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EXTRACTION AND BENEFICIATION OF ORES AND MINERALS

VOLUME 7

PHOSPHATE AND MOLYBDENUM

November 1994

U.S. Environmental Protection Agency
Office of Solid Waste
Special Waste Branch
401 M Street, SW
Washington, DC 20460

DISCLAIMER AND ACKNOWLEDGEMENTS

This document was prepared by the U.S. Environmental Protection Agency. The mention of company or product names is not to be considered an endorsement by the U.S. Government or by EPA.

This Technical Resource Document consists of reports on two site visits conducted by EPA to a phosphate mine in Florida and a molybdenum mine in Idaho during 1991 and 1992. Drafts were distributed for review to representatives of the companies and of state agencies who participated in the site visits, as well as the U.S. Department of Interior's Bureau of Mines and the U.S. Department of Agriculture's Forest Service. Their comments and EPA's responses are presented as appendices to the reports. EPA is grateful to all individuals who took the time to review sections of this Technical Resource Document.

The use of the terms "extraction," "beneficiation," and "mineral processing" in this document is not intended to classify any waste stream for the purposes of regulatory interpretation or application. Rather, these terms are used in the context of common industry terminology.

MINE SITE VISIT:

IMC FOUR CORNERS MINE

March 1993

U.S. Environmental Protection Agency
Office of Solid Waste
401 M Street, SW
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This section of the Technical Resource Document consists of a report on a site visit conducted by EPA to IMC Fertilizer, Inc. Four Corners Phosphate Mine in Florida during 1992. A draft of the report was provided to representatives of IMC Fertilizer, Inc., and the Florida Department of Natural Resources who participated in the site visit. IMC submitted comments on the draft, which are presented in Appendix B. EPA's responses to IMC's comments are summarized in Appendix C.

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1. INTRODUCTION

1.1 Background

EPA has initiated several information gathering activities to characterize mining wastes and waste management practices. As part of these ongoing efforts, EPA is gathering data by conducting visits to mine sites to study waste generation and management practices. As one of several site visits, EPA visited IMC Fertilizer, Inc.'s Four Corners Phosphate Mine near Duette, Florida on March 18, 1992. This report discusses the extraction and beneficiation activities at the site. No discussion of phosphoric acid production is found in this report.

The sites to be visited were selected by EPA to represent both an array of mining industry sectors and different regional geographies. All site visits are conducted pursuant to the Resource Conservation and Recovery Act (RCRA), Sections 3001 and 3007 information collection authorities. For those sites located on Federal land, EPA has invited representatives of the appropriate land management agency (U.S. Forest Service and Bureau of Land Management). State agency representatives and EPA regional personnel also have been invited to participate in each site visit.

For each site, EPA has collected waste generation and management information using a three-step approach: (1) contacting the facility by telephone to obtain initial information, (2) contacting state regulatory agencies by telephone to obtain additional information, and (3) conducting the actual site visit. Information collected prior to each visit is then reviewed and confirmed at the site.

The site visit reports describe mine operations, mine waste generation and management practices, and the regulatory status on a site-specific basis; the information is based on information gathered from State and Federal agency files as well as observations made during the site visit. In preparing this report, EPA collected information from a variety of sources, including IMC Fertilizer, Inc., the Florida Department of Natural Resources (DNR), and other published information. The following individuals participated in the IMC Four Corners site visit on March 18, 1992.

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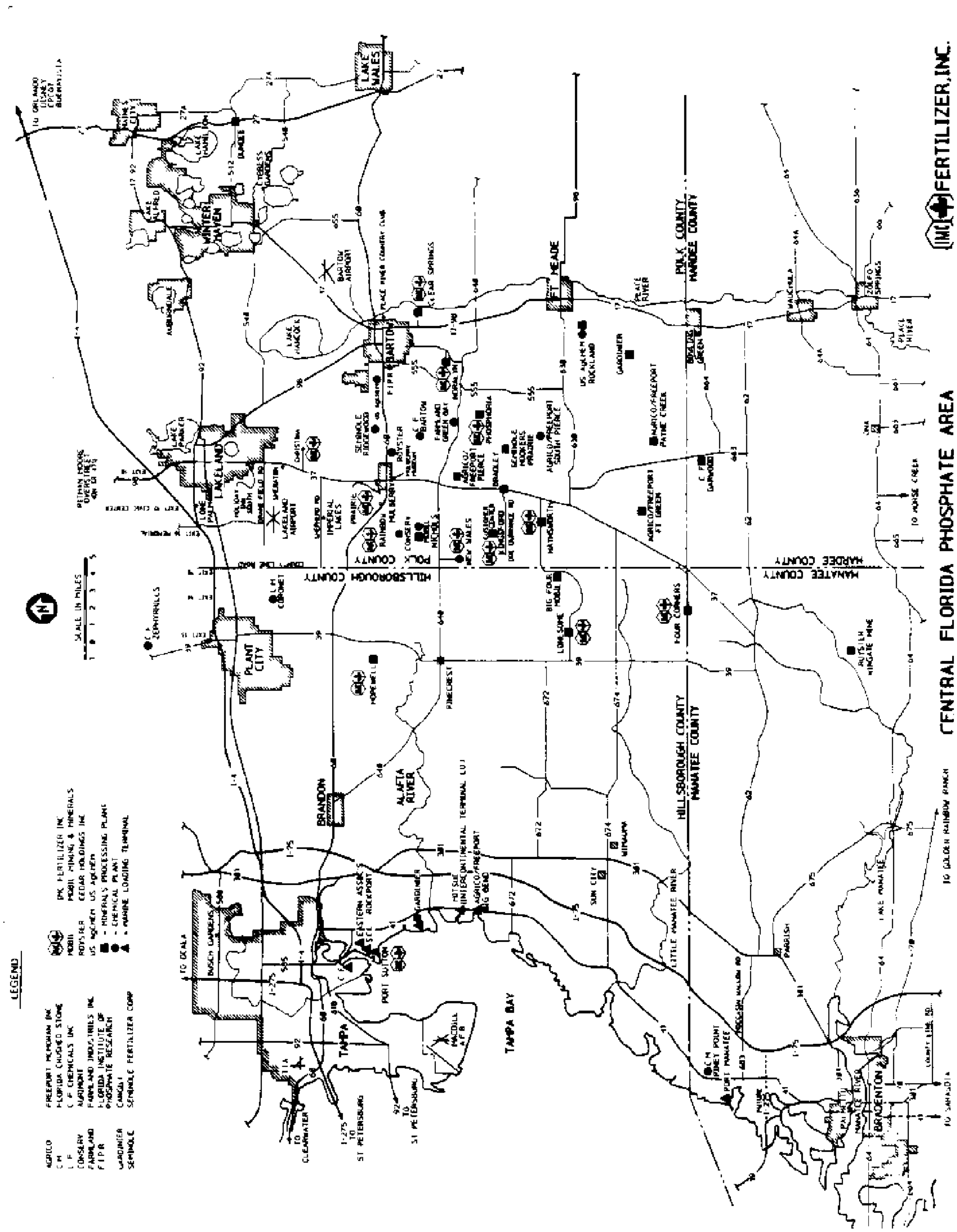
1.2 General Facility Description

IMC Fertilizer, Inc. (IMC) operates a phosphate mine and mill located along State Road 37 in West Central Florida, approximately five miles from Duette, Florida. The facility is comprised of approximately 20,000 acres in Hillsborough and Manatee Counties. According to IMC, several plots of land owned by other parties (identified by IMC as "out parcels") are found within the boundaries of the Four Corners operation. Figure 1 presents a map of the phosphate mining region of West Central Florida and Figure 2 presents a site map for the Four Corners Mine.

Prior to construction of the current operation at IMC, significant historic mining occurred within the site boundaries and in the surrounding area. The Four Corners Mine was originally an equal partnership between IMC and W.R. Grace Corporation. Construction at the site was initially completed in 1983 and operations began in late 1985. The mine operated continuously for 13 months until March 1986, when unfavorable market conditions prompted closure of the facility. In January 1988, the entire operation was acquired by IMC. In January 1989, IMC restarted operations and the facility has operated continuously since then.

Four Corners is IMC's largest operation, with a total reserve of 185 million tons of ore. The maximum capacity of the operation is 7.8 million tons of ore per year. The projected life of the mine is 25-30 additional years from the time the site visit was conducted. The mine operates 5 days per week, 250-260 days per year, with three shifts per day, and produces 5.5 million tons of ore per year. Four Corners has approximately 300 employees.

Figure 1. Map of Phosphate Mining Region of Florida
(Source: U.S. EPA Field Notes)



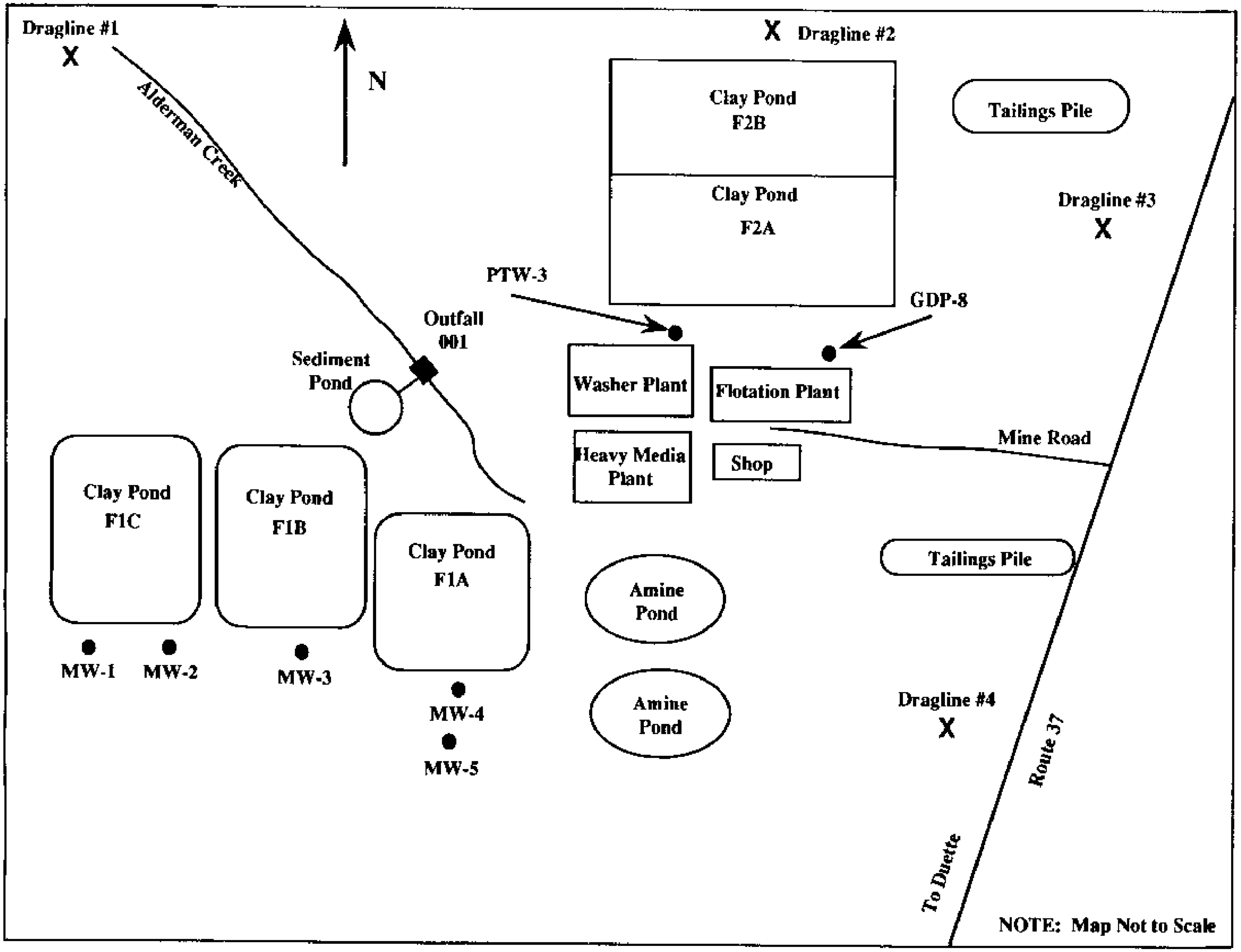


Figure 2. IMC Four Corner Site Map
(Source: U.S. EPA Field Notes)

The Four Corners operation consists of concurrent mining in four separate areas. Draglines remove ore from these areas, water is added, and slurried ore is piped to a washer plant for initial sizing. The washer plant yields a pebble phosphate product and fine flotation feed. The pebble product is tested to determine the concentration of magnesium oxide (MgO). If the MgO concentration is less than one percent, it is considered a product and no further beneficiation is required. If the MgO concentration exceeds one percent, the ore is directed to a patented heavy media separation plant for MgO removal.

The flotation feed is sent to the flotation plant, where the ore is passed through hydraulic sizing and over screens and separated into three sizes. Different flotation methods are used for each size material. The flotation products are then combined with the pebble product and shipped off-site to IMC's New Wales phosphoric acid plant and to other customers.

The washer plant generates oversized debris and undersized clays, which are considered wastes and managed on-site. The flotation plant generates tailings, which are stored in on-site tailings piles before being used as backfill for reclamation and in clay pond construction.

1.3 Environmental Setting

1.3.1 Climate

Between September 1978 and December 1991, the monthly total rainfall ranged from 0 inches (November 1991) to 14.5 inches (September 1979) with the highest rainfall totals typically occurring during the summer months. The total rainfall in 1991 was 39 inches, with an average monthly rainfall of 3.75 inches (IMC, 1992a). Although no information concerning temperatures was available for the Four Corners area, the 1991 mean temperature in Bartow, Florida, a town less than 30 miles from the site, was 72.2°F. In 1991, the highest average monthly temperature (90°F) occurred in June and July and the lowest average monthly temperature (54°) occured in February and November. No information was obtained on wind conditions at the site.

1.3.2 Surface Water

The surface waters in the vicinity of the Four Corners Mine Site are shown in Figure 3. The Little Manatee River begins approximately three miles north of the mill site. Alderman Creek, a tributary of the Little Manatee begins near the facility's clay ponds and receives discharges from IMC's Clay Pond F1 through NPDES permitted outfall 001. Horse Creek and Payne Creek, a tributary of the Peace River, also flow through sections of IMC's property. According to IMC personnel, runoff from most of the site (not including the beneficiation plant) flows into Alderman Creek, Horse Creek, Payne Creek, and the Little Manatee River. In addition, the South Fork of the Little Manatee River

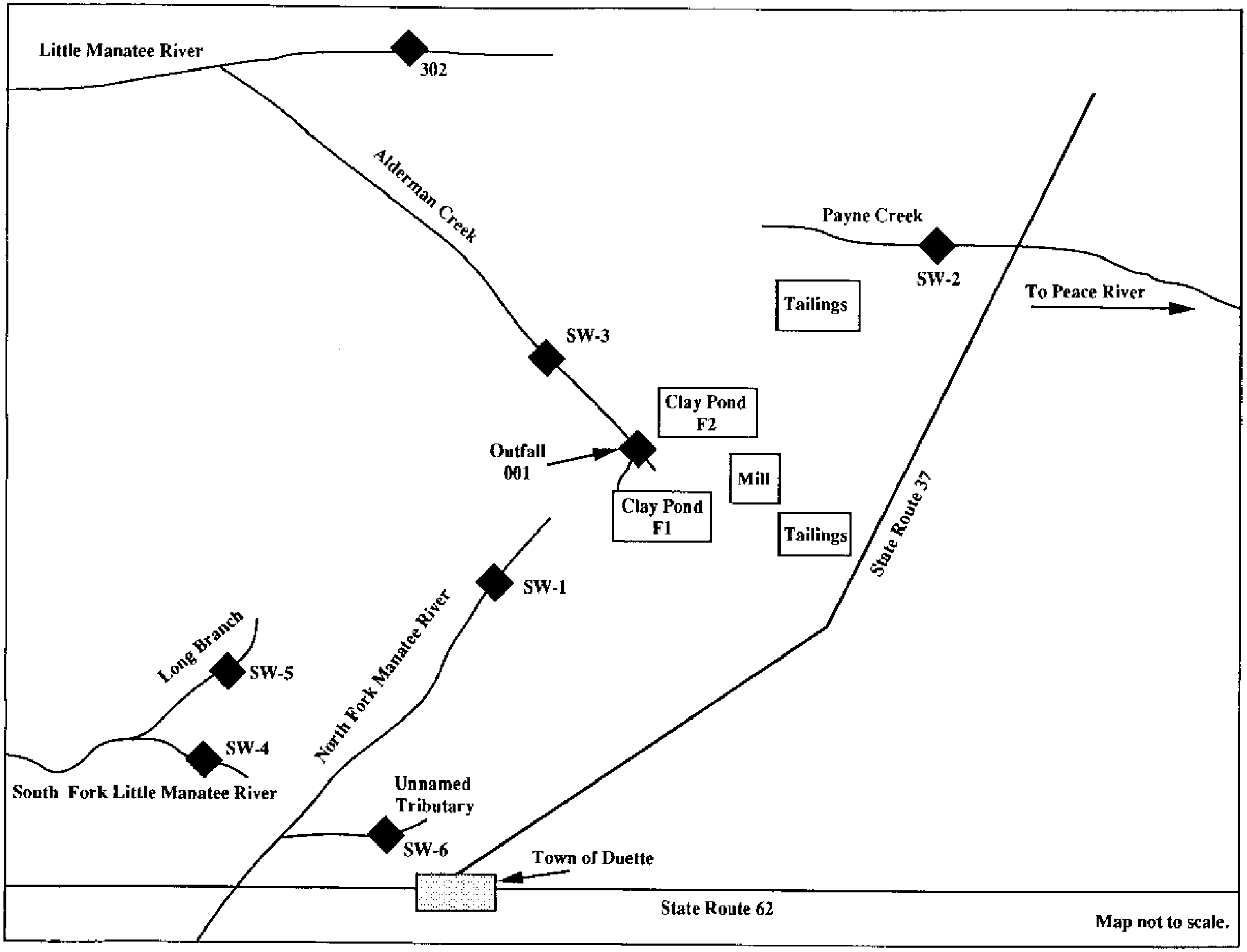


Figure 3. Surface Waters in the Vicinity of IMC Four Corners Mine
(Source: U.S. EPA Field Notes)

and its tributary Long Branch, and the North Fork of the Manatee River, begin approximately 3-5 miles southwest of the plant site. As described in Section 4.6.2, mining and post-mining reclamation activities are being conducted in the wetlands found in these drainage areas. IMC is required by the State to restore wetlands disturbed by mining.

Surface waters in the vicinity of the site are characterized as clear, dark (from tannic acid), and slightly acidic. Flow rates are generally high between July and September, when heavy thunderstorms are common. Low flows typically occur from January through May. All surface waters are designated by the State as Class III fresh waters. Class III fresh waters are protected for recreation uses and for the propagation and maintenance of a healthy, well-balanced population of fish and wildlife. According to IMC, the primary uses of the surface waters in the vicinity of the site are recreational.

1.3.3 Geology

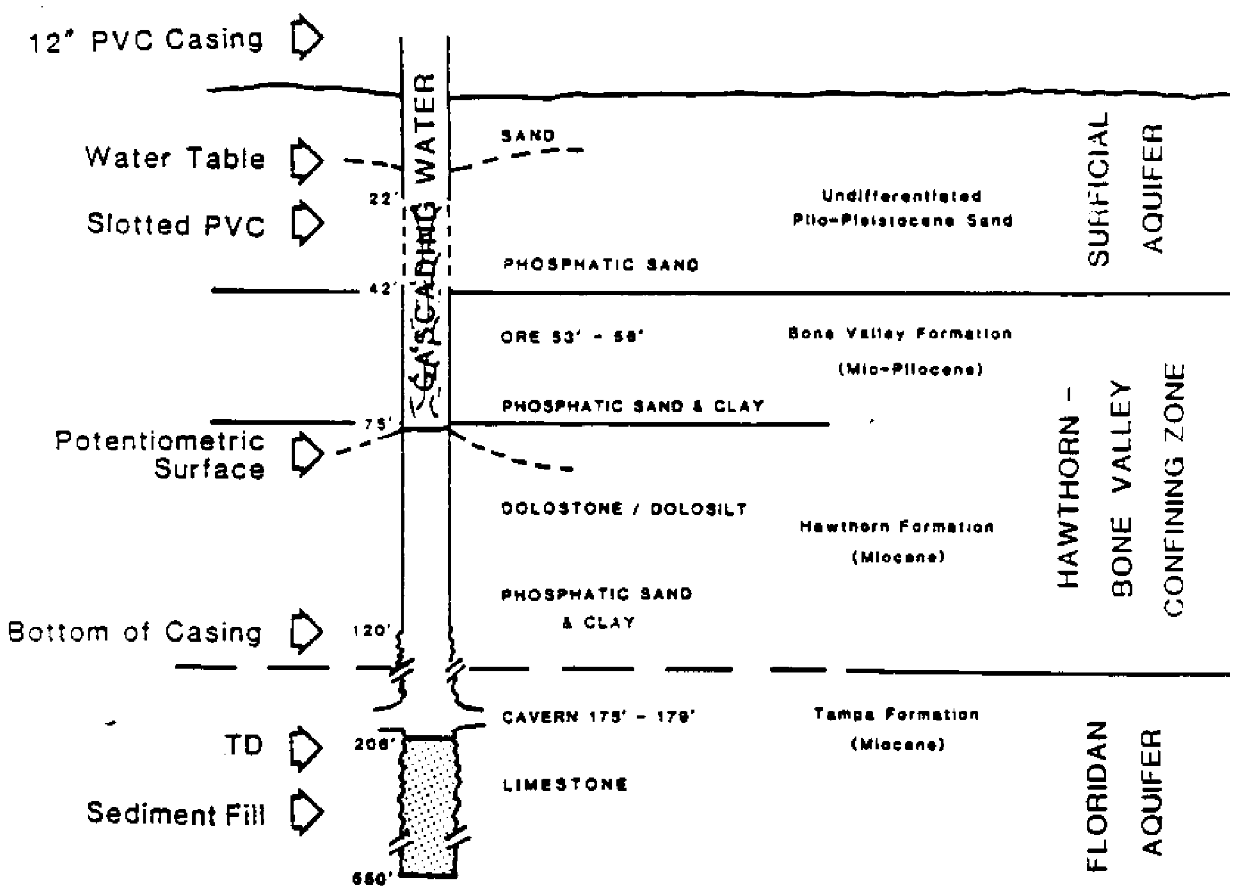
The IMC site is characterized by shallow phosphate deposits interbedded with sand and clay. As shown in Figure 4, from the surface down, the site consists of (1) a thin layer of topsoils, (2) an upper layer of sand, (3) an unconsolidated layer identified as the "leach zone," (4) a zone of phosphate, clay, and sand (from which matrix ore is mined), (5) bed clay, and (6) limestone.

