20-STAFF MEN'S DRY (CLEAN, DIRTY CLOTHS)
21-FOREMEN'S OFFICE (MINE, MILL, TECH)
22-WAITING ROOM, MINE LAMPS
23-SHOWERS (MALE STAFF AND HOURLY)
24-WOMEN'S DRY (ALL CLOTHS, SHOWERS)
25-HOURLY MEN'S DRY (CLEAN CLOTHS)
26-HOURLY MEN'S DRY (DIRTY CLOTHS)
27-ENGINEERING AREA
28-WAREHOUSE
29-PURCHASING AGENT
30-FAB SHOP AREA
31-TECHNICAL FOREMAN
32-SHOP BAY 1
33-SHOP BAY 2
34-ELECTRICAL SHOP AREA
35-CORE STORAGE AREA
36-CORE DROP OFF AND LOGGING AREA
37-ENVIRONMENTAL ENGINEER
38-LAB TECHNICAN
39-LABORATORY
40-SAMPLE DROP OFF AND PREP AREA
VEHICLE DOOR
MAN DOOR
PLEXUS, INC.
BORNITE PROJECT
MARION COUNTY, OREGON
PROVISIONAL BUILDINGS GENERAL LAYOUT
PREPARED BY PLEXUS, INC.
FIGURE 25
NOV., 1992

# THE BORNITE PROJECT
# EXECUTIVE SUMMARY

The Bornite Project proposed by Plexus, Inc. of Salt Lake City, Utah is an underground copper mine. The mine will incorporate development and operation of a highly mechanized, 1,400-ton per day underground mine, operating five days per week. A on-site flotation concentrator will produce 100 tons of copper concentrate per day.

The site is located 50 miles east of Salem, Oregon in the Willamette National Forest on public land managed by the Detroit Ranger District. The project is located in the Cedar Creek drainage, a glaciated valley.

Bornite has a ten year planned life. That includes at least eight years of mining, milling, and concentrating operations, preceded and concluded by a year each of construction and reclamation. About 46 acres would be affected. See Figure 1 for the location of the project.

Some 2.5 million tons of ore will be mined and processed in the project's life. Another 260,000 tons of nonmineralized rock will have to be moved to get at the ore. That non-mineralized material will be used in the construction of mine facilities or stockpiled and used as cemented backfill material underground.

The copper concentrate from the flotation concentrator will be hauled to a deep water port for shipping to a smelter outside of Oregon. A transportation agreement will be obtained from the Forest Service to allow commercial haulage of material on Forest roads.

The non-copper rock, or "tailings", separated from the copper minerals during the flotation process, will be deposited underground as cemented backfill or deposited in a tailings impoundment. Over the life of the mine, 1,267,000 tons of material can be put underground as backfill. The remaining 990,000 tons will be put in the tailings impoundment.

Electric power will be provided by overhead line. Source will be the Tumble Creek power substation near Detroit. Part of the line may be buried for greater reliability.

The transportation route will be from Oregon State Highway 22 near Mehama, up Marion County Road 960 to the Willamette National Forest Boundary. The route then follows Forest Service gravel roads 2290 and 2207 to the mine site. No road construction is required for the project.

# TABLES



# APPENDIX

Specific objectives of the SPCC will be to:

- Reduce the potential for accidental spills and environmental contamination through a well-defined materials management program;
- Provide the operating staff with information to properly respond to a hazardous material or petroleum spill event;
- Clearly define responsibilities for spill notification and control; and
- Provide a response and cleanup program that minimizes or eliminates environmental impacts.

These objectives will be achieved under the direction of the Emergency Response Team Coordinator, who will coordinate and direct a professional team trained in actual emergency response actions.

The basic steps to be taken in any emergency spill situation are:

- Protect the lives of people.
- Render emergency first aid.
- Notify authorities.
- Contain and neutralize the spill.
- Conduct cleanup and remove contaminated materials from the site.
- Monitor potentially affected water resources.
- Document and report incident.
- Reassess spill prevention and response procedures.