The upper two layers (the sand layer and the leach zone) represent overburden material. The leach zone is not found in all areas. Where the leach zone occurs, the average thickness is two feet. The leach zone is completely unconsolidated and consists of coarse phosphate pebbles and aluminum phosphate. The combined depth of the sand layer and the leach zone averages 26 feet. The matrix ore zone extends from approximately 26 feet below the surface to 46 feet below the surface. Within this zone, there are two layers of ore separated by a layer of limestone. IMC is currently mining the lower ore layer.

1.3.4 Hydrogeology

The Central Florida Phosphate district, including the Four Corners Mine Site, can be characterized by three hydrostratigraphic horizons. These are: (1) the surficial aquifer system (1-20 feet deep), (2) the intermediate Hawthorn aquifer (100-200 feet deep, below the limestone) and the deep Floridian aquifer (below 400 feet deep). Each of the three aquifers is separated from the other aquifers by bed clay (FIPR, 1991). All ground water underlying the Four Corners site is classified by the State as G-II, potential drinking water supplies with a total dissolved solids level of less than 10,000 parts per million (ppm).

Figure 4. Geology and Hydrogeology at the Four Corners Site
(Source: FIPR, 1991)



According the IMC staff, the ground-water table in the vicinity of the Four Corners mines ranges from one to three feet below the ground surface. The surficial aquifer contains clean quartz sand and clayey sand, both of eolian and marine origins. The ages of these deposits vary from Plio-Pleistocene to Recent. Organic and Ferruginous B horizons as well as hardpans are locally present. The aquifer is unconsolidated and tends to slump when saturated (FIPR, 1991).

Surficial aquifer water is acidic, reducing, and organic rich. It is seldom used as a public drinking water supply, but it is used for low-yield domestic wells (FIPR, 1991). According to IMC personnel, private (i.e., low-yield domestic) drinking water wells are located in the surficial aquifer less than 1/4 mile from the site boundaries. In addition, surficial aquifer wells in the vicinity of Four Corners are used for agricultural water.

Where present, the leach zone forms the base of the surficial aquifer, and can introduce high levels of radioactivity, fluorides, and other unwanted constituents. The leach zone is a discontinuous weathering profile developed on top of the underlying phosphoric material of the Hawthorn group. It is enriched with aluminum phosphate materials such as wavellite and crandallite, and in uranium and uranium daughters. Some linear circular thickening patterns appear to be related to the development of alluvial dolines and fractures (FIPR, 1991).

The intermediate (Hawthorn) aquifer and the confining Arcadian Formation (Miocene to Pliocene Age) are phosphatic, have extensive clastic horizons, and are characterized by dolostone and limestone. There are also varying degrees of cavernous porosity. The Hawthorn aquifer exhibits typical carbonate-aquifer chemistry, with calcium, magnesium, bicarbonate, and sulfate/sulfide elements present. In the intermediate aquifer fluoride may be slightly elevated and radium-226 may be present near the maximum contaminant level (MCL) of five picocuries per liter (pCi/l) (FIPR, 1991). This intermediate aquifer is the primary source of drinking water for private wells in the vicinity of the Four Corners site.

The Floridian aquifer is one of most productive aquifers in the world. It includes limestone, with minor dolostone and clastic strata of Miocene to Eocene Age. The aquifer is primarily a fractured and karstic aquifer with, to a lesser extent, intergranular and moldic porosity. The Floridian aquifer is confined and artesian. The aquifer is neutral to slightly alkaline, containing high levels of calcium and magnesium (FIPR, 1991). Bicarbonate sulfate is the dominant sulfur species with levels up to 1,500 ppm having been detected (Palm & Associates, 1983a). To obtain water for domestic uses (including drinking water), the facility draws from well PTW-3 completed in the Floridian aquifer.

In May 1991, the Florida Institute of Phosphate Research published *Radiochemistry of Uranium-series Isotopes in Groundwater*. This study of ground water in the phosphate mining region showed that radium levels in the Floridian aquifer do not pose environmental or human health risks. Lead and ypolonium were found in the surficial aquifer (and presumably, would also be found in pumped mine water) at elevated levels (FIPR, 1991).

1.3.5 Wildlife

The EPA site visit team observed abundant wildlife (including many birds and an American alligator), particularly around the clay ponds. According to IMC personnel, bald eagles nest in Manatee County. In addition, the American alligator is a threatened species (as identified by the U.S. Fish and Wildlife Service). No other rare or endangered species are found in the vicinity of the Four Corner site.

2. FACILITY OPERATIONS

Surface mining is currently conducted in four areas at Four Corners. Matrix ore is transported by pipeline to the beneficiation operation. In the beneficiation operation, matrix ore is initially sent to the washer plant, where pebble and flotation feed are separated from clay and debris (coarse oversize) wastes. As necessary, the pebble product undergoes heavy media separation to remove magnesium oxide. The flotation feed is sent to the flotation plant. The following sections describe mining and beneficiation at Four Corners, along with associated operations at the site.

2.1 Mining Operations

The Four Corners site consists of 17,567 minable acres; 2,599 acres have been mined to date. IMC has four draglines, located in four separate areas at the site (see Figure 2). Active mining operations are conducted in each of these areas. Mining consists of clearing the site of brush, initial removal of topsoil and overburden, matrix ore removal, and reclamation. As mining is completed, the dragline moves to a new location in the area. Typically, two draglines strip overburden and topsoil, while the other two draglines remove matrix ore to allow for maximum use of mill capacity. Two of IMC's draglines have 65 cubic yard buckets and two draglines have 43 cubic yard buckets.

Brush is initially removed from areas to be mined. A dragline then moves into the area and removes overburden and a thin layer of topsoil, which together extend to a depth of about 26 feet. The topsoil is generally similar to the sand overburden, except in wetlands areas, where it contains some organic material. Overburden and topsoil are placed in temporary piles for subsequent use in reclamation and/or dam construction. (The piles were not observed by the EPA site visit team.) For every 11 tons of material moved, 6.5 tons of overburden and topsoil and 4.5 tons of matrix ore are sent to the plant. After the overburden and topsoil have been removed, the draglines excavate the matrix ore and place it in "wells." These wells are essentially 50-foot diameter excavations that are 10-15 feet deep. IMC's draglines each have the capacity to place up to 3,000 cubic yards of ore per hour into the wells.

In the wells, a slurry of 45-45 percent solids is created by high pressure water sprayed from hydraulic monitors. The source of the water is IMC's recirculation system (see Section 3.1). The 1,600 horsepower electric hydraulic monitors operate at 250 pounds per square inch (psi). The water is pumped at a rate of 10-12,000 gallons per minute (gpm). At each well, IMC typically uses two monitors, identified as the "left trap gun" and the "right drift gun." The "right drift gun" is used to move the matrix ore toward a 24-inch diameter suction pump. "Grizzlies" (described by IMC as stationary screens) are placed in front of the suction pumps to keep them clear of large sized ore (greater than 9-inch diameter, the nominal capacity of the pumps). The "left trap gun" is used to keep the grizzly clean.

IMC's mining operations at Fours Corners are typical of those found at other phosphate mines. However, the ore body at Four Corners is particularly lean. For every 4.5 tons of matrix material sent to the mill, one ton of product is generated. Therefore, IMC generally uses larger systems and equipment, and their pit pumps operate at much higher rates than other facilities.

The monitors and pumps are mounted on "pit cars." Fresh water is pumped to the pit cars through 24-inch steel pipes from IMC's fresh water management system (i.e., the clay ponds). The total retention time of matrix ore in each well ranges from a few seconds to an hour. Slurried ore is removed at a rate of 1,800-2,000 gpm.

Matrix ore is then pumped from the mine site to the mill (washer) in unlined abrasion-resistant steel pipe (22 inch diameter and 3/8 inch thick). Due to the coarseness of the matrix ore, IMC personnel indicated that plastic piping cannot be used (plastic piping is used at the site for tailings transport, see Section 3.2). Pipeline is laid directly on the ground surface with no secondary containment. Ditches and berms are utilized selectively as required to prevent the off-site drainage of slurried ore to adjacent wetlands or stream systems due to gasket failures, pipeline breaks, etc. This precautionary approach is used only when the potential for off-site drainage exists which might have an impact on ecologically sensitive areas. Along the matrix ore pipelines, there are in-line electric lift pumps every 4,000 feet. IMC currently has 22 older single speed electric pumps and 6 new DC drive, variable speed pumps. Each pump has an automatic shutoff switch that stops pumping if low pressure is encountered (i.e., a leak occurs or a pipeline becomes plugged). According to IMC personnel, the pumps are checked for leakage daily and leakage of matrix ore into the pump oil is more common than leakage of oil out of the pumps. Frequently, the slope from active mining areas to the beneficiation plant (currently from one to three miles) are such that one matrix pipeline has nine lift pumps.

To even out wear, the matrix pipe is rolled 120 degrees every 6 to 8 months of operation. Because the coarseness of the rock provides natural scouring, IMC does not need to pig the matrix pipes. When a pipe is no longer usable for matrix ore transport, it is reclaimed for use in other areas of the facility (e.g., for fresh water transport). Ultimately, when all on-site uses of the piping have been exhausted, it is sold as scrap. (For more information on pipe recycling, refer to U.S. EPA, Office of Solid Waste (1994). *Innovative Methods of Managing Environmental Releases at Mine Sites.*)

After mining is completed in an area, the dragline moves to a new location and IMC begins reclamation activities. Mining areas are reclaimed with removed overburden, topsoil, and mill tailings. They are then revegetated and reforested in accordance with IMC's reclamation plan and State reclamation rules (see

Section 4.1). The entire cycle, from pre-mining activities through reclamation, requires approximately two years.

2.2 Beneficiation Operations

The matrix ore pipelines flow to the beneficiation plant at Four Corners. The raw matrix ore consists of materials of varied sizes up to nine inch diameter rock. IMC uses separate beneficiation methods for different size fractions of ore. While beneficiation methods (except the patented heavy media separation plant) are similar to those used at other phosphate operations, the degree to which the specific methods are tailored to material size is unique to Four Corners.

Beneficiation occurs in three separate plants: (1) the washing plant, (2) the heavy media separation plant, and (3) the flotation plant. Operations in each of these plants are discussed in the following sections.

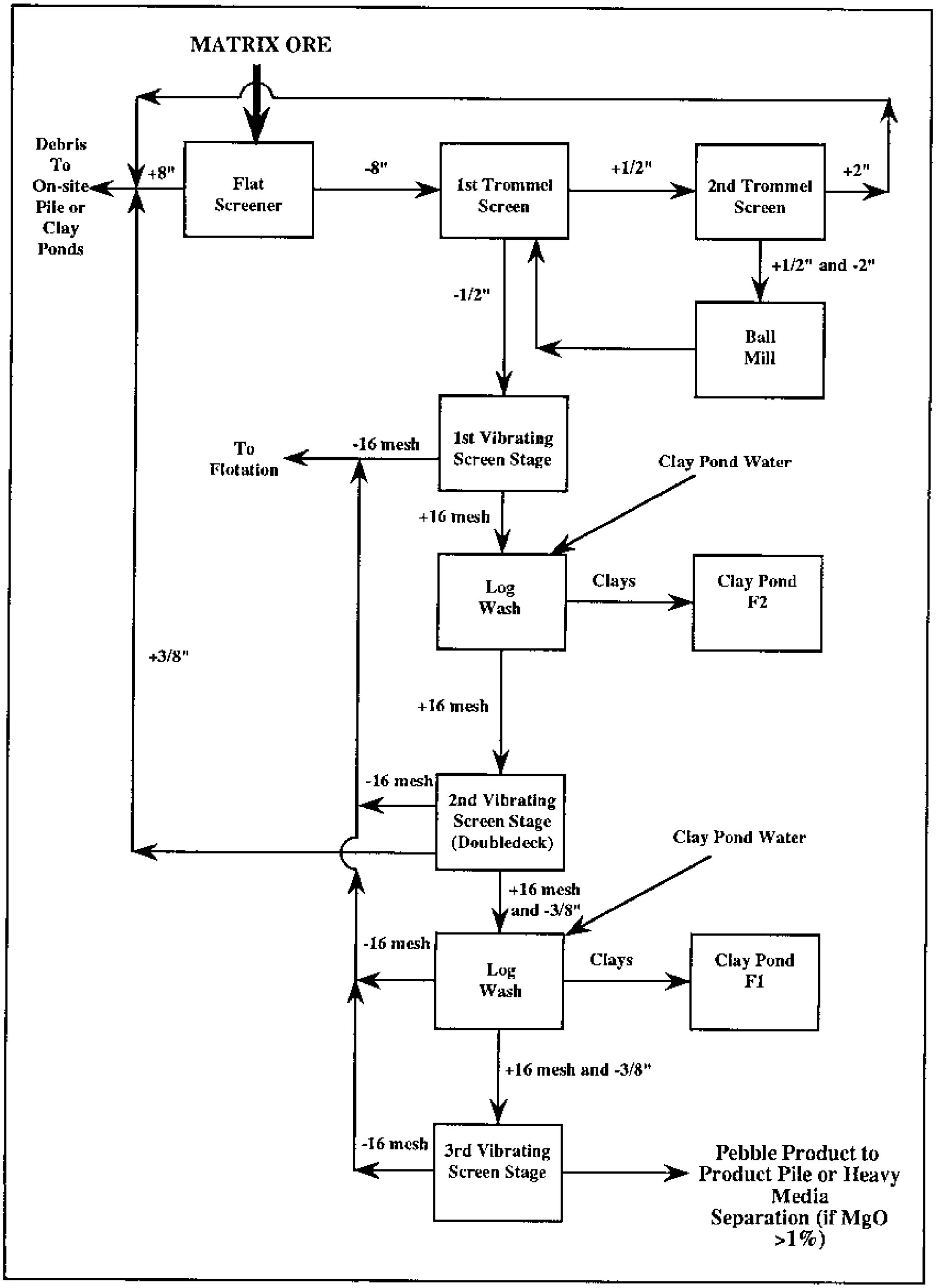
2.2.1 Washing Plant

The washer plant provides for size separation of the matrix ore into clays, fine product, pebble product, and oversized debris. A flow diagram for the washing plant is presented in Figure 5. In the washing plant, there are two washer circuits (the North and South washers). Each circuit can receive matrix ore from two of IMC's four draglines. The two draglines that feed a washer circuit alternate between mining matrix ore and removing topsoil and overburden such that the circuit is only receiving ore from one dragline at any given time.

Matrix ore flows through each washer circuit entirely by gravity. The matrix ore pipeline initially flows into a tub at the top at each circuit. From the tub, the matrix ore enters one of eight parallel trains. Normally, all trains operate simultaneously in each circuit.

In each train, matrix ore passes over a 20-foot long flat metal screen to separate out greater than 8 inch material. The material that passes through the screen (less than 8 inch material) goes to a trommel, which is a rotating circular drum with "punch holes" (openings). The first section of each trommel has 1/2-inch openings (to remove less than 1/2-inch materials), while the second section has 2-inch openings (to remove greater than 1/2-inch and less than 2-inch materials). The greater than 2-inch materials from the trommels is combined with oversized (greater than 8 inch) materials from the first screen and classified as debris. Debris is disposed in the clay ponds or placed in an unlined on-site pile located west of the beneficiation plant (the size of the pile was not determined). Unspecified quantities of debris are subsequently used on-site in reclamation or road construction, or sold for off-site use. Materials that are greater than 1/2-inch and less than 2 inches are ground in a ball mill and sent back through the trommels. The less than 1/2 inch material passes over three vibrating screens (6 inch x 16 inch), identified by IMC as the primary, secondary, and finishing screens. All three screens are designed to separate the less than 1/2-inch material into less than 16 mesh (fine product)

Figure 5. Washer Plant Flow Diagram
(Source: U.S. EPA Field Note)



and greater than 16 mesh (pebble product) materials. The secondary screen is a doubledeck screen, with the second section used to separate greater than 3/8-inch material from the pebble product. According to IMC, the greater than 3/8-inch material has a high MgO content. It is classified as debris and managed with the other debris materials described above.

Between primary and secondary screening and between secondary and finishing screening, the pebble product is washed with unspecified volumes of water to remove clay materials. The water is obtained from the clay pond system. These washing stages are identified by IMC personnel as "log washes." The effluent from the first log wash goes to a primary clays cyclone. The pebble product is sent to the secondary screens, while washwater (with entrained clays) flows at an unspecified rate to Clay Pond F2. The effluent from the second log wash goes to a secondary clays cyclone. The pebble product is sent to the finishing screen, while washwater (with entrained clays) flows at an unspecified rate to Clay Pond F1. Overall, 95 percent of the clay content of the raw pebble product is removed in the washer plant and reports to the clay ponds.

The fine material from the washer plant is sent to the flotation plant. The pebble product from the finishing screen is about 64-65 BPL percent (bone phosphate of lime - the anhydrous calcium phosphate content) and contains about four percent fine material. The pebble product is analyzed for MgO, iron oxide, and phosphorous content to determine whether heavy media separation is required. In the pebble product, MgO is mostly in the form of dolomite. If the concentration of MgO exceeds one percent, the product goes to an unlined storage pile (size not obtained) for feed to the heavy media separation plant. If the MgO concentration is less than one percent, the pebble product is stored in piles for off-site shipment to IMC's New Wales phosphoric acid plant.

2.2.2 Heavy Media Separation Plant

The purpose of the heavy media plant is to remove MgO from pebble product that contains greater than one percent MgO. The heavy media separation process used at the Four Corners plant was patented by IMC in 1981-82. The plant was installed in April 1991, and is the only such plant in the phosphate mining industry. According to IMC personnel, the process has significantly expanded the minable acreage at Four Corners (previously ore with greater than 1.0 percent MgO could not be profitably mined). In the future, IMC anticipates that other plants may be constructed using the technology as mining expands to areas South of Four Corners, where raw pebble product would generally contain MgO in concentrations greater than one percent.

In the heavy media separation plant, an unspecified volume of water is initially added to the pebble product, which is then passed through two stages of hydraulic screening. The pebble product is separated into: (1) greater than 5 mesh material, which is classified as waste (see below), (2) less than 5 mesh to greater than 16 mesh material, which goes to heavy media separation, and (3) residual less than 16 mesh material, which goes to the flotation plant. The wastewater from the screening stages is recycled within the plant.

The less than 5 and greater than 16 mesh material goes to a hydrocyclone, which is loaded with heavy media to provide gravity separation. The media is 90 percent magnetite (specific gravity-5.1) and 10 percent ferrosilicon (specific gravity-7.0). Information was not obtained on how heavy media is stored prior to use or how IMC manages any spent media generated. The overflow (waste) from the hydrocyclone flows to a media screen. The media passes through the screen and is recycled. The waste material is combined with the greater than 5 mesh waste material from the initial hydraulic screening. The underflow from the hydrocyclone goes to another media screen. The media passes through the screen and is recycled, while the material that flows over the screen is pebble product. The heavy media plant generates 360,000 tons per year of pebble product, which is combined with the pebble product that does not require heavy media separation. IMC projects that, in the future, the plant could be used to produce up to 1,000,000 tons per year of pebble product. Without the heavy media plant at Four Corners, pebble product with greater than one percent MgO would be waste material and would be used for reclamation backfill.

The pebble product from the heavy media separation plant is combined with wet pebble product from the washer plant that did not require separation. The wet pebble product (with 7 to 8 percent water) is then segregated based on quality (BPL level) and customer requirements, and placed in one of eight pebble product bins. Product is loaded into railcars through openings in tunnels that pass underneath the bins. Very little pebble product (or fine product) is shipped off-site in trucks. As indicated above, all of the pebble product generated at Four Corners is sent to IMC's New Wales Chemical Plant for processing. Water is drained from the pebble product bins and directed to IMC's water management system (the quantity recovered was not obtained).

IMC's heavy separation plant generates 120,000-180,000 tons per year of material (greater than 5 mesh material from the initial hydraulic screening and oversized material from the hydrocyclone). The material, which is primarily dolomite with 50 percent BPL, is temporarily placed in unlined storage piles (sizes not obtained). Dolomite is an agricultural product; however, the material generated by IMC cannot be sold commercially as "dolomite" because it does not meet fertilizer specifications. The material also contains 15 percent acid insoluble sand, 3-5 percent MgO, and well as unspecified quantities of iron (II) oxide and aluminum oxide. Half of the material is ultimately ground for use as fertilizer filler. Of the remaining 50 percent, some is permanently managed on-site in an unspecified manner, some is used for roadbuilding, and the remainder is sold for other off-site use. The relative percentages in each category were not determined.

2.2.3 Flotation Plant

The less than 16 mesh material from the washer plant is pumped to two "unsized" feed bins (100-foot diameter and 45-foot height). These bins feed the flotation plant, where the material is initially separated into three size fractions; fine, coarse, and spiral. In the first separation stage, "fine" material (less than 35 to greater than 150 mesh) is hydraulically separated (by density). The remaining material (less than 16 and greater than 35 mesh) is then passed over Derrick screens to separate the "spiral" (less than 16 and greater than 24 mesh) and "coarse" (less than 24 and greater than 35 mesh) fractions. Approximately 4,000 tons per hour (5.5 million tons per year) of material is beneficiated in the flotation plant; 2,850 tons per hour (3.9 million tons per year) of fine material, 800 tons per hour (1.1 million tons per year) of coarse material, and 350 tons per hour (0.5 million tons per year) of spiral material. The flotation methods are different for each of the three fractions. Figure 7 presents a flow diagram for the flotation methods used at Four Corners. The following discussions of each flotation method do not describe overall water use and reuse. A broad description of IMC's water management system is provided in Section 3.1.

In spiral, coarse, and fine separation, the first stage is dewatering to approximately 70 percent solids. According to IMC, dewatering provides water savings and improves the efficiency of subsequent conditioning and flotation. In the next step, the fractions are conditioned with the addition of the flotation reagents. The same reagents are used in each type of flotation. The specific reagents, their purposes, and the total quantities used annually in the flotation plant are presented in Table 1.

Table 1. Summary of Flotation Reagent Use at Four Corners (Excluding Amine Flotation) (Source: IMC Fertilizer, Inc.)

Reagent	Purpose	Range of Quantity Used (in tpy)
Fatty acid and Rerefined Oil (API #27) Mixture	Collector	8,000-15,000
Sodium Silicate	Sand Depressor	<5,000
Ammonium Hydroxide	Buffer (to elevate pH to 9)	<5,000

In spiral flotation, conditioning is accomplished in rotating drums. In coarse and fine flotation, conditioning occurs in a series of four tanks, identified as vertical conditioners. The residence time in each vertical conditioner tank is 3-4 minutes and reagents are only added to the first tank.

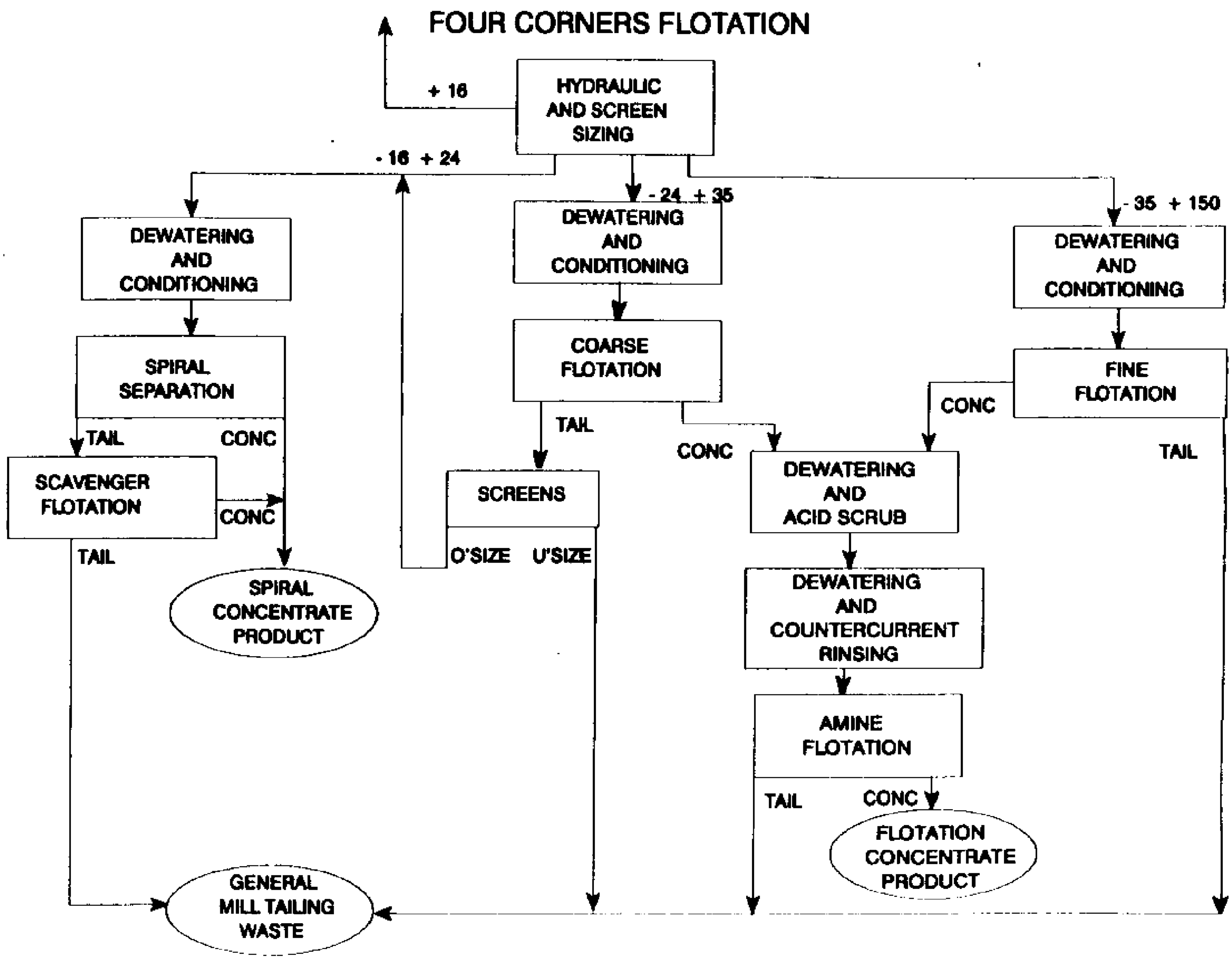


Figure 6. Flotation Plant Flow Diagram
(Source: IMC Fertilizer, Inc.)

In spiral separation, a Humphrey Helical spiral separator (described by IMC as "a trough with many ports") is used to accomplish initial flotation. The overflow is spiral product, while the underflow tailings go to scavenger flotation. Scavenger flotation is accomplished with compressed air agitation in four banks of standard Denver flotation cells. Each bank of cells has five 50 cubic foot pockets. The overflow from the scavenger cells is combined with overflow product from the spiral separators. The underflow discharges to the general mill tailings stream.

According to IMC personnel, it is more difficult to float product from the coarse and fine fractions. As a result, they require more separation stages. The initial coarse flotation is accomplished in four banks of Denver cells, each of which has five 300 cubic foot pockets. Aspirators/draft tubes are used for agitation. The tailings underflow from the initial coarse flotation passes over screens to separate "O" size material (greater than 35 mesh) and "U" size material (less than 35 mesh). Because the O size material contains additional phosphate values, it is directed to spiral separation. The U size material flows to the general mill tailings stream. The overflow, which is 15-20 percent solids, goes to a hydrocyclone for dewatering to 65-70 percent solids. The dewatered product is then sent to sulfuric acid scrubbing.

The initial fine flotation is accomplished in eight banks of Denver cells with five 300 cubic foot pockets in each bank. The overflow is dewatered to 65-70 percent and sent to sulfuric acid scrubbing. The tailings underflow goes to the general mill tailings stream.

While both the initial coarse and fine flotation products go to sulfuric acid scrubbing and subsequent amine flotation, they go through these stages separately. The acid scrub is accomplished with 96 percent sulfuric acid, which removes fatty acids and oil remaining from conditioning. IMC uses 8,000-15,000 tons per year of sulfuric acid. The scrub occurs in two parallel single-stage vertical tanks, with the amount of acid added depending on the quantities of reagents used in the initial flotation stages. The residence time in the acid scrubbing tanks is about four minutes. The effluent from the acid scrub tanks goes to dewatering and countercurrent rinsing with clean water. The wastewater from the acid rinsing stage is managed separately from other flotation plant wastewaters in the clay pond system (see Section 3.1). The rinsed product goes to amine flotation.

Amine flotation of fine product is accomplished in four banks of Denver cells, with five 300-cubic foot pockets in each bank. The amine flotation of coarse product occurs in two separate banks of Denver cells with five 300-cubic foot pockets in each bank. The residence time in the amine flotation cells for both coarse and fine products is 7 to 8 minutes. IMC uses less than 5,000 tons per year of condensate amine. IMC also adds a small amount (about 20 tons per year) of diesel fuel No. 2, to extend the usage of the condensate amine reagent. No other reagents are used in amine flotation and the pH is typically neutral.

In amine flotation, the sands/tailings are floated and the underflow is the product. The tailings flow to the general mill tailings stream. The underflow goes to a hydrocyclone to remove coarse and fine products, both of which are 72 percent BPL and 4 to 5 percent sand. The wastewater flows to an amine reclaim pond, which is separate from the facility's general water management system.

IMC performs assays to determine the quality (BPL level) of the fine product. The fine concentrate is then segregated according quality and customer requirements, and placed in one of six open fine product bins to allow for blending. Similar to the pebble product bins, fine product is loaded into railroad cars through openings in tunnels that pass underneath the bins. Water is drained from the fine product bins and directed to IMC's water management system (the quantity recovered was not available). According to IMC personnel, the fine product generated by the flotation plant contains 7 to 8 percent moisture, while the fine product shipped off-site contains 10 percent moisture. The reason why the moisture content of the product increases despite dewatering was not obtained.

2.3 Associated Operations

Prior to use, flotation reagents are stored in above-ground tanks in an uncovered reagent yard. The tanks in the yard include:

- One 180,000 gallon fatty acid tank and two 204,000 gallon flotation fuel oil tanks. Fuel and fatty acids are blended in a 180,000 gallon tank. An additional 180,000 gallon is empty and can also be used for fuel oil/fatty acid mixing as necessary. The tanks are all surrounded by secondary containment dikes. IMC personnel noted that Florida Statute 17.710, Florida's used/rerefined oil requirements, has led to use of better quality used oil. The statute requires that rerefined oil meet specific gravity levels. Therefore, IMC indicated that they occasionally test the specific gravity of incoming rerefined oil. No chemical constituent analyses are performed.

- Two 39,000 gallon aqueous ammonia tanks (ammonia is purchased in aqueous form). The aqueous ammonia is mixed with water to obtain anhydrous ammonia, which is stored in two 18,000 gallon tanks. Neither the aqueous nor anhydrous ammonia tanks have any form of secondary containment.

- Three diesel fuel tanks (the sizes of these tanks were not obtained). Two of the diesel fuel tanks feed the amine flotation process, while the other tank feeds a boiler in the reagent yard that can be used to generate steam to heat the reagent tanks, as needed. According to IMC personnel, heating has not been required to date. All three diesel fuel tanks have secondary containment dikes.

- Two 19,800 gallon sulfuric acid tanks. These tanks are surrounded by secondary containment dikes and are equipped with overflow alarms. The site visit team observed evidence of spillage around the sulfuric acid tanks.

- Two 21,000 gallon concentrated amine tanks (amine is purchased in concentrated form). The concentrated amine is mixed with water (10 percent amine/90 percent water mixture) to produce aqueous amine. The aqueous amine is stored in two 51,800 gallon tanks. All these amine tanks are surrounded by dikes.

While all heavy equipment maintenance is performed at IMC's Noralyn facility, a small shop is located at Four Corners. A chemical storage area behind the shop includes 500 gallon tanks, which are used to store mineral spirits, antifreeze, motor oil, and hydraulic oil. This storage area has secondary containment (i.e, dikes). There are no underground storage tanks at the Four Corners site.

All electric power is obtained from off-site sources. According to IMC personnel, construction of an on-site power plant was considered. However, IMC determined that it would not be economical. Standby diesel power generators are located at the site for use during power outages.

3. WASTE AND MATERIALS MANAGEMENT

This section describes several of the wastes and materials that are generated and/or managed at Four Corners Phosphate mine and the means by which they are managed. It should be noted that a variety of wastes and other materials are generated and managed by phosphate extraction and beneficiation operations.

Some, such as flotation tailings, are generally considered to be wastes and are managed as such, typically in on-site management units. Even these materials, however, may be used for various purposes (either on- or off-site) in lieu of disposal. Some quantities of tailings, for example, may be used as construction or foundation materials at times during a mine's life. Many other materials that are generated and/or used at mine sites may only occasionally or periodically be managed as wastes. Some materials are not considered wastes at all until a particular time in their life cycles.

The issue of whether a particular material is a waste clearly depends on the specific circumstances surrounding its generation and management at the time. In addition, some materials that are wastes within the plain meaning of the word are not "solid wastes" as defined under RCRA and thus are not subject to regulation under RCRA. These include, for example, mine water or process wastewater that is discharged pursuant to an NPDES permit. It is emphasized that any questions as to whether a particular material is a waste at a given time should be directed to the appropriate EPA Regional office.

The following subsections describe several of the more important wastes (as defined under RCRA or otherwise) and nonwastes alike, since either can have important implications for environmental performance of a facility. Wastes and materials generated at Four Corners include clays (and co-managed wastewaters), flotation tailings, debris, mine water, runoff, and other wastes and materials (e.g., waste oil and grease, steel pipe, spent solvents, laboratory wastes, trash, tires, and batteries). Table 2 presents a summary of all of the materials generated at Four Corners and IMC's management practices. A discussion of the water recirculation system is also provided in the description of IMC's clay ponds.

3.1 Clay Ponds and Water Management

The clay pond system at IMC is used to dispose of clay materials removed from the matrix ore in the washer plant, as well as providing for process water management/recirculation. The complete water balance for IMC Four Corners is presented in Figure 8. Clay represents 25 percent of the matrix ore and 7.5 million tons of dry clay waste are generated annually. As indicated in Section 2.2.1, clays are separated from the pebble product in two log washing stages. The effluent from the first log wash flows to the primary clays cyclone. In the primary cyclone, the pebble product is removed and directed to the secondary screens. The wastewater (with entrained clays) flows by pipeline to Clay Pond F2. The effluent from the second log wash is directed to the secondary clays cyclone. In the secondary cyclone, the pebble product is removed and directed to the finishing screen. The wastewater flows by pipeline to Clay Pond F1.

Wastewater generated by most flotation plant operations (including countercurrent rinsing) flows into an open steel launder (identified by IMC as the "secondary launder"). The secondary launder is approximately 50 feet long by 10 feet wide. The launder also serves as the source of makeup water for the rinsing operations in the flotation plant. Twelve pumps controlled by an automatic system are used to regulate the flows in and out of the secondary launder. There is a bleed stream, which flows by steel pipeline to Clay Pond F2. According to IMC, the flow from the secondary launder comprises less than one percent of the total flow into the clay pond system. No additional information was obtained on the specific streams that flow into the secondary launder and their individual flow rates.

As indicated above, IMC operates two clay ponds at the Four Corners Mine (F1 and F2). Both ponds are approximately 50 feet deep and are surrounded by 20 foot thick dams constructed of rolled compacted clay material. The crests of the dams are 35 feet above grade. The site visit team observed more than ten feet of freeboard in Clay Pond F2 (Clay Pond F1 was not visited). Each pond is divided into multiple cells. The cells are also separated by dams constructed of compacted clay. Cells F1A-C and F2A-B are currently permitted by the State Department of Natural Resources and were operational during the site visit. IMC has recently applied for a permit for Cell F2C and IMC is planning F3 to be located in a previously mined area. The combined area of all cells in F1 is 740 acres (areas of individual cells were not obtained). F2A and F2B each cover approximately 600 acres.

Pervious tailings are placed on the outsides of the dams. The site visit team observed growth on slopes of the clay ponds, as well as abundant plant and animal life in the ponds and return ditches (including at least one alligator). The clay ponds were not constructed with liners. IMC claims that a natural clay liner forms with clay settling. Based on an IMC aerial photograph of the site prior to construction of F2B, this cell was apparently built over a reclaimed mining area. Studies conducted in the early 1980s by Gordon & Palm Associates, Inc. state that clay ponds do not pose a risk to ground water (see Section 4.2.1 for a further discussion of these studies). As a result of this finding, all clay ponds at phosphate mines in Florida are exempted from State ground-water monitoring requirements. However, Manatee and Hillsborough Counties require IMC to monitor ground water at five wells located in the shallow surficial aquifer south of Clay Pond F1. IMC also conducts ground-water monitoring at production wells GDP-7 and 8 in the Floridian aquifer. GDP-8 is located in the mill area south of Clay Pond F2. The location of well GDP-7 was not determined, although it is assumed to be in the vicinity of GDP-8 (see Section 4.1.1 for greater detail on

Table 2. Summary of Waste & Materials Generation and Management at Four Corners (Source: IMC Fertilizer, Inc.)

Waste	Quantity Generated	Management Practice
Primary Clays	7.5 million tons dry*	Clay Pond F2, complete recycle
Secondary Clays	7.5 million tons dry*	Clay Pond F1, mostly recycle with discharge from outfall 001
Flotation Wastewater (except acid scrub)	Not determined	Combined in secondary launder, most recycled from launder, bleed from launder to clay ponds
Acid Scrub Water	Not determined	Combined with secondary clays and sent to F1
Amine Process Wastewater	Not determined	Managed separately in amine ponds, complete recycle after makeup water addition
Tailings	19.5 million tons (1991)	Stored on-site for use in backfill or dam construction
Debris	Not determined	Stored in on-site piles for on-site use in reclamation or as road based material, or sold for unspecified off-site use
Runoff - Plant Area	Not determined	Collected and sent to F1, 1.1 MGD discharged through outfall 001
Runoff - Other Areas	122.08 MGD	Uncontrolled
Mine Water	Not determined	Stored in ponds as convenient, reclaimed to beneficiation plant wherever possible
Waste Oil	16,618 gallons/year (1991)	Off-site rerefining, then returned to IMC for reuse
Steel Pipe	Not determined	Pipe is reused on-site as long as possible (pipe recycling program), ultimately sold as scrap
Dragline Grease	1,355 gallons/year hazardous, no data for non-hazardous	Tested to determine hazardousness, if hazardous sent off-site to Chem Waste Management, no information on management if non-hazardous
Spent Solvents	1,892 lbs/year proprietary, 294 lbs/year naptha	Sent off-site as hazardous waste
Laboratory Wastes	Not determined	Sent off-site as hazardous waste
Tires	Not determined	Most exchanged with supplier, some shredded and landfilled off-site
Batteries	Not determined	Exchanged with supplier
Trash	10 Containers	Containers sent to County Landfill
Sanitary Wastewater	Up to 0.0075 MGD	Treated in aeration system and sent to clay ponds

*7.5 million tons represents total quantity of clays generated. No data were available for individual quantities of primary and secondary clays.