The Bornite Project personnel will develop the capability to handle an emergency spill before the start-up of on-site activity, thereby minimizing the threat of environmental contamination and injury to humans or wildlife after the introduction of potentially harmful materials to the site.

To lessen the visual impact, buildings will be constructed using colors and materials selected to be harmonious with the natural surroundings. Perimeter fencing will be colored to blend with the landscape.

## 3.13 WATER MANAGEMENT PLAN

A water management plan was completed (Plexus, 1992) to determine the impact of the mine on the permit area. The plan is based on the following three concepts:

- Recycling of project water to minimize disturbance to the aquifers on the project site.

- Capture and storage of precipitation during wet periods for use in dry seasons. This minimizes the need to withdraw water from the aquifers unless absolutely necessary.

- Maximizing recharge of the aquifers by allowing seepage from the tailings impoundment area and water ponds.

Discharge to surface waters would occur from the process water pond. Discharge water would be treated, if necessary, to allow it to meet drinking water quality standards.

## 3.14 ENVIRONMENTAL CONSEQUENCES AND MITIGATION

The Bornite Project will be designed to minimize the risks of environmental disturbance. Mitigation steps include design, training, procedure implementation, prevention, and control countermeasures.

### 3.14.1 On-Site Spill Prevention and Contingency Plan

An On-Site Spill Prevention and Counter-measure Plan (SPCC) will define procedures to deal with any emergency situation associated with a spill of substances with significant contaminant potential. The SPCC's primary purpose is to define and describe basic management responses to spills and to provide an emergency operational handbook for emergencies, such as an accidental release of process chemicals or fuel. Potential spill sources at the site will include petroleum products and chemical reagents. The SPCC addresses emergency responses to spills of each of these materials. The SPCC plan is developed in accordance with Oregon Revised Statutes, Chapter 468 (1986 and 1987).

The Emergency Response Team will be made up of mine personnel specially trained in spill containment and neutralization procedures, and in first-aid treatment. All Emergency Response Team members will be well-trained and equipped with the knowledge and materials needed to fulfill their duties. Team members will be issued copies of the SPCC and will get annual emergency response training, including a review of the SPCC.

Team members will be available by telephone on a 24-hour basis. In an emergency, the Emergency Response Team coordinator will be contacted immediately and will be responsible for notifying other team members as needed.

Proper storage and handling of substances with contamination potential will significantly reduce the probability of a spill. In addition to a thorough materials management program, special safety provisions at the Bornite Project will include an on-site, fully equipped spill treatment trailer.

The trailer will contain:

- First aid supplies, including:
    - A set of instructions on first-aid treatment
    - Standard first-aid kit, including bandages, scissors, tweezers, soap, antiseptic medicine, etc.
- Portable dam for fuel spill containment
- Log book to document trailer inspections and use
- Spill Contingency Plan
- 100 feet of 1-1/2 inch diameter rubber hose
- Centrifugal pump
- 50 feet by 50 feet impermeable plastic sheet
- Monitoring equipment, including:
    - Water sample bottles

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- Notify authorities.

- Contain and neutralize the spill.

- Conduct cleanup and remove contaminated materials from the site.

- Monitor potentially affected water resources.

- Document and report incident.

- Reassess spill prevention and response procedures.

The Bornite Project personnel will develop the capability to handle an emergency spill before the start-up of on-site activity, thereby minimizing the threat of environmental contamination and injury to humans or wildlife after the introduction of potentially harmful materials to the site.

- Preservatives
- Empty 100-gallon tank for initial containment of concentrated spills or to mix treatment fluid for diversion pond

- Full safety gear, including:
  - Respirators
  - Waders
  - Rubber gloves
  - Waterproof suits
  - Face shields
  - Hard hats/helmets
  - Tool kit
  - Shovels

Procedures will be established for handling of all chemicals. Training and education of employees will be ongoing. Data sheets and first aid recommendations will be kept in selected areas.

Fuels, including diesel, gasoline, and lubricating oils, will be handled carefully to avoid spills. Strict adherence to the transportation plan will do much to reduce the probability of fuel spills. On-site fuels will be stored in facilities designed to contain spills. Fueling sites will be located and constructed to minimize fuel losses.

Three types of spills must be considered:

- Spills during transport to the site
- Fuel losses in storage and fueling area
- Fuel spills in areas not designed for containment, such as fuel trucks servicing construction equipment.

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- Centrifugal pump
- 50 feet by 50 feet impermeable plastic sheet
- Monitoring equipment, including:
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Following are actions to be taken in response to fuel spills:

**Spill Containment**

If possible, all flammable materials in and adjacent to the spill site should be removed immediately. Fuel spills must then be contained as soon as possible after the loss has occurred to prevent spreading and to simplify cleanup.

**Fueling Pad Spills.** Fueling pads will be designed to contain all spilled fuel. No further containment would be required.

**Land Spills.** To prevent the spill from spreading laterally, an earthen dike or dam of sufficient size to intercept both the fuel and affected water would be constructed.

**Removal of Fuel and Contaminated Material**

**From Fueling Pad.** Fuel may be removed by suction and used or placed in the designated disposal area in containers. The containers will be moved to an approved disposal site.

**From Land.** Remove free product by suction. Contaminated soil beneath the spill must then be removed. Both the product and soil will be moved to an approved disposal site. If considered a potential groundwater contamination problem, monitoring wells should be installed to determine the extent of fuel in groundwater. If groundwater is contaminated, the fuel must be removed with recovery wells or trenches, and the water/fuel mixture taken to a disposal area.

**From Water.** A suction pump may be used to remove fuel, or a commercial skimmer may remove fuel mechanically. If neither method is feasible, incineration may be used with the approval of fire control authorities.

The major concern for fuel spills that enter water is to protect water users and aquatic life. Rapid containment and absorption are the most important factors in handling such spills.

While none of the chemicals or reagents proposed for use has been classified as hazardous, stringent procedures in the design of on-site storage facilities will reduce the possibility of spills.

- Preservatives
- Empty 100-gallon tank for initial containment of concentrated spills or to mix treatment fluid for diversion pond

- Full safety gear, including:
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### 3.14.2 Chemical Handling Procedures

To minimize the potential for accidental spills and environmental contamination, process chemicals at the Bornite Project will be stored and handled in strict accordance with the following guidelines.

**Diesel Fuel** will be stored in a 7,500 gallon tank adjacent to the shop area.

**Gasoline** will be stored in a 500-gallon tank adjacent to the shop area. Light-duty vehicles will be refueled directly from the tanks.

**Ammonium Nitrate** and other explosives will be stored on-site in a controlled access area at a safe distance from the principal areas, separate from the storage of process chemicals.

**Frother (Methyl Isobutyl Carbinol)** or the equivalent will be received in 55-gallon drums and stored in the process area.

**Collector (Dithiophosphate)** or the equivalent will be received in 55-gallon drums and stored in the process area.

**Flocculent** used in the milling process will be received in 55-gallon drums or bags weighing not more than 100 pounds, and stored in the process area.

## 3.15 WORK FORCE

The Bornite Project is planned for construction start in the spring of 1993, depending upon receipt of permits and approvals. Construction of surface facilities will occur over the next nine to eleven months. An average of 85 workers, with a peak of 100, will be employed during this period.

After construction, operating manpower needs will drop to 79 to 85 and continue at that level throughout the productive life of the project. About 82 percent will be hired from the local Marion/Linn County labor pool.

Plexus will develop a training program to retrain local workers to work in a mining environment. Skills available from individuals experienced in agriculture, construction, and timber industries will be considered desirable. It is expected that local hiring will provide a more stable, long-term work force. Table 12 identifies the positions and staffing of the mine.

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While none of the chemicals or reagents proposed for use has been classified as hazardous, stringent procedures in the design of on-site storage facilities will reduce the possibility of spills.