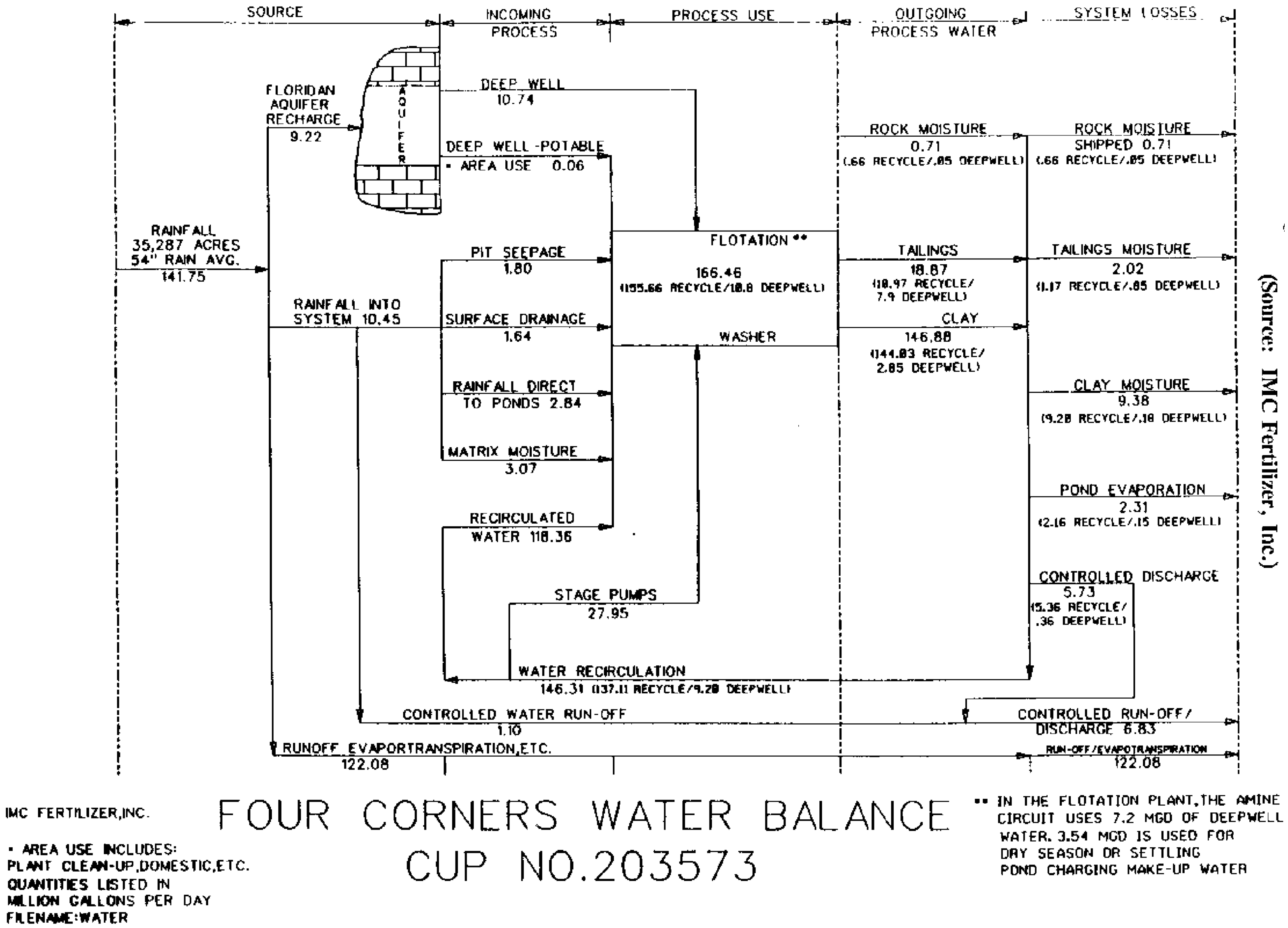


Figure 7. IMC Four Corners Water Balance
(Source: IMC Fertilizer, Inc.)

(Source: IMC Fertilizer, Inc.)

ground-water monitoring at Four Corners). In addition, piezometers are located throughout the clay pond dams to monitor stability.

Clay pond water is reclaimed and returned to the beneficiation plant in unlined ditches. According to IMC's water balance, 146.88 million gallons per day (MGD) flow into the clay ponds. The total return flow to the washer and flotation plants from the clay ponds is 129.46 MGD. Clay Pond F1 is specifically used for managing secondary clay cyclone wastewater and wastewater from the sulfuric acid washing stage in the flotation plant. The acid scrub water has a pH of 2.5 prior to commingling with secondary cyclone wastewater in the beneficiation plant (the volumes of acid scrub water and secondary cyclone wastewater generated were not available). The combined stream that enters Pond F1 has a pH of 4.5. Pond F1 overflows into a small unlined pond, which discharges to Alderman Creek through a V-notched weir. The discharge to Alderman Creek is through IMC's NPDES-permitted outfall 001. As shown in Figure 3, Alderman Creek flows into the North Branch of the Little Manatee River. According to IMC's water balance, an average of 5.73 MGD of secondary clay cyclone and sulfuric acid wash water is combined with 1.10 MGD of controlled runoff and discharged through outfall 001. Assuming that 129.46 MGD are recirculated and 6.83 MGD are discharged through outfall 001, 10.59 MGD of clay pond water would be lost to other sources (e.g., evaporation and infiltration).

According to IMC, the amine flotation operation at Four Corners requires very "clean" makeup ywater. Therefore, the amine process has a separate water management system. Wastewater from the amine process flows to a reclaim pond. From the reclaim pond, water flows through a canal to a "clean" pond. No information was obtained on areas or depths of each pond. Neither of the ponds or the canal is lined. No analysis is performed on the pond water and no ground-water monitoring is conducted. Approximately 7.2 MGD of water is added to the clean pond from deep ground-water wells located in the Floridian aquifer. The clean pond provides the makeup water for amine flotation. A water balance for the amine pond system was not available.

3.2 Tailings

According to IMC, the flotation plant at IMC generated approximately 19.5 million tons of tailings during 1991, and 22.9 million tons were projected to be generated during 1992 (no information was available to indicate whether these quantities represent wet or dry tailings). According to IMC, because of the grain shape (rounded), IMC's tailings sands cannot be used in construction as filler. Therefore, tailings are slurried to tailings piles for storage and subsequent on-site use. Water is decanted from the tailings piles with approximately 16.85 MGD recirculated to the beneficiation plant. The dried tailings remain stored at the site until they can be used for clay pond dam construction or reclamation of mined areas (the quantity of dried tailings currently stored on-site was not available).

There are two unlined tailings piles at Four Corners. Dried tailings from one tailings pile will be used for the construction of the Clay Pond F2C dam. Pond F2C construction was proposed to begin in September 1992 and be completed 20 months later. According to IMC, the tailings pile planned for Clay Pond F2C dam construction is 500 feet long, 500 feet wide and 150 feet high. Dried tailings from the other tailings pile are planned for use in Pond F3 dam construction. Based on observation, the site visit team estimated that this tailings pile was 1/2 mile long, 1/4 mile wide, and about 100 feet high. Information on the specific size of this tailings pile was not obtained from IMC. In addition, no information was obtained on the specific methods used to construct either tailings pile.

IMC personnel indicated that tailings piles are temporary and agreements with Florida DNR require that the tailings must be used in dam construction or reclamation within 24 months. However, the pile intended for Pond F3 construction has been located at the site since July 1990 and, according to IMC, will remain in place for at least two more years from the time of the site visit.

Similar to the clay ponds, the studies conducted by Gordon & Palm Associates, Inc. in the early 1980s concluded that tailings from phosphate operations do not pose risks to ground-water. As a result, all phosphate operations including Four Corners are also exempted from State ground-water monitoring for their tailing piles. However, ground-water monitoring is required by Manatee and Hillsborough Counties. The monitoring wells at Four Corners are located in the vicinity of the clay ponds, not the tailings piles (see Section 4.1.1 for more detail on IMC's ground-water monitoring system). Under the conditions of IMC's State surface water discharge permit, IMC is required to annually collect and analyze a single sample of the tailings pile decant water for hydrocarbons and PCBs (FL DER, 1987). The results of a December 1991 tailings pile water analysis showed a toluene level in the tailings of 0.012 mg/l. All other values were below detection limits. An IMC letter (dated 3/9/92) reporting these data to the State indicated that resampling would be performed to verify the presence of toluene. Results of the verification testing were not available at the time of the site visit (IMC, 1992b). According IMC, phthalates are the only hydrocarbons that have generally been found in Four Corners Mine tailings pile water (elevated phthalate levels are often caused by laboratory contamination of samples). In addition, IMC personnel indicated that the tailings contain approximately 2-3 percent heavy minerals (the specific minerals and relative concentrations were not identified). No information was available on the oil and grease content of the tailings, although the absence of hydrocarbons would imply that the tailings contain little, if any, oil and grease.

3.3 Debris

Debris consists of oversized materials from the washer plant. No data on waste characterization or quantities were available for the debris material. Debris is placed in an unlined pile west of the beneficiation plant or one of the clay ponds. No information was obtained on the current size of the debris pile. IMC has sold some of the debris (amount and specific reuse not identified). In addition, debris is used in reclamation and as road base material. No additional information was obtained on the generation and management of debris materials.

3.4 Runoff

As shown in the water balance for the Four Corners facility, most runoff (up to 122.08 MGD) from facility property is uncontrolled. However, runoff from the beneficiation plant area (along with process leaks and spillage), product piles, and haul roads is collected and managed in IMC's clay pond water management system. Figure 8 shows that 1.1 MGD is discharged directly through outfall 001. The remainder of storm water collected from these areas (specific flows not obtained) is recirculated to the plant. According to IMC personnel, the water management system has sufficient capacity to control all collected runoff from the plant for up to a 100-year, 24-hour storm event. They cited a storm event where the beneficiation plant was covered by a foot of water and no runoff was discharged uncontrolled (the date, size, and return interval of the event were not determined).

3.5 Mine Water

Mine water collects in active mining areas at the site. IMC pumps mine water from location to location at the site as necessary based on convenience. IMC did not have readily available estimates of the total quantity of mine water that accumulates or the quantities stored in specific locations. Wherever possible, mine water is pumped to the clay pond system for use in the beneficiation plant. According to IMC's water balance for Four Corners, approximately 1.80 MGD of mine water/pit seepage flows into the water management system.

3.6 Other Wastes and Materials

Other wastes and materials generated at the site include: waste oil, dragline grease, spent solvents, laboratory wastes, tires, batteries, trash, and sanitary wastewater and sludge. Each of these and IMC's management practices are described in the following sections.

3.6.1 Waste Oil

All waste oil generated at Four Corners is collected in 55 gallon drums and shipped off-site to National Oil Corporation. National rerefines IMC's waste oil and returns the oil to Four Corners for reuse. In 1990 and 1991, respectively, IMC shipped 13,178 and 16,618 gallons of waste oil from Four Corners to National Oil. In 1992, 2,561 gallons had been shipped off-site as of March 18, 1992 (National Oil Service, 1992).

3.6.2 Steel Pipe

IMC has initiated a pipe recycling/reuse program at Four Corners. Significant quantities of steel pipe are used for matrix ore transport from mining areas to the beneficiation plant. When this pipe can no longer be used for ore transport, it is recycled for less demanding on-site uses (e.g., fresh water transport). When all on-site uses have been exhausted, the steel pipe is sold as scrap. According IMC personnel, their pipe recycling/reuse program has proven to be profitable. Quantities of pipe used and resold were not determined. (For more information on pipe recycling, refer to U.S. EPA, Office of Solid Waste (1994). *Innovative Methods of Managing Environmental Releases at Mine Sites.*)

3.6.3 Dragline Grease

Waste dragline grease is collected in 55 gallon drums for off-site disposal. In the past, dragline grease used at Four Corners contained 1,1,1-trichloroethane (TCE) and waste grease was considered a hazardous waste (D040). The dragline grease now used at Four Corners no longer contains TCE. However, IMC continues to detect leaching of residual TCE from the machinery into the grease. As a result, IMC must test each drum of waste grease to determine whether it is hazardous. In 1991, 1,355 gallons (200 drums) of waste grease were shipped off-site as hazardous waste to Chemical Waste Management in Ohio. No information was obtained on the quantity of waste grease that was found to be non-hazardous or how it was managed.

3.6.4 Spent Solvents

IMC uses proprietary solvent for most equipment cleaning in the shops at Four Corners. This solvent is identified with hazardous waste code D039, which indicates that it contains elevated levels of trichloroethylene. The proprietary solvent is collected in Safety Kleen containers and ultimately removed for off-site hazardous waste management by Safety Kleen. In 1991, 1,892 pounds of the proprietary solvent were shipped off-site.

In addition, IMC washes carburetors with naptha. Spent naptha is collected by Safety Kleen for off-site management. The spent naptha is identified with hazardous waste codes D006 (cadmium) and D018 (benzene). In 1991, 294 pounds of spent naptha were shipped off-site.

3.6.5 Laboratory Wastes

Laboratory wastes are placed in lab-packs and shipped off-site in 55-gallon drums. Information on the specific types of laboratory wastes generated at Four Corners and the quantities disposed was not obtained.

3.6.6 Tires and Batteries

Most tires are exchanged with IMC's supplier. However, some tires are shredded and landfilled off-site. All batteries are exchanged with IMC's supplier. No information was obtained on how batteries and tires are stored on-site prior to pickup. The quantities of tires and batteries sent off-site were also not determined.

3.6.7 PCBs

The IMC Four Corners Mine was constructed without PCBs. A PCB survey was recently completed at the site and no PCBs were found.

3.6.8 Trash

All trash generated at Four Corners is shipped to the Manatee County municipal landfill. Approximately 10 containers per week are sent to the Manatee County landfill (sizes of containers were not obtained).

3.6.9 Sanitary Wastewater

All sanitary wastewater generated at Four Corners is treated in an on-site wastewater treatment plant. The facility is a "Type II" extended aeration sewage treatment plant with chlorinated effluent. The wastewater treatment plant was not visited by the site visit team and no information was obtained on quantities of chlorine used or storage methods. The capacity of the plant is 0.0075 MGD. The chlorinated effluent is discharged to IMC's clay pond system. Sewage sludge is land applied (FL DER, 1989a). No information was obtained on the total quantity of sewage sludge generated or disposed.

4. REGULATORY REQUIREMENTS AND COMPLIANCE

IMC's Four Corners Mine is addressed by an array of Federal, State, and local environmental and operating permits and authorizations. They are issued by EPA; the U.S. Army Corps of Engineers; the Florida Departments of Natural Resources, Environmental Regulation, and Health and Rehabilitative Services; the Southwest Florida Water Management District; and Hillsborough and Manatee Counties. These permits and authorizations address the design and operation of the Four Corners Mine as well as controlling impacts on ground-water, surface water and air. Each of the permits and authorizations applicable to IMC Four Corners is addressed in the following sections.

4.1 Operational Requirements and Permits

4.1.1 Development of Regional Impact Studies and County Development Orders

Under Florida State Law (380 F.S.), IMC Four Corners was required to prepare Development of Regional Impact (DRI) plans. Separate DRI plans are required for each county and the DRI plans must be formally updated when significant modifications/expansions of operations are planned. DRI plans must specifically include: an analysis of the mine development's impact on the environmental and natural resources, local economies, and public facilities (Craft and Bakker, Undated). The State is divided into 11 planning districts and the DRI plans are submitted to the appropriate district (Tampa District for Four Corners). The Planning District provides comments to the counties on DRI plans. The counties then issue Development Orders.

IMC Four Corners has separate DRI plans for Manatee and Hillsborough Counties. The initial proposed Four Corners DRI plan was submitted to Manatee County in September 1975. The DRI plan describes the planned operation and its environmental impacts on Manatee County, proposed reclamation activities, and economic impacts. IMC specifically proposed to reclaim (through revegetation and reforestation) all disturbed areas (including mined land, clay ponds, and tailings impoundments) (W.R. Grace, 1975). A Development Order was issued on December 27, 1977 by Manatee County for Four Corners based on the final DRI plan. On March 23, 1989, IMC requested a substantial deviation from their Manatee County DRI for expansion of mining operations at the site. A modified Development Order was issued by Manatee County on September 5, 1991 (IMC, 1992c).

An initial DRI Plan similar to the plan for Manatee County was submitted to Hillsborough County and a Development Order was issued by Hillsborough County in the late seventies/early eighties. No additional information on the original Hillsborough County DRI or Development Order was available. IMC has a pending request for a substantial deviation. IMC is proposing to combine the DRIs and Development Orders for all 54,000 acres of IMC's Four Corners, Lonesome, and Kingsford operations located in Hillsborough County. Thirty-six thousand acres of these three mines are permitted for development under separate Development Orders. The proposed DRI requests authorization to develop the remaining 18,000 acres of reserves. The reserve land proposed for development at Four Corners consists primarily of "window" out parcels within the facility's existing boundaries (IMC, 1992d).

The existing Development Orders for Manatee and Hillsborough Counties require IMC to conduct ground water and surface water monitoring to ensure no impacts on the surrounding environment. Ground water monitoring wells (MW-1 through 5 and GDP-7 and 8) at Four Corners anre shown on Figure 2, the Four Corners site map included in Section 1.2. Surface water monitoring locations are shown on Figure 3, the map of surface water in the area. Ground and surface water monitoring data must be submitted quarterly to Manatee and Hillsborough Counties.

As shown on Figure 2, five ground water monitoring wells (MW-1 through 5) are located south of Clay Pond F1. IMC also conducts monitoring at production wells GDP-7 and 8 in the Floridian aquifer. GDP-8 is located near the mill and south of Clay Pond F2. The location of GDP-7 was not specified, although it is assumed to be in the vicinity of GDP-8. No information was obtained on the ground water flow velocity or direction at the site and no distinction was made in the available references between upgradient and downgradient wells. In addition, the specific depths of the wells were not determined. Ground water monitoring data for January 1991 through November 1991 are presented in Appendix A. All constituents were found below the applicable primary and secondary drinking water standards except pH, iron, and color. However, based on the findings in the 1983 Palm & Associates Report (see Section 4.2.1), the levels of pH, iron, and color are consistent with natural conditions in the area.

Surface water monitoring is required monthly at locations SW 1 through 3 and SW 6 (where monitoring began in October 1991) and semiannually at locations SW 4 and 5. No information was obtained on the monitoring frequency at location 302, the Little Manatee River prior to the confluence with Alderman Creek. Surface water monitoring data for January 1991 through November 1991 for locations SW-1 through SW-6 are presented in Table 3 (no data were available for location 302). With the exception of outfall 001, there are no controlled discharges from IMC's operations to local surface waters. As a result, it is not possible to assess the potential impacts of mining operations (including uncontrolled discharges of mine water and runoff) on surface waters using the data provided in Table 3. However, the following general observations are noted:

- As noted in Section 1.3, surface waters in the area are characterized as acidic. Monitoring data for location SW-3 (in Alderman Creek below outfall 001) indicate a more neutral pH than other monitoring locations. This may be the result of the neutral discharge from outfall 001.

Table 3. Summary of 1991 Surface Water Monitoring (Source: IMC Fertilizer, 1991)

Parameter	Units	Monitoring Location					
		SW-1	SW-2	SW-3	SW-4	SW-5	SW-6
pH	s.u.	4.6-5.6	5.1-6.1	6.5-7.5	6.4	6.4-6.5	5.7-6.2
Turbidity	NTU	0.8-3.7	0.6-4.6	0.4-5	2.7-6.7	1.3-1.6	1.1-4.5
Total Solids	mg/l	96-276	72-220	200-412	71-172	63-116	131-148
TSS	mg/l	0.4-80	1-4.8	1-6	1-16	1-1.6	1-5.6
Chloride	mg/l	11-53	10-36	5-29	11.2-20	9.2-13	29.6
Sulfate	mg/l	2-60	2.1-38	24-328	15.1-18	9-13.6	10.5
Fluoride	mg/l	0.1-0.6	0.1-1	0.5-2	0.4	0.2	0.3
Nitrite	mg/l	0.1	0.1	0.1	0.1	0.1	0.1
Nitrate	mg/l	0.1-0.86	0.1-0.49	0.1-0.49	0.1	0.1-0.8	0.1
Ammonia N	mg/l	0.1-1.8	0.1-1.2	0.1-1.3	0.1-0.2	0.1-0.2	0.2-0.6
TKN	mg/l	0.1-3.8	0.6-2.2	0.3-2.5	0.6-1	0.6-0.7	0.6-1.9
Total N	mg/l	0.1-3.8	0.6-2.5	0.3-2.7	0.6-1	0.8-1.4	1.7-1.9
Organic N	mg/l	0.1-2.2	0.6-1.7	0.6-1.7	0.5-0.8	0.4-0.6	1.5
Total P	mg/l	0.1-0.9	0.1-0.6	0.4-1.7	0.1-0.9	0.3	0.20.7
Total PO_4	mg/l	0.9-1.5	0.3-0.9	1.2-4.4	N/A	N/A	N/A
BOD_5	mg/l	0.5-3.2	0.5-8	0.5-4.5	0.7-1.6	0.6-1.3	1.5
Oil & Grease	mg/l	1-12.1	1-35.5	1-5.8	1-5.7	1-103	29-74
Gross Alpha	pCi/l	1-2	1-3	1-11	1	1-2	1-5
Radium 226	pCi/l	0.1-0.5	0.1-0.7	0.2-1.2	0.9	1	0.4
Radium 228	pCi/l	0.5-1.2	0.4-1.7	0.6-7.5	1.1	1.3	0.8
Dissolved O_2	mg/l	1.5-4.5	1.1-4.8	3.4-6.9	5.6-6.2	5.8-7.1	1.5-3.2

N/A = No monitoring data available, TKN = Total Kjeldahl Nitrogen

- Oil and grease levels in the area, as indicated by monitoring results from locations SW-1 through SW-6, exceed the applicable Florida water quality standard for oil and grease in Class III waters (fresh).

- November 1991 sampling at location SW-3 showed a Radium 228 level of 7.5 pCi/l, which exceeds the Florida water quality standard for Total Radium in Class III waters (fresh) of 5 pCi/l.

- Florida water quality standards require a dissolved oxygen content level of greater than 5 mg/l. Monitoring at locations SW-1, SW-2, and SW-6 consistently shows dissolved oxygen levels below the State standard. At monitoring location SW-3, three of ten samples collected during 1991 had a dissolved oxygen content of less than 5 mg/l (IMC, 1992a).