Table 12. Bornite Project Typical Manpower Requirements

| Mine | | Processing | | Administration | |
|---|---|---|---|---|---|
| Mine Superintendent | 1 | Mill Superintendent | 1 | General Manager | 1 |
| Mine Engineer | 2 | General Foreman | 1 | Secretary | 1 |
| Mine Geologist | 2 | Metallurgist | 1 | Accounting Clerk | 2 |
| Surveyor | 3 | Lab Technician | 2 | Safety/Env Engr | 1 |
| Mine Clerk | 1 | Shift Foreman | 4 | | |
| Shift Foreman | 3 | | | | |
| Mechanical Foreman | 1 | | | | |
| Maintenance | 7 | Maintenance | 5 | | |
| Equipment Operator | 7 | Mill Operator | 14 | | |
| Blaster | 3 | | | | |
| Miner | 16 | | | | |
| **Subtotal** | **46** | | **28** | | **5** |
| **TOTAL** | **79 Employees** | | | | |



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# 4.0 RECLAMATION PLAN

## 4.1 POST-RECLAMATION LAND USE

The Bornite project is located entirely within the Willamette National Forest. The area is designated as general forest by the Willamette National Forest . Reclamation of the area will return the area to a general forest condition. The Willamette National Forest may propose the area be reclaimed to a recreational site. This alternative is addressed in Section 4.2.1.

## 4.2 RECLAMATION OBJECTIVES

The objective of the Reclamation Plan is to produce a geologic and erosionally stable post-mining topography similar to predisturbance conditions and capable of supporting productive forest growth with a high value for use by wildlife. These objectives will be achieved through a program of sound operations engineering and planning, which creates: a tailings area with 2:1 out slopes, reestablishes the natural flow of surface water across the site, salvages topsoil for reclamation, and reclaims the area with native forest species.

The reclamation program calls for removal of all structures and regrading and recontouring. When the post-mine topography has been established, topsoil application will occur, followed by revegetating the area. A combination of stabilizing and native plant species will be used for revegetation.

In general, the objectives of the reclamation plan are:

- To leave the area free from hazards to the public health and safety;
- To stabilize the site to prevent erosion and sedimentation on both a short and long-term basis;
- To re-establish a productive vegetation and wildlife habitat consistent with predevelopment conditions and the accepted land use objective; and
- To achieve a visual compatibility with the surrounding landscape.

The Bornite mine operation is being planned to keep site disturbance as small as possible during the operating period. Only as much area will be disturbed as needed.

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| Equipment Operator | 7 | Mill Operator | 14 | | |
| Blaster | 3 | | | | |
| Miner | 16 | | | | |
| **Subtotal** | **46** | | **28** | | **5** |
| **TOTAL** | **79 Employees** | | | | |

### 4.2.1 Reclamation Alternatives

The Willamette National Forest would consider using the reclaimed mine area as a campground or recreation. Current Forest Service regulations will not allow modification of land use at this time; thus a reclamation goal for recreation use cannot be considered. The Forest Service may amend the Forest Plan to include recreation as a land use for the Bornite site. The DOGAMI permit would be amended at that time to incorporate the change.

## 4.3 TOPSOIL RESOURCES

### 4.3.1 Soil Suitability

Evaluations of soil suitability for revegetation were made for all soils sampled and chemically characterized based on criteria established by the Oregon Department of Geology and Mineral Industries (DOGAMI, 1991). Electrical conductivity, saturation percentage, texture, sodium adsorption ratio, and boron concentrations of the study area soils all fall in the DOGAMI "suitable" category.

Soils at the Bornite Mine site get more than 80 inches of annual precipitation and have developed an entirely different morphology and chemistry than those in arid and semi-arid regions. Using DOGAMI criteria, many soil horizons in the study area are not "suitable" for reclamation due to low overall pH values and the large amount of coarse fragments. However, the success of the existing vegetation growth indicate they are suitable for reclamation. Impacts to soil resources are unavoidable and will be minimized by the stripping, storing, and reapplication of soils to the tailing and other disturbance areas after end of mining activities or sequentially to the tailings as they are stabilized. With successful reclamation, long-term impacts to soils will be minimized. The project would disturb about 46.0 acres of soils previously disturbed by timbering practices in the early 1950's.