Hillsborough County also requires IMC to use 11 additional wells (identified as GHO-2, GSO-2, GD-6, SMW-1, SMW-2, SMW-3, SMW-3A, SMW-5, SMW-5A, SMW-6, and SMW-7, specific locations not obtained) to monitor withdrawal rates in one area of the property. The original purpose of this monitoring was to determine the potential impacts of mining operations on one out parcel, identified by IMC as the Schuman property. These wells are now used to monitor the overall impacts of IMC's operations on ground water flow. IMC continuously monitors ground water flow in three of these wells, located in the surficial (GSO-2), intermediate (GHO-2) and Floridian aquifers (GD-6). The other eight wells are located in the surficial aquifer and ground water flow is monitored monthly. Withdrawal rate data for these wells were not reviewed by the site visit team.

According to IMC personnel, Manatee and Hillsborough Counties require that the ground water table at the property boundaries not be permanently lowered more than one foot. As a result, IMC must install piezometers to measure ground water depth whenever mining occurs within 1,000 feet of property boundaries. After mining is completed in these areas, the ground water table must be restored to within one foot of natural conditions. Information on measures used to restore the ground water table after mining was not obtained.

Both the Manatee and Hillsborough County Development Orders require reclamation of mined and other disturbed land in compliance with State requirements (see Section 4.1.2). Manatee County holds a $10,000 bond for reclamation of the site. Hillsborough has required financial guarantees from IMC. In addition, Manatee County requires that IMC maintain $10,000,000 of environmental incident liability insurance.

According to IMC personnel, State and County approval is required for construction of all clay ponds (and any other berms) as well as tailings storage and disposal practices (including intermediate storage prior to use in reclamation). More specific information on design and operating criteria and the approval process was not obtained.

4.1.2 State Reclamation Requirements

The Florida Department of Natural Resources (DNR) is responsible for ensuring reclamation of phosphate mines. The requirements for phosphate mine reclamation are listed in Chapter 16C-16 of DNR's operating rules. Specifically, phosphate mines are required to submit a conceptual reclamation plan at least 6 months prior to initiation of mining. In addition, detailed reclamation plans are required for "logical" reclamation units (typically less than 640 acres) at a site prior to mining of the unit. However, no approval of conceptual reclamation plans or plans for individual units is required prior to commencing mining. Specific reclamation requirements include providing for at least 80 percent vegetative ground cover and 10 percent forest land with 200 trees per acre in upland areas. Upland slopes must be no steeper than 4:1. The requirements also call for wildlife habitat replacement and restoration of wetlands (Craft and Bakker, Undated). Financial assurance is required; however, compliance with the reclamation standards is considered adequate financial assurance. Finally, unit reclamation and restoration must be completed within two years of cessation of mining in the unit.

The site visit team did not review the IMC Four Corners conceptual reclamation plans or the plans for individual units. As indicated previously, approximately two years are required from the initiation of mining activities to completion of reclamation. Limited information was found on specific ongoing reclamation activities at Four Corners. IMC did note that they are constructing a scrub habitat in one mining area. According to DNR personnel, IMC has fully complied with all State reclamation requirements. Because of IMC's compliance with reclamation requirements, DNR does not require bonding for Four Corners (Bakker, 1992).

DNR reclamation rules suggest that exposed tailings can not be permanently disposed of above grade. According to IMC, tailings at Four Corners can only be stored prior to use in reclamation or clay pond construction for two years. However, the site visit team noted that the tailings planned for use in construction of future Clay Pond F3 have already been piled at the site for at least two years and construction of Pond F3 is not scheduled to be completed until 1993.

4.2 Ground Water

4.2.1 State Ground Water Protection Requirements

In 1982, the Florida Environmental Regulatory Commission passed a rule that required ground water monitoring systems at phosphate mines by March 1984. However, the rule provided an exemption from these requirements for facilities that could show subsurface discharges would not impair the designated uses of the underlying ground water.

The Florida Phosphate Council contracted with Gordon F. Palm & Associates, Inc. (hereafter referred to as Palm & Associates) to conduct a comprehensive sampling of mine water, tailings, and clay ponds as well as shallow and deep aquifers underlying operating and non-operating phosphate mines. The sampling plan was approved by Florida Department of Environmental Regulation (DER). Clay water was only sampled at non-operating mines and no sampling was performed at the Four Corners Mine site. In addition, it is unclear whether this study considered impacts of such units as IMC's secondary clay/sulfuric wastewater pond (F1) and the amine process water management system. (Palm & Associates, 1983a)

The findings of the study were that:

- All samples of ground water showed levels of heavy metals, trihalomethanes, pesticides, and nitrates below primary drinking water standards.

- All samples of ground water showed levels of chlorides, copper, and surfactants below secondary drinking water standards.

- Some samples of ground water exceeded primary drinking water standards for fluoride, turbidity and fecal coliform and secondary drinking water standards for iron, manganese, pH, TDS, sulfate, and color. All exceedances were generally assumed to pose no risk because the pollutant levels were consistent with natural ground water conditions in the area. Some exceedances in ground water samples were explained as representative of natural conditions, while no explanation was provided for other exceedances (Palm & Associates, 1983a).

In 1983, Palm & Associates also released the report "Chemicals and Reagents Used in the Beneficiation of Phosphate Rock." Chapter 2 of the report considered the common reagents used in phosphate rock beneficiation and the potential impacts on ground water. All chemicals were found to be unlikely to cause ground water contamination. The following findings are specifically applicable to chemical use at IMC:

- Tall oils/fatty acids - The report considered only one product used by one company. To the best of the Company's knowledge the product is biodegradable. Ground water contamination was concluded to be unlikely.

- Kerosene/fuel oil - Based on one article that indicates that one product is biodegradable and the general assumption that fuel oils will be removed by evaporation, auto-oxidation, and oxidation by microorganisms, ground water contamination was concluded to be unlikely. The report also notes that kerosene and fuel oils are very insoluble.

- Amines - The report refers to a section from a Kirk Othmer reference on fatty acid amines (not the amines used at Four Corners), which indicates that they are biodegradable. The report also cites a chemical producer's statements that, while their single product (a mixture of tallow amines and aliphatic alcohols) may be acutely toxic, it is unlikely to cause chronic effects.

- Ammonia - Ammonia was assumed to be oxidized by bacteria to nitrate. The Florida drinking water standard for nitrate is 10 ppm. The report cites the results of nitrate analysis of 184 samples collected from the phosphate mining areas of northern and central Florida that showed no nitrate levels at or above 10 ppm.

- Sulfuric acid - The report considered the potential impacts of sulfate, which has a secondary drinking water standard of 250 ppm. The Report cited the results of a 1982 Florida Phosphate Council study which showed only two of 16 samples of mill tailings (both from the same mine) exceeded this level. Excess use of sulfuric acid was cited for this mine. Ground water monitoring in the area of this mine show levels below 250 ppm. A few samples collected from ground water underlying other phosphate mines were noted as exceeding 250 ppm. The report suggested that these exceedances were caused by other sources. Therefore, the use of sulfuric acid was concluded to pose low potential for ground water contamination (Palm & Associates, 1983b).

Based on the results of these studies, DER exempted all phosphate mining operations (including Four Corners) from State ground water monitoring requirements in 1984. DER requirements are limited to the annual analysis of Four Corners mill tailings required under IMC's surface water discharge permit (see Section 3.2).

4.2.2 Summary of Ground Water Monitoring and Use at Four Corners

While Four Corners is exempted from State ground water monitoring requirements, ground water use and potential degradation are addressed by a number of other State and local permits. The ground water monitoring wells at Four Corners, their purposes (water supply and/or environmental monitoring), and the applicable permits are summarized below. More detailed information can found in this section under the descriptions of the specific permits.

- Wells MW-1 through MW-5 are located in the surficial aquifer and IMC is required under their County Development Orders to monitor these wells to determine potential impacts on local surface waters (the surficial aquifer recharges surface water in the area) (see Section 4.1.1).

- Wells GHO-2, GSO-2, GD-6, SMW-1, SMW-2, SMW-3, SMW-3A, SMW-5, SMW-5A, SMW-6, and SMW-7 are only used to monitor withdrawal rates. GHO-2 is located in the Hawthorn aquifer and GSO-2 is located in the Floridian aquifer. The other wells are all located in the surficial aquifer. Monitoring of these wells is required under IMC's Hillsborough County Development Order to measure the potential for drawdown (see Section 4.1.1).

- Wells GDP-7, GDP-8, and GDP-10 are production wells in the Floridian aquifer that provide water to the flotation plant (primarily the amine flotation process). Under IMC's County Development Orders, GDP-7 and GDP-8 are monitored to assess potential impacts on the Floridian impacts. Wells FCS-1 through FCS-7 are also in the Floridian aquifer and provide pump seal water. The withdrawal rates from these wells are regulated under IMC's water use permit (see Sections 4.1 and 4.5).

- Well PTW-3 in the Floridian aquifer provides an average of 0.06 MGD of potable water to the plant. The operation of this well is regulated under IMC's potable water permit (see Section 4.6.4).

4.3 Surface Water

4.3.1 NPDES Permit

The State of Florida is not authorized to implement the NPDES permitting program. NPDES Permit No. FL0036412 for IMC Four Corners was issued by EPA Region IV. The current NPDES permit was issued on September 30, 1991 and expires on September 30, 1996. The permit establishes effluent limitations and monitoring requirements for the discharge from outfall 001 (below Pond F1) to Alderman Creek. The discharge includes wastewater from the secondary clay cyclone in the washer plant, wastewater from acid scrubbing in the flotation plant, mine water, treated sanitary wastewater, and storm water. Ninety percent of the total annual discharge from outfall 001 occurs during storm events. However, according to IMC personnel, a continuous discharge is maintained to avoid stagnation in Pond F1. The effluent limitations in the permit are based on the effluent guidelines for discharges of process wastewater and mine dewatering from phosphate mines (see 40 CFR Part 436, Subpart R) and the permit writer's best professional judgment (BPJ). The specific permit limitations are presented in Table 4 (U.S. EPA, 1991a).

Table 4. NPDES Permit Requirements for Outfall 001
(Source: U.S. EPA, 1991a)

Parameter	Discharge Limitations			Monitoring Frequency
	Daily Minimum	Daily 30-Day Average	Daily Maximum	
Flow	N/A	Report (MGD)	Report (MGD)	Weekly
TSS (non-volatiles only)	N/A	12 mg/l	25 mg/l	Weekly
TSS (all)	N/A	30 mg/l	60 mg/l	Weekly
Total Phosphorous*	N/A	Report (mg/l)	Report (mg/l)	Weekly
Dissolved Oxygen	5.0 mg/l	N/A	N/A	Monthly
Un-ionized Ammonia**	N/A	N/A	0.02 mg/l	Monthly (Calculated)
Total Ammonia	N/A	N/A	Report (mg/l)	Monthly
Temperature	N/A	N/A	Report (°C)	Monthly
Total Kjeldahl Nitrogen	N/A	N/A	Report (mg/l)	Monthly
Specific Conductance***	N/A	N/A	1,275 (µmhos/cm)	Monthly
pH	6.0 s.u.	N/A	9.0 s.u.	Weekly

N/A = Not Applicable (i.e., no limit or monitoring requirement)

*The permit only requires monitoring for phosphorous. However, if the monthly average exceeds 3 mg/l for more than one month of a calendar year, IMC is required to: (1) document the monitoring data, (2) assess the cause and origin of the phosphorous discharge, (3) describe current phosphorous control practices, (4) evaluate the environmental significance of the elevated levels, and (5) identify reasonable methods to abate. A notice of the discharge must be publicly released in a local newspaper.

**The un-ionized ammonia concentration is calculated monthly as described in the permit using the total phosphorous and temperature levels.

***The specific conductance must not be more than 50 percent above background or exceed 1,275 µmhos/cm, whichever is less stringent.

According to IMC personnel, Four Corners does not have a Spill Prevention, Countermeasure, and Control Plan, because all potentially hazardous materials are "contained" at the site. The NPDES permit required IMC to update their best management practice (BMP) plan within six months of issuance of the permit and implement the updated plan within 18 months (U.S. EPA, 1991a). At the time of the site visit, IMC was updating their BMP Plan for Four Corners.

Table 5 summarizes discharge monitoring data for outfall 001 from September 1990 through December 1991.

IMC conducts self-inspections of the permitted discharge twice per week and EPA conducts annual NPDES compliance inspections.

4.3.2 State Surface Water Discharge Permit

The discharge from outfall 001 is similarly addressed by a State Discharge Permit. The previous Permit (No. I041-111263C) was issued on April 23, 1986 and expired on April 23, 1991. According to IMC, no new permit has been issued to date and the facility continues to follow the requirements of the previous permit. The effluent limitations and monitoring requirements for flow, TSS (both "total" and "non-volatiles only" monitoring required), total phosphorous, and pH are equivalent to the requirements under IMC's NPDES permit. Previously required monitoring for fluorides, specific conductance, un-ionized ammonia, dissolved oxygen, total kjeldahl nitrogen, and total sulfate was deleted, at IMC's request, as of a June 22, 1987 modification to the permit. As shown previously in Table 4, however, IMC is required to monitor for all of these parameters, except sulfate, under their current NPDES permit. IMC has continued to monitor and submit data for sulfate even though it is not required under either their NPDES or State Discharge Permits. In addition, as required under State regulations, IMC is about to undertake a study to determine whether permit limits are adequate to ensure compliance with State water quality standards (FL DER, 1987).

The expired permit also required an annual analysis of a single tailings decant water sample for hydrocarbons and PCBs. Toluene (at 0.012 mg/l) was the only constituent detected in a December 1991 tailings decant water sample. As indicated previously, verification sampling and analysis was to be performed after the site visit. DER is awaiting the results of verification sampling (IMC, 1992b).

To assess compliance with State Discharge Permit requirements, DER conducts annual inspections at Four Corners.

Table 5. Summary of Monitoring Data for Outfall 001 (9/90 - 12/91)
(Source: IMC 2nd quarter, 1992)

Parameter	Monitoring Results	Comments
Flow	0.056 - 42.275 MGD	Very high flow during summer
pH	6.42 - 7.7	Within permit limits
Fluoride	ND - 2.7 mg/l	Required under previous NPDES permit
TSS (all)	0 - 28 mg/l	Within permit limits, most values less than 5 mg/l
TSS (non-volatiles only)	0 - 18 mg/l	Within permit limits, most values less than 1 mg/l
Dissolved Oxygen	5.3 - 22.7 mg/l	Within permit limits
Total Ammonia	Not Available	Report only requirement, used to calculate un-ionized ammonia
Un-ionized Ammonia	ND - 0.0155 mg/l	Calculated as noted above, within permit limits
Temperature	Not Available	Report only requirement, used to calculate un-ionized ammonia
Sulfate	17.8 - 245.4 mg/l	Required under previous NPDES permit
Kjeldahl Nitrogen	0.21 - 2.91 mg/l	None
Specific Conductance	296 - 603 µmhos/cm	Within permit limits
Gross Alpha	1.0 - 6.8 pCi/l	Required under previous NPDES permit

ND = Not Detected

4.4 Air

DER issues permits for most air pollution sources; however, a permit is not required for mining, which is considered an area source. Mining operations are generally required by DER to take reasonable precautions to minimize fugitive dust emissions and ensure compliance with ambient air quality standards (Craft and Bakker, Undated). According to IMC, all dust settles on-site and no off-site dust problems have been caused by the Four Corners operations. Where necessary, water wagons are used for on-site dust control.

DER has issued Permit No. A041-197666 for air emissions from IMC's heavy media separation plant. This permit was issued on June 19, 1991 and expires on June 19, 1996. The permit specifically addresses two emissions sources: Emission Source 01 - the magnetite storage bin and Emission Source 02 - the ferrosilicon storage bin. Particulate emissions from these two sources are controlled during unloading and transfer by two fabric filter baghouses (one baghouse for each bin). No information was obtained on the quantity of dust collected or how collected dust is managed. The permit notes that no chemical additives are used to prevent oxidation or decomposition of the media, improve kinetic stability of suspension, or reduce media viscosity. The permit includes the following requirements:

(1) The maximum allowable particulate emissions rate from both bins is 0.6 ton per year.
(2) Visible emissions must not exceed 5 percent opacity.
(3) The maximum transfer rate for magnetite and ferrosilicon cannot exceed 15 tons/hour and 5 tons/hour, respectively.
(4) Annual visible emissions testing is required for each bin (within 15 days of April 15), data must be submitted to DER, and testing must be performed at or near maximum transfer rates.
(5) Proof of compliance with the visible emissions limit allows IMC to assume compliance with the particulate limit. However, DER may require particulate testing, as necessary.
(6) Reasonable precautions must be taken against uncontrolled emissions (FL DER, 1990a).

IMC conducts self-inspections of the emissions sources monthly and DER conducts air permit compliance inspections at least annually.

4.5 Water Use Permit

The State of Florida is divided into five water management districts, which regulate the use of water resources, including wetlands, both during mining and after mining activities have been completed. The Southwest Florida Water Management District issued Water Use Permit No. 203573.3 to IMC for the Four Corner Mine on March 27, 1990 with an expiration date of March 27, 1996. The permit specifically addresses IMC's 11 water supply wells in the deep Floridian aquifer. Four of these wells (GDP-4, GDP-7, GDP-8, and GDP-10) are high volume production wells that continuously provide "clean" water to the amine flotation process (annual average 7.2 MGD) and makeup water to the clay pond water management system during the dry season (annual average 3.54 MGD). GDP-4 is only allowed to be used as a standby well. The remaining seven wells (FCS1 - FCS7) are much lower volume wells that are used to provide pump seal water. Table 6 provides recent pumping rates for March 1991 through February 1992 for each of these wells. Table 6 also provides a comparison of the actual withdrawal rates to the permitted levels for each well. As shown in this Table, IMC has frequently exceeded the daily average withdrawal limits for two of the pump seal water wells and recently began exceeding the daily average limits for the high volume production wells.

The permit also requires IMC to perform quarterly monitoring at well GDP-7 in the Floridian Aquifer for chlorides, sulfates, and TDS. These data were not reviewed by the site visit team. However, IMC conducts monthly monitoring of well GDP-8 in the Floridian aquifer for sulfate, specific conductance, fluoride, gross alpha, chloride, TDS, pH, and nitrate.

Table 6. Ground-water Withdrawal Rates for IMC Four Corners (Source: IMC, 1992e)

Date	Well Flow Data (in MGD)									
	GD-7	**GD-8**	**GD-10**	**FCS-1**	**FCS-3**	**FCS-4**	**FCS-6**	**FCS-7**	**FCS-8**	**TOTAL**
Daily Avg Limit	3.5	3.5	3.5	0.08	0.08	0.08	0.08	0.08	0.08	10.81
Daily Max Limit	7.05	7.05	7.05	0.144	0.144	0.144	0.144	0.144	0.144	15.01
3/91	0.801	3.999	4.529	0.122	0.031	0.083	0.057	0.028	0	9.649
4/91	0.670	4.122	3.266	0.108	0.027	0.076	0.075	0.035	0	8.380
5/91	3.501	3.919	0.046	0.119	0.027	0.079	0.096	0.015	0	7.801
6/91	3.053	3.570	0.001	0.043	0.029	0.090	0.086	0	0	6.871
7/91	1.442	2.993	1.605	0.103	0.036	0.101	0.107	0.006	0	6.393
8/91	3.519	3.827	0	0.202	0.002	0.007	0.105	0.021	0	7.684
9/91	4.578	2.379	2.296	0.226	0.019	0.056	0.150	0.025	0	9.729
10/91	3.348	1.603	4.760	0.216	0.031	0.096	0.116	0.046	0	10.216
11/91	4.387	0.005	4.692	0.247	0.026	0.053	0.075	0.054	0	9.538
12/91	3.473	2.084	2.036	0.211	0.053	0.044	0.032	0.017	0	7.949
1/92	4.295	4.382	3.407	0.187	0.050	0.054	0.044	0.021	0	12.438
2/92	2.102	3.990	3.724	0.185	0.059	0.065	0.190	0.032	0.059	10.406

In addition, the water use permit requires IMC to submit reports to the Southwest Florida Water Management District by April 1, 1991 and August 1, 1995 on water conservation activities at the site. These reports must address both the flotation circuit and water management system (SWFWMD, 1990). The 1991 report was not obtained or reviewed by the EPA site visit team.

4.6 Other Permits

4.6.1 Wastewater Treatment Plant Operating Permit

DER issued Permit No. D041-155739A to IMC on 12/16/88 for operation of the Four Corners sanitary wastewater treatment plant. The permit includes the effluent limits and monitoring requirements presented in Table 7 for the discharge from chlorination to the clay pond system.

Sewage sludge is land applied on-site. No information was obtained on IMC's land application methods or the land application area. The permit provides that the sludge must be sampled annually and tested for: total nitrogen, total phosphorous, total potassium, cadmium, copper, lead, nickel, zinc, pH, and percent total solids (FL DER, 1989a). These data were not obtained.