### 4.3.2 Clearing of Site

The site is currently in the forested condition described in the vegetation section. One of the first project activities will be timber removal. The harvest will occur in stages, with clearing of adequate area for the advancing stage of operation. In the initial stage of the tailings impoundment operation, only enough trees will be removed to facilitate construction and topsoil removal.

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- To stabilize the site to prevent erosion and sedimentation on both a short and long-term basis;
- To re-establish a productive vegetation and wildlife habitat consistent with predevelopment conditions and the accepted land use objective; and
- To achieve a visual compatibility with the surrounding landscape.

The Bornite mine operation is being planned to keep site disturbance as small as possible during the operating period. Only as much area will be disturbed as needed.

Trees with commercial value will be harvested and taken to a local timber mill for further processing. Small trees without commercial value will be incorporated into the topsoil stockpile piles.

Along the Cedar Creek access road and along the French Creek transmission line route, only selective clearing would be needed. The transportation route should require only individual tree removal based upon transportation plan needs. A visual barrier of trees will be left in place between the existing Forest Service road corridor and the operation. This barrier will also contain the relocated Bornite Brook.

The project will not impact any federally listed Category 1 or 2 plants or species listed as endangered or threatened by the Oregon Natural Heritage. Likewise, the project will not impact any old growth forest or potential old growth groves.

Pacific yew trees in the Douglas fir forest will be harvested in agreement with the Forest Service Yew management plan.

### 4.3.3 Topsoil Removal and Storage

Topsoil will be removed and stored in stockpile until needed for reclamation. The initial activity will be removal of timber from the site. This is accomplished by standard logging techniques used in the region. The clearing and grubbing operation is followed by topsoil stripping and stockpiling as an initial task. Stripping will be done with large equipment, presumably by local contractor. Equipment used will be dependent on contractor availability. Scrapers, bulldozers, offroad trucks, and front end loaders are the types of equipment that will be used to excavate and store salvaged topsoil.

After vegetation has been removed, the areas designated for topsoil removal will be marked. Equipment will then excavate roads and work areas. A small grizzly may be set up in areas to facilitate removal of oversize material encountered in stripping. Topsoil, with rock removed, will be loaded into trucks or scrapers and hauled to the designated storage area. Two stockpile areas have been designated.

The topsoil storage pile will be on upland sites to minimize water erosion. During the life of the topsoil storage piles, the protective vegetation cover will be monitored for any erosion or weed infestations. Topsoil from disturbed areas will be stripped and deposited in designated topsoil stockpile areas. Topsoil stockpiles will be constructed with 2:1 side slopes. Seeding to prevent erosion will occur immediately after completion of construction as ground and weather conditions allow. A seed mix consisting of fast growing grasses will be seeded initially to prevent erosion. The seed mixture will consist of the following and will be applied at the following rate of pure live seed.

### 4.2.1 Reclamation Alternatives

The Willamette National Forest would consider using the reclaimed mine area as a campground or recreation. Current Forest Service regulations will not allow modification of land use at this time; thus a reclamation goal for recreation use cannot be considered. The Forest Service may amend the Forest Plan to include recreation as a land use for the Bornite site. The DOGAMI permit would be amended at that time to incorporate the change.

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### 4.3.2 Clearing of Site

The site is currently in the forested condition described in the vegetation section. One of the first project activities will be timber removal. The harvest will occur in stages, with clearing of adequate area for the advancing stage of operation. In the initial stage of the tailings impoundment operation, only enough trees will be removed to facilitate construction and topsoil removal.