Effluent and sewage sludge monitoring data must be submitted monthly to DER. In their October 1989 monthly report, IMC reported greater than 2,400 counts of fecal coliform per 100 milliliters of effluent. All other parameters were below permit limits. As a result of the elevated fecal coliform level, DER sent a warning letter to IMC on February 23, 1990 requesting development of a plan of

Table 7. Effluent Limits and Monitoring Requirements for the Discharge from IMC's Wastewater Treatment Plant (Source: FL DER, 1989a)

Parameter	Monitoring Frequency	Effluent Limit
BOD and TSS	Every other month	20 ppm annual avg 30 monthly avg. 45 weekly avg. 60 sample max.
Fecal Coliform	Quarterly	200 counts/100 ml (annual and monthly avg)
Nitrate	Every other month	12 mg/l
Flow	Daily, 5/week	0.0075 MGD
pH	Daily, 5/week	6 - 8.5 s.u.

action (FL DER, 1990b). In response, on March 7, 1990, IMC notified DER that the exceedance was caused by an empty chlorine tank at the time of sampling and that IMC would take action to ensure that this would not happen again (IMC, 1990a).

IMC conducts self-inspections of the wastewater treatment plant five times per week and DER performs compliance inspections at least annually.

4.6.2 Wetlands Permits

Wetlands are located throughout the Four Corners Site in the Little Manatee River, Alderman Creek, Payne Creek, and Horse Creek drainages. Mining operations in wetlands areas are permitted by DER and the U.S. Army Corps of Engineers (hereafter referred to as the Corps). IMC's current operations in wetlands and the applicable permits are listed in Table 8.

4.6.3 Tank Permits

In 1991, DER adopted a tank rule (17-762 F.A.C) requiring secondary containment for all "pollutant" storage tanks, including tanks in IMC's Four Corner reagent storage yard and the shop tanks. All regulated tanks at Four Corners have secondary containment (ammonia tanks, which do not have secondary containment, are specifically exempted from rule requirements). IMC conducts self-inspections of their storage tanks monthly and the State and/or Counties conduct tank inspections at least annually, sometimes semi-annually. In 1991, inspections by Manatee County (October 23,

Table 8. Summary of Wetlands Permits for IMC Four Corners Mine

Permit Number/ Issuing Agency	Date of Issuance/ Expiration Date	Permit Description and Requirements
Corps Permit No. 89IPC-20418	2/26/90 - 2/26/95	This permit covers mining activities in approximately 63.9 acres of wetlands. IMC will subsequently reclaim 90 acres of freshwater marsh and 24.25 acres of bay swamp. Eighty percent plant cover must be achieved. The reclamation must be completed within 2 years of mining cessation.
DER Permit No. 29,41&531404579 Corps Permit No. 199004637	6/16/89 - 6/16/99 12/2/91 - 10/23/96	The DER permit addresses a broad range of mining activity in 527.6 acres of herbaceous wetlands, 68 acres of shrubby wetlands and 45.8 acres of forested wetlands in the headwaters of Alderman Creek, Horse Creek, and Payne Creek. IMC is required to restore 830.9 acres of herbaceous wetlands, 75.6 acres of shrubby wetlands, and 155.6 acres of forested wetlands in these basins, permit identifies specific reclamation activities (including use of mine tailings) for each disturbed area. The Corps permit addresses a subset of the area covered by the DER permit.
DER Permit No. 291638103 Corps Permit No. 89IPC-20393	7/17/89 - 7/17/99 7/17/89 - 9/18/94	Both the DER and Corps permits call for the construction of an elevated pipeline and three road/pipeline crossings over the Little Manatee River, and a dragline walkpath under Payne Creek. As a result of this action, approximately 1 acre of wetlands will be filled. As required by the Hillsborough County, IMC is required to create 1.5 acres of herbaceous wetlands and 1.5 acres of forested wetlands within the affected drainage basins.

Sources: FL DER, 1989b and c; FL DER, 1990b; IMC 1990b and c; U.S. Army, 1986; U.S Army, 1989; U.S. Army 1990; and U.S. Army 1990b.

1991) and Hillsborough County (July 7, 1991) found no violations at Four Corners (FL DER, 1991a and b).

4.6.4 Domestic Water Supply Permit

Well PTW-3 provides an average of 0.06 MGD of potable water to the plant. Potable water is used for domestic needs as well as equipment washing. Construction and operation of well PTW-3 is addressed by Permit No. W4-113203191 issued by the State Department of Health and Rehabilitative

Services (DHRS). The current permit became effective on September 10, 1991 and expires on September 10, 1996. DHRS conducts at least annual inspections at Four Corners. The site visit team did not review this permit or recent DHRS inspection reports. According to IMC personnel, there have been no violations of permit requirements to date.

REFERENCES

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APPENDIX A

1991 GROUNDWATER MONITORING DATA

IMC Fertilizer - Four Corners Mine

Manatee County - Ground Water Sampling Requirements

	Location: MW-1 Parameter	Units	Jan	Feb	Mar	Apr	May 05/17/91	Jun	Jul	Aug	Sep	Oct	Nov 11/15/91	Dec
1	pH	Std. Units					7.2						6.0	
2	Conductivity	Umhos/cm					100						120	
3	Total Nitrogen	mg/l					1.7						0.3	
4	Ammonia Nitrogen	mg/l					0.3						0.2	
5	Nitrate	mg/l					0.18						0.10	
6	Nitrite	mg/l					0.10						0.10	
7	Sulfate	mg/l					4.0						4.0	
8	Sulfite	mg/l											2.00	
9	Total Phosphorus - P	mg/l					0.4						0.1	
10	Total Organic Carbon	mg/l					1.0						0.3	
11	Total Alk as CaCO3	mg/l					1.0							
12	Calcium	mg/l					1.7							
13	Magnesium	mg/l					0.8							
14	Sodium	mg/l					10.4							
15	Potassium	mg/l					0.1							
16	Chloride	mg/l					16.0							
17	Fluoride	mg/l					0.2							
18	Arsenic	mg/l					0.010							
19	Barium	mg/l					0.1							
20	Cadmium	mg/l					0.005							
21	Chromium	mg/l					0.010							
22	Iron	mg/l					2.3							
23	Lead	mg/l					0.010							
24	Mercury	mg/l					0.0005							
25	Selenium	mg/l					0.010							
26	Silver	mg/l					0.010							
27	Color	Co. color					5							
28	Oil and Grease	mg/l					1.0							
29	Surfactants	mg/l					0.05							
30	Gross Alpha	pCi/l					4.0						4.0	
31	Radium 226	pCi/l												
32	Radium 228	pCi/l												

IMC Fertilizer - Four Corners Mine
Manatee County - Ground Water Sampling Requirements

	Location: MW-2 Parameter	Units	Jan	Feb	Mar	Apr	May 05/17/91	Jun	Jul	Aug	Sep	Oct	Nov 11/15/91	Dec
1	pH	Std.Units					4.8						5.6	
2	Conductivity	Umhos/cm					150						160	
3	Total Nitrogen	mg/l					2.3						0.5	
4	Ammonia Nitrogen	mg/l					0.8						0.1	
5	Nitrate	mg/l					0.23						0.10	
6	Nitrite	mg/l					0.10						0.10	
7	Sulfate	mg/l					9.0						21.0	
8	Sulfite	mg/l											2.00	
9	Total Phosphorus - P	mg/l					3.4						3.0	
10	Total Organic Carbon	mg/l					1.0						24.0	
11	Total Alk as CaCO3	mg/l					1.0							
12	Calcium	mg/l					4.0							
13	Magnesium	mg/l					1.0							
14	Sodium	mg/l					12.7							
15	Potassium	mg/l					0.1							
16	Chloride	mg/l					18.0							
17	Fluoride	mg/l					0.6							
18	Arsenic	mg/l					0.010							
19	Barium	mg/l					0.1							
20	Cadmium	mg/l					0.005							
21	Chromium	mg/l					0.010							
22	Iron	mg/l					16.8							
23	Lead	mg/l					0.011							
24	Mercury	mg/l					0.0005							
25	Selenium	mg/l					0.010							
26	Silver	mg/l					0.010							
27	Color	Co. color					20						225	
28	Oil and Grease	mg/l					1.0						11.6	
29	Surfactants	mg/l					0.05						0.05	
30	Gross Alpha	pCi/l					2.0						4.0	
31	Radium 226	pCi/l												
32	Radium 228	pCi/l												

IMC Fertilizer - Four Corners Mine
Manatee County - Ground Water Sampling Requirements

Location: MW-3 Parameter		Units	Jan	Feb	Mar	Apr	May 05/17/91	Jun	Jul	Aug	Sep	Oct	Nov 11/15/91	Dec
1	pH	Std. Units					5.3						5.6	
2	Conductivity	Umhos/cm					170						200	
3	Total Nitrogen	mg/l					1.7						0.7	
4	Ammonia Nitrogen	mg/l					0.3						0.2	
5	Nitrate	mg/l					0.20						0.10	
6	Nitrite	mg/l					0.10						0.10	
7	Sulfate	mg/l					11.0						49.0	
8	Sulfite	mg/l											2.00	
9	Total Phosphorus - P	mg/l					0.7						2.3	
10	Total Organic Carbon	mg/l					4.0						1.1	
11	Total Alk as CaCO3	mg/l					1.0							
12	Calcium	mg/l					4.8							
13	Magnesium	mg/l					3.2							
14	Sodium	mg/l					9.6							
15	Potassium	mg/l					0.1							
16	Chloride	mg/l					11.0							
17	Fluoride	mg/l					0.5							
18	Arsenic	mg/l					0.010							
19	Barium	mg/l					0.1							
20	Cadmium	mg/l					0.005							
21	Chromium	mg/l					0.010							
22	Iron	mg/l					25.6							
23	Lead	mg/l					0.010							
24	Mercury	mg/l					0.0005							
25	Selenium	mg/l					0.010							
26	Silver	mg/l					0.010							
27	Color	Co. color					20							
28	Oil and Grease	mg/l					1.0							
29	Surfactants	mg/l					0.05							
30	Gross Alpha	pCi/l					1.0						2.0	
31	Radium 226	pCi/l												
32	Radium 228	pCi/l												

IMC Fertilizer - Four Corners Mine
Manatee County - Ground Water Sampling Requirements

Location: MW-4 Parameter	Units	Jan	Feb	Mar	Apr	May 05/17/91	Jun	Jul	Aug	Sep	Oct	Nov 11/15/91	Dec
1 pH	Std Units					5.4						4.5	
2 Conductivity	Umhos/cm					70						80	
3 Total Nitrogen	mg/l					1.7						0.4	
4 Ammonia Nitrogen	mg/l					0.2						0.2	
5 Nitrate	mg/l					0.20						0.10	
6 Nitrite	mg/l					0.10						0.10	
7 Sulfate	mg/l					15.0						1.0	
8 Sulfite	mg/l											2.00	
9 Total Phosphorus - P	mg/l					3.6						0.1	
10 Total Organic Carbon	mg/l					1.0						0.1	
11 Total Alk as CaCO3	mg/l					1.0							
12 Calcium	mg/l					0.3							
13 Magnesium	mg/l					0.9							
14 Sodium	mg/l					7.1							
15 Potassium	mg/l					0.1							
16 Chloride	mg/l					15.0							
17 Fluoride	mg/l					0.1							
18 Arsenic	mg/l					0.010							
19 Barium	mg/l					0.1							
20 Cadmium	mg/l					0.005							
21 Chromium	mg/l					0.010							
22 Iron	mg/l					1.8							
23 Lead	mg/l					0.010							
24 Mercury	mg/l					0.0005							
25 Selenium	mg/l					0.010							
26 Silver	mg/l					0.010							
27 Color	Co. color					5							
28 Oil and Grease	mg/l					1.0							
29 Surfactants	mg/l					0.05							
30 Gross Alpha	pCi/l					10.0						9.0	
31 Radium 226	pCi/l											0.3	
32 Radium 228	pCi/l											0.2	

IMC Fertilizer - Four Corners Mine

Manatee County - Ground Water Sampling Requirements

	Location: MW-5 Parameter	Units	Jan	Feb	Mar	Apr	May 06/17/91	Jun	Jul	Aug	Sep	Oct	Nov 11/15/91	Dec
1	pH	Std. Units					5.2						5.0	
2	Conductivity	Umhos/cm					100						100	
3	Total Nitrogen	mg/l					2.4						0 6	
4	Ammonia Nitrogen	mg/l					0.2						0 2	
5	Nitrate	mg/l					0.10						0.10	
6	Nitrite	mg/l					0 10						0 10	
7	Sulfate	mg/l					6.0						7.0	
8	Sulfite	mg/l											2.00	
9	Total Phosphorus - P	mg/l					0 8						0 2	
10	Total Organic Carbon	mg/l					1.0						0.1	
11	Total Alk as CaCO3	mg/l					1.0							
12	Calcium	mg/l					1.3							
13	Magnesium	mg/l					0.7							
14	Sodium	mg/l					11.5							
15	Potassium	mg/l					0.1							
16	Chloride	mg/l					20.0							
17	Fluoride	mg/l					0.1							
18	Arsenic	mg/l					0.010							
19	Barium	mg/l					0.1							
20	Cadmium	mg/l					0.005							
21	Chromium	mg/l					0.010							
22	Iron	mg/l					1.0							
23	Lead	mg/l					0.010							
24	Mercury	mg/l					0.0005							
25	Selenium	mg/l					0.010							
26	Silver	mg/l					0.010							
27	Color	Co. color					25							
28	Oil and Grease	mg/l					1.0							
29	Surfactants	mg/l					0.05							
30	Gross Alpha	pCi/l					3.0						4.0	
31	Radium 226	pCi/l												
32	Radium 228	pCi/l												

APPENDIX B

COMMENTS SUBMITTED BY IMC FERTILIZER, INC., ON DRAFT SITE VISIT REPORT

The following is a list of IMC's changes to the Draft Report "Mine Site Visit: IMC Four Corners Mine" dated September 1992. The Page and Section numbers in the following list correspond to the September, 1992 Draft report. The paragraph numbers were obtained by counting the number of paragraphs under each Section heading, and therefore may not correspond to the paragraph number on a particular page.

Page 1, Section 1.1:	Revise list of participants to reflect recent IMC management changes. Jim Burleson's new title is "Vice President, Florida Operations".
Page 2, Section 1.1:	Revise list of participants to reflect recent IMC management changes. Lee Thurner's new title is "Vice President & General Manager, Florida Minerals Operations".
Page 2, Section 1.1:	Revise list of participants to reflect recent IMC management changes. Gene Armbrister's new title is "Production Services Manager".
Page 2, Section 1.2, paragraph 1:	Inset the words "beneficiation plant" in sentence 1 to better define operations. Add "Polk County" in sentence 2 to the list of counties that the Four Corners Mine is located in.
Page 2, Section 1.2, paragraph 2:	Replace the word "ore" with "product" to more accurately describe IMC's reserves in sentences 1, 2, & 4. Delete the last sentence because operations were not expanded to 7 days as originally scheduled.
Page 5, Section 1.2, paragraph 1:	Replace the words "concentrate product" with "flotation feed" in sentence 3.
Page 5, Section 1.2, paragraph 2:	Replace the words "fine concentrate" with "flotation feed" in sentence 1. Insert the words "through hydraulic sizing" to better describe the flotation process in sentence 1. Insert the words "and to other customers" to indicate that IMC's products are shipped to other customers in addition to the New Wales Plant in sentence 3.
Page 5, Section 1.2, paragraph 3:	Replace the words "disposed of" with "stored" in sentence 2. Add the words "and used as a backfill for reclamation, and in clay pond construction." to better describe the use of tailings in sentence 2.
Page 5, Section 1.3.2, paragraph 1:	Replace the word "mill" with "plant" in sentence 2. Replace the words "Clay Pond F1" with "water recirculation system" in sentence 3. Replace the words "a tributary" with "tributaries" in sentence 4. Insert the words "disturbed mining areas" in sentence 5. Insert the phrase "and the North Fork of the Manatee River" in sentence 6. Replace the word "mill" with

	"plant' in sentence 6. Insert the phrase "and the Army Corps of Engineers" in the last sentence (No.8).
Page 7, Section 1.3.3, paragraph 1:	Insert the words "variable thickness", replace the words "from which" with "the", and replace "ore is mined" with "zone" in sentence 2. This parenthetical phrase should read "the matrix zone".
Page 7, Section 1.3.3, paragraph 2:	Insert the words "where present" in sentence 1. Delete the last two sentences and replace with "The matrix zone sometimes contains two layers of ore separated by a layer of limestone. In this situation, IMC mines both ore layers."
Page 7, Section 1.3.4, paragraph 1:	In sentence 2, Correct the depth of the surficial aquifer system from 20 to 100 feet, replace the word "limestone" with "matrix" in the second parenthetical phrase, and correct the depth of the Floridan aquifer from below 400 to below 200 feet.
Page 10, Section 1.3.4, paragraph 2:	Replace the word "high" with "elevated" in sentence 1.
Page 11, Section 1.3.5, paragraph 1:	Add the sentence "According to IMC personnel, the Gopher tortoise and Indigo snake are identified as Species of Special Concern by the Florida Game and Freshwater Fish Commission and have been observed in the Four Corners Mine area." after the third sentence.
Page 13, Section 2, paragraph 1:	Insert the word "currently" in the first sentence. Replace the words "fine products" with "flotation feed" in sentences 3 & 5. Add "course oversize" in sentence 3 to describe debris material.
Page 13, Section 2.1, paragraph 1:	Replace the words "initial removal" with "site clearing" and add the words "initial removal of" in sentence 4. Insert the word "alternately" and replace the word "mill" with "plant" in sentence 6.
Page 13, Section 2.1, paragraph 2:	Insert the words "are set aside" and replace the word "mill" with "plant" in sentence 5.
Page 13, Section 2.1, paragraph 3:	Indicate the percent solids in the wells as "40-45 %" in sentence 1. Replace the words "clay pond" with "water recirculation" in sentence 2 to better describe the water source.
Page 14, Section 2.1, paragraph 5:	Insert the word "recirculation" in sentence 2. Change the flow rate from 1,800-2,000 to 18,000 to 20,000 gpm in sentence 4. Delete sentence 5, it is not needed.

Page 14, Section 2.1, paragraph 6:	Replace the words "pit cars" with "mine site" and insert the word "washer" in sentence 1. Insert the following after sentence 3, "Ditches and berms are utilized selectively as required to prevent the off-site drainage of slurried ore to adjacent wetlands or stream systems due to gasket failures, pipeline breaks, etc. This precautionary approach is used only when the potential for off-site drainage exists which might impact ecologically sensitive areas." Replace the word "daily" with "hourly" in sentence 7. Insert the words "and distance" and "up to" in sentence 8.
Page 14, Section 2.1, paragraph 7:	Replace the word "reduce" with "even out" in sentence 1.
Page 14, Section 2.1, paragraph 8:	Replace the word "moves" with "walks" in sentence 1. Replace the word "with" with "using fill materials that include" and insert the word "sand" in sentence 2. Insert the words "County and State approved" in sentence 3. Insert the words "a minimum of" in sentence 4.
Page 14, Section 2.2, paragraph 1:	Replace the phrase "The matrix ore pipelines flow" with "Matrix ore is transported through pipelines" in the first sentence.
Page 15, Section 2.2.1, paragraph 1:	Replace the words "fine product" with "flotation feed" in sentence 1.
Page 15, Section 2.2.1, paragraph 2:	Replace the word "at" with "of" in sentence 2.
Page 15, Section 2.2.1, paragraph 3:	Delete the entire paragraph (continues on page 17). This process description is not accurate and should be replaced with the following. "In each train, matrix ore passes over a 20 foot long flat metal screen to separate out material larger than 16 mesh (1 mm). The material larger than 16 mesh goes to a trommel, which is a rotating circular drum with "punch holes" (openings). The first section of each trommel has 3/4 inch openings (to remove less than 3/4 inch material), while the second section has 2.5 inch openings (to remove greater that 3/4 inch and less than 2.5 inch material). The material larger than 2.5 inch from the trommel is classified as debris. Debris is disposed of in the clay ponds or placed in an unlined onsite pile located west of the beneficiation plant (the size of the pile was not determined). Unspecified quantities of debris are subsequently used on-site in reclamation or road construction, or sold for off-site use. Materials that are greater than 3/4 inch and less than 2.5 inches are crushed in a hammer mill and sent back thru the flat metal and trommel screens. The material passing thru the 3/4 inch portion of the trommel passes over an additional flat metal screen to remove some material

passing 16 mesh. The oversize from this passes over three vibrating screens. All three screens are designated to separate the less than 3/4 inch material into less than 16 mesh (flotation feed) and greater than 16 mesh (pebble product) material. The secondary screen is a doubledeck screen, with the upper section used to separate the material larger than 10 mm (3/8 inch) from the pebble product. According to IMC, the greater than 3/8 inch material has a high MgO content. It is classified as debris and managed with the other debris materials described above."

Page 16, Figure 5: Replace this figure with the revised Figure 5 (attached). The original is not correct.

Page 17, Section 2.2.1, paragraph 4: Replace the words "clay pond " with "water recirculation" in sentence 2. Replace the word "washes" with "washers" in sentence 3. Replace the word "wash" with "washer" in sentences 4 and 6.