Table 13. Topsoil Stockpile Seed Mixture

| Scientific Name | Common Name | Application Rate |
|---|---|---|
| Bromus marginatus | Mountain Brome | 3 lb/acre |
| Dactylis glomerata | Orchardgrass | 3 lb/acre |
| Festuca ardundinacea | Tall fescue | 3 lb/acre |
| Lolium multiflorum | Annual rye | 3 lb/acre |
| Lolium perenne | Perennial ryegrass | 3 lb/acre |
| **Total** | | **15 lbs/acre** |

### Soil Volume

The two stockpiles will have a capacity of 142,900 cubic yards. Adequate area exists to enlarge the stockpile volume area if the course fragment portion is included in the storage. Table 3 illustrates the volume of soil available for reclamation for each mapping unit affected by mining activities. Estimated stripping depths range from 8 to 44 inches, depending on soil type. The total volume of soils available is 220,400 $yd^3$. However, if the estimated percent of coarse fragments are removed, the volume of material ranges from 77,100 to 142,900 $yd^3$, depending on the estimate of percent coarse fragments. Placing the material, coarse fragments included, uniformly over 46 acres would create a soil depth of about 36 inches. Excluding the coarse fragments, the soil depth would range from about 12 to 23 inches, depending on the actual percent of coarse fragments.

## 4.4 DECOMMISSIONING OF FACILITIES

Upon closure, all process buildings and related facilities will be removed and salvaged. Concrete foundations will be broken up and placed either in mine workings or in the process water pond and buried. Then the site will be graded to reestablish a natural drainage. The sediment control pond, which is unlined, will be incorporated into the final grading. The synthetic liners in the process water and mine water ponds will be freed from their anchors, folded in on themselves, and covered with fill material prior to covering by topsoil and revegetation.

Unless designated by the U.S. Forest Service for land management or recreation purposes, all roads will be closed and reclaimed following mine closure. The compacted roads will be ripped, graded, and water-barred to permit natural drainage and revegetation. Fencing will be removed to reestablish access to the site.

Trees with commercial value will be harvested and taken to a local timber mill for further processing. Small trees without commercial value will be incorporated into the topsoil stockpile piles.

Along the Cedar Creek access road and along the French Creek transmission line route, only selective clearing would be needed. The transportation route should require only individual tree removal based upon transportation plan needs. A visual barrier of trees will be left in place between the existing Forest Service road corridor and the operation. This barrier will also contain the relocated Bornite Brook.

The project will not impact any federally listed Category 1 or 2 plants or species listed as endangered or threatened by the Oregon Natural Heritage. Likewise, the project will not impact any old growth forest or potential old growth groves.

Pacific yew trees in the Douglas fir forest will be harvested in agreement with the Forest Service Yew management plan.

### 4.3.3 Topsoil Removal and Storage

Topsoil will be removed and stored in stockpile until needed for reclamation. The initial activity will be removal of timber from the site. This is accomplished by standard logging techniques used in the region. The clearing and grubbing operation is followed by topsoil stripping and stockpiling as an initial task. Stripping will be done with large equipment, presumably by local contractor. Equipment used will be dependent on contractor availability. Scrapers, bulldozers, offroad trucks, and front end loaders are the types of equipment that will be used to excavate and store salvaged topsoil.

After vegetation has been removed, the areas designated for topsoil removal will be marked. Equipment will then excavate roads and work areas. A small grizzly may be set up in areas to facilitate removal of oversize material encountered in stripping. Topsoil, with rock removed, will be loaded into trucks or scrapers and hauled to the designated storage area. Two stockpile areas have been designated.

The topsoil storage pile will be on upland sites to minimize water erosion. During the life of the topsoil storage piles, the protective vegetation cover will be monitored for any erosion or weed infestations. Topsoil from disturbed areas will be stripped and deposited in designated topsoil stockpile areas. Topsoil stockpiles will be constructed with 2:1 side slopes. Seeding to prevent erosion will occur immediately after completion of construction as ground and weather conditions allow. A seed mix consisting of fast growing grasses will be seeded initially to prevent erosion. The seed mixture will consist of the following and will be applied at the following rate of pure live seed.

# THE BORNITE PROJECT

## OPERATING AND RECLAMATION PERMIT



**Submitted to**
**The Oregon Department of Geology**
**and Mineral Industries**

**November 25, 1992**

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