Page 17, Section 2.2.1, paragraph 5: Delete sentences 3 - 6 and replace with the following. "The pebble product from the finishing screen is conveyed to one of six pebble product bins. Water is drained from these bins and directed to IMC's water recirculation system. After assays are obtained for this pebble, it is conveyed from the bin to an open heavy media storage pile if MgO is greater than 1%, or if MgO is less than 1%, it is conveyed to open product storage piles where it is stored by grade.

The stored product is conveyed from feeders located beneath the open storage piles to railcar loading facilities. Most of the product is sent to IMC's New Wales Chemical Plant for processing, but some is also sold to other customers."

Page 17, Section 2.2.2: Insert a note regarding this section, the Heavy Media Separation Plant, stating **"This following section dealing with IMC's Heavy Media Plant should be treated as confidential"**.

Page 18, Section 2.2.2, paragraph 1: Replace the word "expanded" with "increased" and "acreage" with "reserves" in sentence 4.

Page 19, Section 2.2.2, paragraph 4: Delete this paragraph and replace with the following "The pebble product from the heavy media separation plant is conveyed to one of two pebble product bins After assays are obtained for this heavy media product the material is conveyed from the bin to open product storage piles where it is stockpiled according to grade Most of the product is sent to IMC's New Wales Chemical Plant for processing, but some is sold

	other customers. Water is drained from the pebble product bins and directed to the on-site water recirculation system."
Page 19, Section 2.2.2, paragraph 5:	Insert the word "media", and replace "oversized" with "overflow" in the first sentence.
Page 20, Section 2.2.3, paragraph 1:	Replace the word "density" with "size" in sentence 3. Correct the production numbers contained in sentence 5, (5.5 to 23, 3.9 to 16, 1.1 to 5, and 0.5 to 2).
Page 22, Section 2.2.3, paragraph 3:	Replace the time from "3-4 minutes" to "1 minute" in sentence 3.
Page 22, Section 2.2.3, paragraph 4:	Delete the word "Helical" in sentence 1. Replace the words "The overflow" with "Materials left in the trough" and "underflow" with "port" in sentence 2. Replace the word "agitation" with "supplied to mechanical agitators" in sentence 3.
Page 22, Section 2.2.3, paragraph 5:	Replace the word "float" with "obtain" and add the words "because of its lower feed grade (%BPL)" in sentence 1. Replace the word "Denver" with "Wemco" in sentence 3. Insert the words "Mechanical agitators pull air thru" and delete "are used" in sentence 4. Replace the words "O size" with "oversize" and "U size" with "undersize" in sentence 5. Replace the words "O size" with "oversize" in sentence 6. Replace the words "U size" with "undersize" in sentence 7.
Page 22, Section 2.2.3, paragraph 6:	Replace the word "Denver" with "Wemco" in the first sentence.
Page 22, Section 2.2.3, paragraph 7:	Insert the words "water recirculation" in sentence 7.
Page 22, Section 2.2.3, paragraph 8:	Replace the word "Denver" with "Wemco" in sentences 1 and 2.
Page 23, Section 2.2.3, paragraph 9:	Replace the word "remove" with "dewater" in sentence 3.
Page 23, Section 2.2.3, paragraph 10:	Delete the words "fine concentrate" in sentence 1 Delete sentences 2 and 3 and replace with "After assays are obtained on the amine concentrate, the bin is unloaded thru gates to conveyors which transport to open product storage piles." Replace the word "management" with "recirculation" in sentence 4 Correct the percent moisture contents listed in sentence 5 (change 7 to 8-10, and 10 to 7). Delete the last sentence of the paragraph.

Page 23, Section 2.3, paragraph 1.1:	Insert the word "tank" in sentence 3. Insert the words "with impervious floors" in sentence 4. Replace the word "Statute" with "Chapter" in sentence 5. Replace the word "statute" with "regulations" in sentence 6. Replace the word "No" with "In addition" and insert the word "occasionally" in sentence 8.
Page 23, Section 2.3, paragraph 1.2:	Replace "39,000" with "18,000" and the word "aqueous" with "anhydrous" (two times) in sentence 1. Replace the word "aqueous" with "anhydrous" and visa versa and change "18,000" to "39,000" in sentence 2. Add the following to the subparagraph, "It should be noted that Four Corners has recently made a process change from the use of aqueous ammonia to the use of aqueous soda ash. Ammonia is no longer stored at Four Corners as of October, 1992."
Page 23, Section 2.3, paragraph 1.3:	Insert the sizes of the three diesel tanks (19,800, 19,800, and 204,700) and delete the phrase "the sizes of these tanks were not obtained" in sentence 1. In sentence 2, indicate the size of the diesel tanks that feed the amine process as 19,800 gallons and refer to the tank that feeds the boiler as the "larger tank". Add the sentence "Heating of the aqueous soda ash tanks will be required during winter months." after sentence 3. Insert the words "with impervious floors" in the last sentence.
Page 24, Section 2.3, paragraph 1.4:	Insert the words "with impervious floors" to sentence 2. Insert the following to the end of the subparagraph. "Small spills have occurred in the past which tend to etch the concrete secondary containment. Spills are cleaned up as soon as discovered in accordance with IMC's "Mineral Acid Storage Tank Containment and Integrity Plan" which was prepared in October, 1992 pursuant to Chapter 17-767 - F.A.C."
Page 24, Section 2.3, paragraph 1.5:	Insert the words "with impervious floors" to the last sentence.
Page 24, Section 2.3, paragraph 2:	Replace the word "all" with "most" in sentence 1. Replace "500" with "300-2,000" in sentence 2. Replace the words "This storage area has" with "All regulated tanks are located within" in sentence 3.
Page 24, Section 2.3, paragraph 3:	Replace the words "are located at the site for use" with "would be obtained and used" in the last sentence.
Page 25, Section 3.1, paragraph 1:	Replace the words "dispose of" with "store" in the first sentence. Replace the word "wash" with "washer" in sentences 5 and 8.

Page 25, Section 3.1, paragraph 3:	Insert the word "currently" in sentence 1. Replace the phrase "20 foot thick" with "30 foot wide at top with less than 2 1/2 to 1 side slopes" in sentence 2. Replace the word "clay" with "soil" in sentence 7. Replace the "State Department of Natural Resources" with the "Florida State Department of Environmental Regulation" in sentence 7. Replace the words "previously mined" with "future mining" in sentence 8. Note that this paragraph continues to page 28.
Page 26, Table 2:	Dragline grease: change the quantity to 11,355 gallons/year hazardous and 0 gallons non-hazardous in 1991. Change the off-site TSD to Chemical Conservation Corp. Add the sentence, "Non-hazardous dragline grease would also be sent off-site to Chemical Conservation Corp."
Page 26, Table 2:	Spent Solvents: Indicate the listed quantities as 1991.
Page 26, Table 2:	Laboratory Wastes: Indicate that none were generated in 1991.
Page 28, Section 3.1, paragraph 4:	Replace the words "were not constructed with liners" with "are constructed pursuant to Chapter 17-762, F.A.C. requirements which do not require the use of liners" in sentence 4. Replace the words "reclaimed mining" with "previously mined" in sentence 5. Delete "Hillsborough County" in sentence 8. Insert the phrase "pursuant to Southwest Florida Water Management District rules" in sentence 9. Replace the word "mill" with "plant" in sentence 10.
Page 28, Section 3.1, paragraph 5:	Replace the word "reclaimed" with "decanted" in the first sentence. Replace the words "small unlined pond" with "return water ditch and is recycled in the plant. Excess water flows to a small pond..." in sentence 7. Insert "FDER/" in sentence 8. Add the phrase "and entrainment in the settled clay" to the last sentence.
Page 29, Section 3.1, paragraph 6:	Insert the words "either required or" in sentence 7. Insert the words "the" and "section" in sentence 8.
Page 29, Section 3.2, paragraph 1:	Replace the second "IMC" with "Four Corners", insert the word "dry", and delete the phrase "no information was available to indicate whether these quantities represent wet or dry tailings" in sentence 1. Replace the word "cannot" with "are not suitable" in sentence 2. Add the following after sentence 2, "DNR rules require that tailings must be used on-site in dam construction, and as fill material in reclamation.

Page 29, Section 3.2, paragraph 2: Correct the dimensions of the tailings pile (5000 feet long and 50 feet high) in sentence 4. Correct the height from 100 feet to 50-60 feet in sentence 6. Replace sentence 8 that states "In addition, no information was obtained on the specific methods used to construct either tailings pile." with "Tailings piles are constructed by hydraulically pumping tailings with slurry water. The water is recovered and returned to the mine recirculation system for reuse."

Page 29, Section 3.2, paragraph 3: Delete the words "within 24 months" in sentence 1. Delete the word "However" from sentence 2. Add the sentences, "This tailings pile is specifically being stored for F3 construction. The DNR is aware of this plan and has not indicated any problems." to the end of the paragraph.

Page 30, Section 3.2, paragraph 4: Replace "mg/l" with "ug/l" in sentence 6. Replace sentence 9 that states "Results of the verification testing were not available at the time of the site visit." with "The results of the resampling were below detection limits." Insert the word "naturally" in sentence 11.

Page 30, Section 3.4, paragraph 1: Replace the words "clay pond water management system" with "water recirculation system" in sentence 2. Insert the words "site , active mining and reclamation areas, and clay settling ponds" in sentence 5.

Page 31, Section 3.5, paragraph 1: Replace the words "clay pond" with "water recirculation" in sentence 4.

Page 31, Section 3.6.1, paragraph 1: Insert the phrase "or dedicated above ground waste oil tanks" in the first sentence. Replace the word "Corporation" with "Service" and add "a division of International Petroleum Corporation" in sentence 1. Replace the word "returns" with "resells", add "to them for reuse at", and replace "for" with "among other locations" in sentence 2.

Page 31, Section 3.6.2, paragraph 1: Insert the word "to" in sentence 5.

Page 31, Section 3.6.3, paragraph 1: Insert the word "lot" to sentence 5. Replace "1,355" with "11,355", add the word "approximately", and replace "Waste Management in Ohio" with "Conservation Corporation in Orlando, FL, Valdosta, GA, and Michigan" in sentence 6. Delete sentence 7. Replace with "Waste grease that is determined to be non-hazardous is handled and disposed of in the same manner as the hazardous material. In 1992, 2,585 gallons of non-hazardous and 4,840 gallons of

	hazardous grease had been shipped off site to Chemical Conservation Corporation for proper disposal as of August 20, 1992."
Page 32, Section 3.6.4, paragraph 1:	Replace the word "trichloroethylene" with "tetrachloroethylene" in sentence 2. Insert the words "supplied by" in sentence 3.
Page 32, Section 3.6.4, paragraph 2:	Insert the words "supplied by" in sentence 2.
Page 32, Section 3.6.5, paragraph 1:	Insert the words "If generated, hazardous", "would be", replace "55-gallon" with "lab-pack", and add "for proper disposal" in sentence 1. Replace sentence 2 with "No hazardous laboratory wastes were generated in 1991."
Page 32, Section 3.6.6, paragraph 1:	Insert the words "at approved facilities" in sentence 2.
Page 33, Section 3.6.9, paragraph 1:	Replace the words "clay pond" with "water recirculation/management" in sentence 5. Insert the word "off-site" in sentence 6.
Page 35, Section 4, paragraph 1:	Insert the word "Polk" in sentence 2.
Page 35, Section 4.1.1, paragraph 1:	Insert the word "regional" and replace "District" with "Bay Regional Planning Council" in sentence 4. Replace "Planning District" with "Regional Planning Council" and add the words "coordinates interagency review" in sentence 5.
Page 35, Section 4.1.1, paragraph 2:	Insert the phrase "which is stayed in effect pending the settlement of contested requirements" in the last sentence.
Page 35, Section 4.1.1, paragraph 3:	Replace the words "in the late seventies/early eighties" with "on January 4, 1978" in sentence 1. Replace the words "the remaining" with "an additional" and insert the phrase "as well as the combining of previously issued development orders" in sentence 6. Insert the phrase "and areas adjacent to the mine" to the last sentence of the paragraph on page 36.
Page 36, Section 4.1.1, paragraph 4:	Correct the spelling of "are" in sentence 2.
Page 36, Section 4.1.1, paragraph 5:	Insert the phrase "and are sampled semiannually" in the first sentence. Replace the word "monitoring" with "sampling" and indicate that monitoring is only done at GDP-8 in sentence 2. Replace the word "mill" with "plant" in sentence 3.

Page 36, Section 4.1.1, paragraph 6:	Replace the first two sentences with "Surface water monitoring is required quarterly at locations SW1, SW2, SW3, and SW6 (monthly monitoring was required at SW6 from October, 1991 to September, 1992). In addition, location SW 3 is required to be sampled monthly each year from May to October. Monitoring is required semiannually at locations SW4 and SW5. Monitoring is also performed quarterly at location 302, the Little Manatee River prior to the confluence with Alderman Creek." Replace the word "controlled" with "process impacted surface water" and "surface waters" with "streams" in sentence 4. Delete the words "As a result", insert the words "non process related", and delete the phrase "(including uncontrolled discharges of mine water and runoff)" in sentence 5.
Page 36, Section 4,1,1 paragraph 6.1:	Insert the word "typically" in sentence 1.
Page 38, Section 4.1.1 paragraph 6.2:	Add the sentence "These levels may be attributable to County Mosquito Control Activities." to the end of the paragraph.
Page 38, Section 4.1.1 paragraph 6.3:	Add the sentence "Because radium is virtually insoluble in the pH range from 2-10, it is likely that this finding owes to inadvertently collected solids in the sample." to the end of the paragraph.
Page 38, Section 4.1.1 paragraph 6.4:	Add the sentence "However, it should be pointed out that black water rivers and streams which receive heavy marsh water inflows, frequently exhibit low D.O. levels naturally." to the end of the paragraph.
Page 38, Section 4.1.1, paragraph 7:	Insert the words "and/or ground water levels" in sentence 1. Add the following after sentence 1, "Well GD-6 is an alternate production well. The other listed wells exist for water table monitoring." Replace the word "flow" with "levels" in sentences 3 and 4. Replace the words "flow is" with "levels are" in sentence 5.
Page 38, Section 4.1.1, paragraph 8:	Replace the word "ground" with "surficial", delete the word "permanently", and add the words "due to mining impacts" in sentence 1. Replace sentences 3 and 4 with "Recharge ditches, constructed according to specifications established by site specific modeling work, are used to prevent off-site groundwater level drawdown. These ditches are maintained full of clear water during mining and until reclamation has re-established pre-existing conditions. Sub-surface seepage from these ditches serves to maintain the water table off-site."

Page 38, Section 4.1.1, paragraph 9:	Replace "$10,000" with "$5,700,000" in sentence 2. Replace the word "incident" with "impairment" in the last sentence.
Page 39, Section 4.1.2, paragraph 1:	Insert "F.A.C." to sentence 2. Insert the words "a history of consistent" and "normally" in sentence 9. Insert the words "and associated operations" in the last sentence.
Page 39, Section 4.1.2, paragraph 2:	Insert the words "a minimum of" and replace "are" with "is" in sentence 2.
Page 39, Section 4.1.3, paragraph 3:	Delete the words "for two years" in sentence 2. Delete the words "however", "already", "at least", and "completed", replace the word "completed" with "initiated" and replace "1993" with "1994" in sentence 3.
Page 40, Section 4.2.1, paragraph 2:	Replace the words "approved by" with "designed and supervised by" in sentence 2. Add the following sentence after sentence 2, "All associated sampling activities were conducted by a contract laboratory in the presence of a DER observer." Insert the word "pond" in sentence 3. Add the following sentence after sentence 3, "The study was conducted prior to mining activities at Four Corners." Add to the end of the paragraph, "All Florida phosphate beneficiation facilities employ an acid wash step, and all facilities typically handle their associate wastewater fractions via discharge to clay settling areas."
Page 41, Section 4.2.1 paragraph 4.5:	Replace the word "mill" with "sand" and insert "decant water" in sentence 2.
Page 41, Section 4.2.1, paragraph 5:	Replace the word "mill" with "sand" and insert "decant water" in sentence 2. Insert the following paragraph, "It should be noted that IMC's surface water management systems are currently fished both commercially and for sport. A sustainable commercial harvest of 25,000 pounds of fish per week is currently taken from these areas. A sport fisheries program is currently managed by a private fishing club. The competition for membership is fierce and poaching is a consistent problem due to the prevalence of trophy bass in waters found throughout IMC's respective mines. This tremendous fisheries resource within the active mine recirculation system is indication of the high quality of our mine recirculating water systems. Four Corners is no exception and currently retains a fisheries biologist to control fish in the vicinity of its plant area surface water pumping station. This is required due to the damage that fish have caused to the plant pumps in the past."

Page 42, Section 4.2.2 paragraph 1.2:	Replace the words "withdrawal rates" with "water levels" in sentence 1. Replace the words "measure the potential for drawdown" with "evaluate drawdown impacts" in sentence 4.
Page 42, Section 4.2.3 paragraph 1.3:	Replace the words "flotation process" with "circuits" in sentence 1. Replace "Under IMC's County Development Orders, GDP-7 and" with "As required by the SWFWMD, well" in sentence 2. Replace the word "seal" with "sealing" in sentence 3.
Page 43, Table 4, Notes*:	Change the first sentence to "The permit requires weekly phosphorus analysis for monitoring purposes only." Replace the word "the" with "a" and insert the words "prepare a report that includes" in sentence 2. Replace the word "discharge" with "availability of the report for review".
Page 43, Table 4, Notes ** :	Change to indicate that un-ionized ammonia is calculated using total ammonia, temperature, and pH.
Page 44, Section 4.3.2, paragraph 1:	Replace the word "only" with "solids", and add the word "are" in the sentence 4 parenthetical phrase. Insert the word "to" in the last sentence.
Page 46, Section 4.4, paragraph 1:	Replace the word "all" with "most" in sentence 3.
Page 46, Section 4.4, paragraph 3:	Insert "or Manatee County" in the first sentence.
Page 47, Section 4.5, paragraph 1:	Replace the words "clay pond water management" with ""water recirculation" in sentence 4. Replace the word "seal" with "sealing" in sentences 5 and 8. Replace the word "Planning" with "Water Management" in the last sentence.
Page 47, Section 4.5, paragraph 2:	Insert the sentence "At SWFWMD's request, sampling is performed at GDP-8 instead of GDP-7" after the first sentence.
Page 47, Section 4.5, paragraph 3:	Replace "1991" with "1993" in sentence 1. Add the following after the first sentence, "A recent change in SWFWMD's rules require facilities within a Water Use Conservation Area (WUCA) to submit these reports by July, 1992. Four Corners is located within a WUCA. IMCF was not aware of this updated requirement until September, 1992 (due to address errors in SWFWMD's computer mailing list), and is currently in the process of preparing the required report."
Page 47, Section 4.6.1, paragraph 1:	Replace the words "clay pond" with "mine water recirculation" in sentence 2.

Page 47, Section 4.6.1, paragraph 2:	Replace the words "land applied on-site" with "stabilized and land applied off-site be a qualified licensed contractor."
Page 49, Section 4.6.1, paragraph 3:	Delete the words "and sewage sludge" in the first sentence. Add "Sewage sludge test data are submitted annually."
Page 51, Section 4.6.2, paragraph 2:	Delete the last sentence that states "No further information was found on any subsequent actions taken by IMC or the Corps." Add the following, "This matter has been settled with the Corps through negotiations finalized in October, 1992. The disturbed areas were permitted through Hillsborough County at the time of mining and have since been permitted through the Corps."
Page 51, Section 4.6.3, paragraph 1:	Insert the words "with impervious floors" in sentence 2.
Page 51, Section 4.7, paragraph 1:	Add the following sentences to the end of the paragraph, "Petroleum spills of less than 25 gallons do not require regulatory notifications. This reporting exception is stipulated in Chapter 17-762, F.A.C. - DER rules."

APPENDIX C

EPA RESPONSE TO COMMENTS SUBMITTED BY IMC FERTILIZER, INC., ON DRAFT SITE VISIT REPORT

EPA Response to Comments Submitted by
IMC Fertilizer, Inc.,
on Draft Site Visit Report

EPA has revised the report to incorporate all of the comments and suggestions made by IMC. In some cases, EPA made minor changes to wording suggested by IMC in order to attribute the changes to IMC or to enhance clarity. In response to IMC's comment and suggested language for the heavy media section, EPA deleted much of the process description; this obviated the need to label the section as "confidential".

MINE SITE VISIT:

CYPRUS THOMPSON CREEK

June 1992

U.S. Environmental Protection Agency
Office of Solid Waste
Special Waste Branch
401 M Street, SW
Washington, DC 20460

DISCLAIMER

This document was prepared by the U.S. Environmental Protection Agency (EPA). The mention of company or product names is not to be considered an endorsement by the U.S. Government or by EPA.

This section of the Technical Resource Document consists of a report on a site visit conducted by EPA to Cyprus Minerals Corporation's Thompson Creek Molybdenum Mine near Challis, Idaho during 1991. A draft of this report was provided to representatives of Cyprus Minerals Corporation, the U.S. Forest Service, and the U.S. Bureau of Land Management. Cyprus Minerals Corporation provided comments, which are presented in Appendix B. The Forest Service and the Bureau of Land Management did not provide comments. EPA's responses to Cyprus' comments are summarized in Appendix C.

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INTRODUCTION

Background

EPA has initiated several information gathering activities to characterize mining wastes and waste management practices. As part of these ongoing efforts, EPA is gathering data by conducting visits to mine sites to study waste generation and management practices. As one of several site visits, EPA visited Cyprus Minerals Corporation's Thompson Creek Mine near Challis, Idaho on August 28 and 29, 1991. This report discusses the extraction and beneficiation activities at the site.

The sites to be visited were selected by EPA to represent both an array of mining industry sectors and different regional geographies. All site visits are conducted pursuant to the Resource Conservation and Recovery Act (RCRA), Sections 3001 and 3007 information collection authorities. For those sites located on Federal land, EPA has invited representatives of the appropriate land management agency (U.S. Forest Service and Bureau of Land Management). State agency representatives and EPA regional personnel also have been invited to participate in each site visit.

For each site, EPA has collected waste generation and management information using a three-step approach: (1) contacting the facility by telephone to obtain initial information, (2) contacting state regulatory agencies by telephone to obtain additional information, and (3) conducting the actual site visit. Information collected prior to each visit is then reviewed and confirmed at the site.

The site visit reports describe mine operations, mine waste generation and management practices, and the regulatory status on a site-specific basis; the information is based on information gathered from State and Federal agency files as well as observations made during the site visit. In preparing this report, EPA collected information from a variety of sources, including the Cyprus Thompson Creek facility, the Idaho Department of Lands (IDL), the U.S. Forest Service (USFS), and other published information. The following individuals participated in the Cyprus Thompson Creek site visit on August 28 and 29, 1991.

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Les Darling, Director, Environmental Affairs (303) 643-5325

<u>Cyprus Copper Company</u>
Jamie Sturgess, Manager, Environmental Affairs (303) 643-5782

<u>Cyprus Thompson Creek</u>
Bert Doughty, Supervisor, Environmental Affairs (208) 838-2200
Don Hilleary, Chief Engineer
Jim Kopp, Operations Supervisor

Marvin Harmer, Chief Metallurgist
Turk Terrill, Mine Superintendent

U.S. EPA
Van Housman, Chemical Engineer (703) 308-8419

Science Applications International Corporation
Ingrid Rosencrantz, Environmental Scientist (703) 734-2508
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U.S. Forest Service
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U.S. Bureau of Land Management
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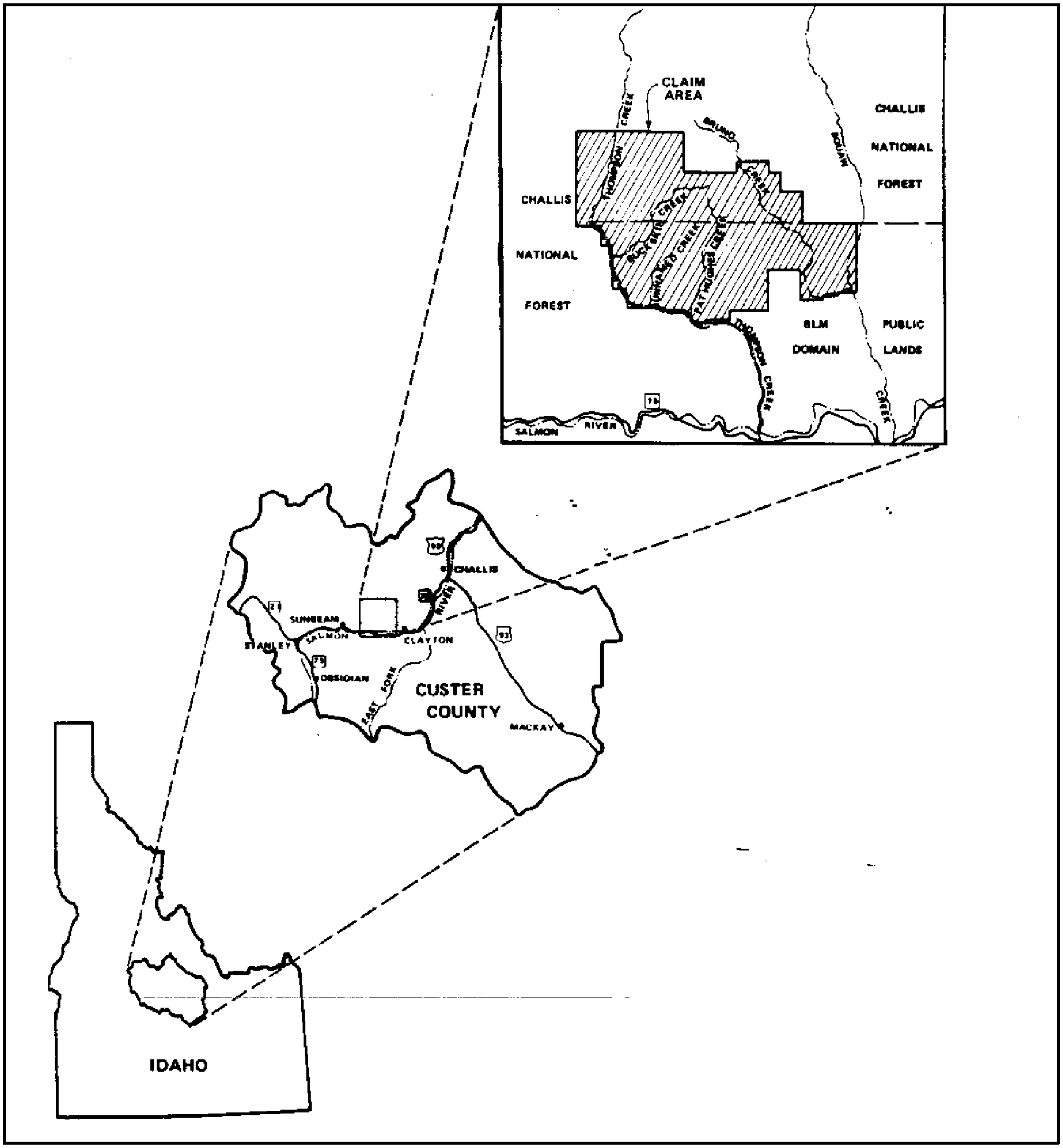
General Facility Description

Cyprus Minerals Corporation (Cyprus) mines molybdenite (molybdenum disulfide, MoS_2) from an open pit mine near Challis in central Idaho (see Figure 1). The mine site is located in an area of high mountain ranges, and numerous lakes, streams, and valleys near the Salmon River and its tributaries, which flow through the lower elevations. Elevations range from 5,500 feet at the Salmon River to 9,487 feet near the mine site. The active facility is located on nearly 1,935 acres of mixed ownership including: private lands (521 acres), Bureau of Land Management (BLM) administered Federal land (781 acres), and USFS administered Federal land (633 acres of the Challis National Forest). Cyprus also controls a mineral claim block of about 16,000 acres around the Thompson Creek Mine.

The mine is located in Custer County, approximately 35 miles southwest of Challis, the county seat of Custer County. The nearest town is Clayton, which has a population of 42 and is approximately 12 miles from the site. Access to the mine site is from State Highway 75, along an unpaved county road that generally parallels Squaw Creek. The road crosses Squaw Creek, first west to east about 1.5 miles from its intersection with State Highway 75 and from east to west about 4 miles from the intersection.

Figure 1: Location of Thompson Creek Molybdenum Project
(Source: USFS 1980)



Several historic mining operations are located in the vicinity of the Cyprus Thompson Creek site. An old tungsten mine is buried under the Buckskin waste rock dump. The remains of the mill associated with this mine are located along Thompson Creek downstream of the site (see later discussion of ongoing joint Cyprus/USFS remediation activities on tailings generated by the mill). A small gold mine (circa 1929) was located north of the tailings pond (not on Cyprus property). Finally, an old silver/zinc mine (1930s-1940s) was operated in the area (also not on the Cyprus property).

Cyprus staked its first mineral claims at Thompson Creek in 1967. During 1974 and 1975, a preliminary feasibility study for a large open pit and concentrator was prepared. Based on the results of this study, Cyprus Minerals initiated additional technical studies to better define the potential project. On May 25, 1979, Cyprus Minerals submitted its Notice of Intent to Operate and Initial Plan of Operations to the Challis National Forest. In 1981, mining operations began and the first concentrates were produced in 1983.

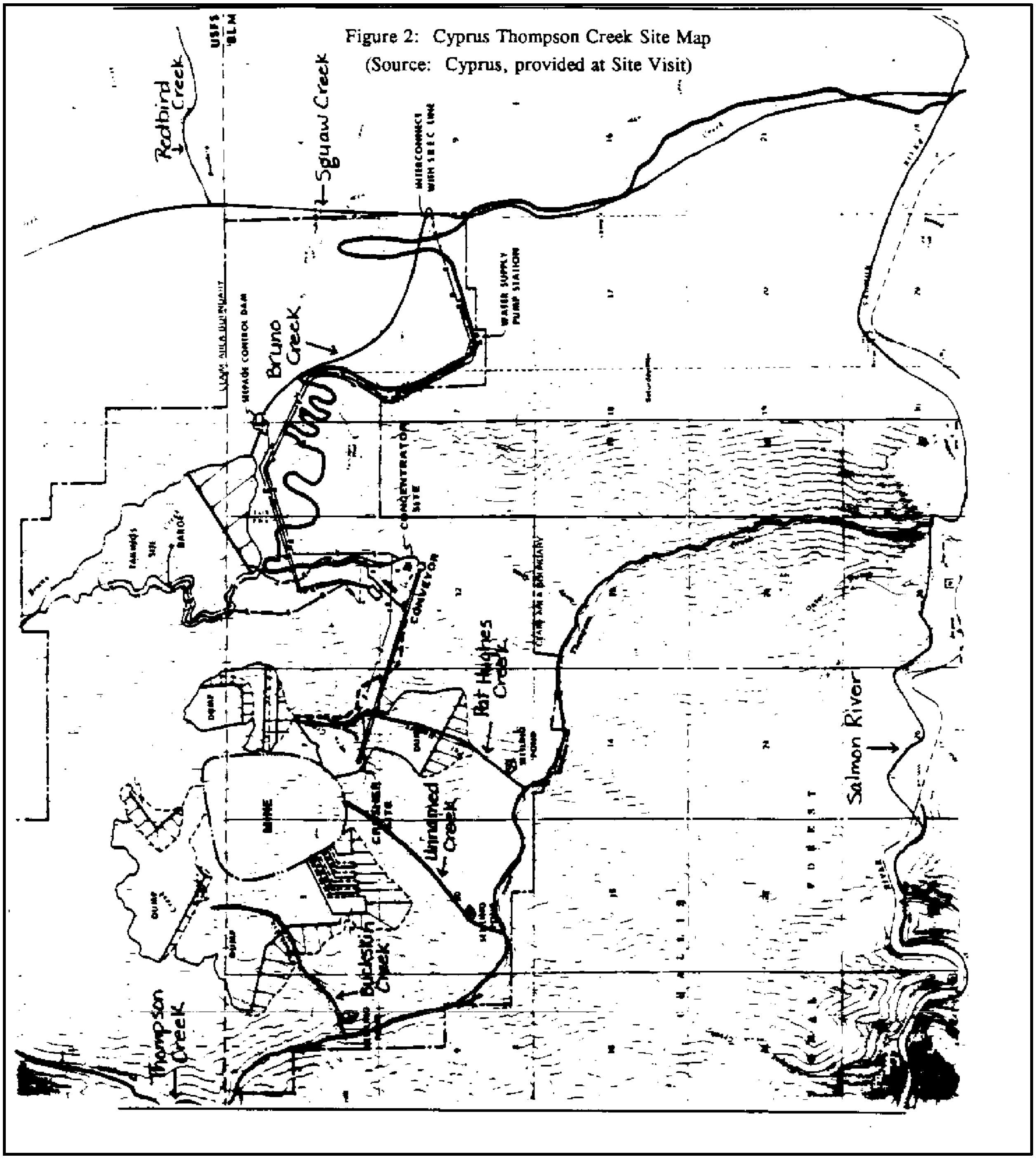
The Cyprus Thompson Creek Mine site currently consists of (1) an open pit mine and two associated waste rock dumps; (2) a primary in-pit crusher; (3) a mill that includes grinding and concentration by flotation, and (4) a tailings impoundment. These units, as well as various support and maintenance facilities, are shown in Figure 2. During the site visit, the facility was only conducting stripping operations (i.e., removing overburden and waste rock to access the orebody). As a result, the mill was temporarily inactive.

Environmental Setting

Climate. The Thompson Creek Project is located in a fairly rugged mountainous region of central Idaho. This region is west of the Continental Divide and approximately 525 miles east of the Pacific Ocean. The prevailing air flow over the local area near the project is from the west; however, local topographic features considerably influence surface wind velocity and direction. The canyons and ridges probably cause channeling and lee eddies. The maximum sustained wind velocity recorded by an on-site weather station (in operation since 1972) has been 15 mph. Wind gusts have not been measured; however, strong gusts estimated to be in the range of 40-60 mph have occurred. On-site wind direction tends to be north-south approximately 50 percent of the time and variable the remainder of the time. The average annual precipitation at the project site is estimated to be 10 to 20 inches or greater, depending on the altitude. The maximum and minimum recorded temperatures have been 93°F and -25°F, respectively (USFS 1980).

Surface Water. The mine site is located in the drainage systems of Bruno Creek, Thompson Creek, Squaw Creek, Buckskin Creek, and Pat Hughes Creek, all of which are tributaries of the Salmon River. The waste rock dumps overlie Buckskin Creek and Pat Hughes Creek, which flow into Thompson Creek. Cyprus' tailings impoundment overlies Bruno Creek, which can be diverted

Figure 2: Cyprus Thompson Creek Site Map
(Source: Cyprus, provided at Site Visit)



around the impoundment, as necessary. Bruno Creek feeds Squaw Creek. Both Thompson Creek and Squaw Creek flow directly into the Salmon River, approximately five miles from the site. All of these waterbodies are classified by the State as Class II waters and must be protected for the following general uses: (1) agricultural water supply, (2) cold water biota, (3) salmonid spawning, and (4) secondary contact recreation (State of Idaho 1989). In addition, the Salmon River downstream of the facility is further designated as a domestic water supply and for primary contact recreation. The Salmon River south of the mine site is designated as a Special Resource Water, because of salmonid spawning grounds. According to Cyprus personnel, surface water in the vicinity of the facility is only used as a drinking water supply for animals on nearby ranches. In addition, Cyprus obtains makeup water from the Salmon River for use in the mill (when the mill is operating).

Geology. The bedrock geology of the region is a sequence of Paleozoic sedimentary rocks intruded by Cretaceous igneous rocks known as the Idaho batholith. A large portion of the area is overlain by a series of Tertiary volcanic rocks called the Challis volcanics (USFS 1980).

The Paleozoic sedimentary rocks range in age from the Cambrian to Pennsylvanian geologic periods, and vary in sequences of argillite, quartzite, limestone, dolomite, and shale, some several thousand feet thick. The primary sedimentary rocks from the oldest to youngest are the Saturday Mountain, Copper Basin, and Wood River formations. These sedimentary rocks have been intruded by a biotite granodiorite-quartz monzonite stock known as the Idaho batholith. In some areas of intrusion, contact metamorphism has occurred, creating silicification and hornfelsing of the argillite. Intrusive rocks can be exposed on the ground surface at the mine site but are generally overlain with volcanics at the site (USFS 1980).

Complex folding and faulting exists in the Paleozoic sedimentary units of the claim area. A thrust fault is thought to exist near Bruno Creek. The thrust plane is at a low angle and the effect has been to thrust younger Mississippian rocks on top of the older Ordovician sequence at this location. A variety of other faults including bedding plane slippage have been noted in the Bruno Creek area. The age of folding and faulting in the project area remains uncertain. The deformation clearly took place before the extrusion of the Challis volcanics (38-49 million years) and may have been completed by stresses related to the intrusion of the nearby plutonic rocks during mid-Cretaceous time (85-100 million years). There is no known evidence to indicate that faults in this area have been recently active (no specific timeframes were provided in the reference) (USFS 1980).

The site is located in the USGS Class II Intermountain Seismic Zone. In the vicinity of the mine site, there were a total of 56 earthquakes from 1935 to 1980 with Richter magnitudes of 4.0 or greater. The majority of earthquake epicenters in the study area are located about 12 miles west of the project area. This region of seismic activity is referred to as the Sunbeam District. There are, however, no major faults within 12 miles of the project area. Therefore, it is unlikely that a fault structure exists in the project vicinity that could produce an earthquake event exceeding a 7.6 magnitude (USFS 1980).

Of particular note, in 1983, a major earthquake (7.3 on the Richter scale) was centered approximately 40 miles from the mine site. This earthquake caused property damage and two fatalities in Challis. Cyprus personnel who were present at the site at that time noted severe tremors in the vicinity of the tailings impoundment.

Hydrogeology. The occurrence and distribution of ground water within the project area is determined by the complex hydrogeology of the region. The area is mountainous with steep slopes along drainages. The primary sources of ground water include: (1) infiltration of runoff into surface soils, (2) stream channel underflow within alluvial deposits, and (3) water in fracture and fault zones of bedrock formations.

Relatively small quantities of ground water are contained within the surface soils and decomposed bedrock comprising the soil mantle. Alluvial deposits occur in stream channel bottoms; ground water in the alluvium is in direct connection with surface water within the stream courses. The major stream channels in the project area are Squaw and Thompson Creeks, which are tributaries of the Salmon River. The direction of surface water flow is generally to the south. The mine site is characterized by narrow, steep-sided and v-shaped valleys. Based on existing information, alluvial deposits are probably less than 100 feet in thickness and 300 feet in width along the stream courses (USFS 1980). According to Cyprus, an alluvial aquifer is found at depths ranging from 0 to 20 feet below ground in the vicinity of the creekbeds.

Argillaceous sediments of the Copper Basin and Saturday Mountain formations are the primary sedimentary bedrock aquifers in the mine site area. The lithology of these units is largely argillite, bedded limestones, and dolomite. The well-consolidated, and in some locations metamorphosed, nature of these rocks creates low porosity, preventing the production of significant amounts of ground water from pore spaces. However, these formations are extremely folded and at some locations are nearly vertical (USFS 1980).

In general, there is a continuous supply of baseflow to the streams throughout the year from the alluvial and bedrock aquifers. Larger quantities of baseflow occur during periods of high precipitation and snow melt; however, this contributes a smaller percentage to total surface water runoff. Baseflow may constitute 90 percent or more of the total stream flow during dry periods of the year (USFS 1980).

The shallow alluvial aquifer is used for livestock drinking water on nearby ranches. The uppermost bedrock aquifer is encountered at a depth of 150 feet. Cyprus has two potable water wells on the site at a depth of 250 feet. These wells are approximately one mile apart and produce 15 and 20-25 gallons per minute (gpm), respectively. According to Cyprus personnel, there are no other uses of the aquifers in the immediate vicinity of the site. Other than the on-site wells, the nearest drinking water well is at the Red Bird Mine three miles from the mine site.

Air Quality. The mine site is located in an undeveloped area in Custer County, Idaho. The air quality at the site is characterized as excellent because of the remoteness of the area and the absence of sources of pollutant emissions. There are no ambient air quality monitoring stations in the vicinity of the mine site. However, the baseline air quality was expected to be typical of a remote area. The primary pollutant was expected to be total suspended particulates because of mining operations. Hydrocarbons, carbon monoxide, and nitrogen oxides would not be expected to be appreciable because of the lack of significant motor vehicle traffic (USFS 1980).

FACILITY OPERATIONS

Cyprus staked its first mineral claims at Thompson Creek in 1967. Prior to the commencement of mining operations, Cyprus drilled more than 160,000 feet of exploration holes from surface and underground locations and outlined a significant molybdenum deposit containing at least 200 million tons of ore averaging 0.18 percent molybdenite (MoS_2) (USFS 1980). Mining began in 1981 and the first concentrates were produced from the mill in 1983. In 1986, the mill was shutdown for one month. The mill was also inactive from October 1987 to March 1988, when only minor stripping operations (i.e., removal of overburden and waste rock) were underway. At the time of the site visit, the mill was inactive, although waste rock and overburden stripping operations in the mine continued to access additional ore. (According to Cyprus, milling operations resumed after the site visit in November 1991.) Assuming continuous operation of the mine and mill, the operation was originally planned to be active for 20 years. With the periods of inactivity discussed above, the operation has approximately 13 years from the date of the site visit of operation remaining.

Mining Operations

Along a ridge in the Salmon Mountains, Cyprus operates a large open pit where molybdenite (MoS_2) ore is mined from quartz monzonite. The top of the open pit is at an elevation of approximately 8,400 feet above sea level with the orebody encountered at 7,300-7,400 feet (or at a depth of approximately 1,000 feet). The pit currently extends down to the 7,050 foot level, with plans to expand down to an elevation of 6,400 feet (i.e., to a depth of 2,000 feet). The mine operates continuously 24 hours per day, seven days per week, 365 days per year.

When mining began in 1981, approximately 130 million tons of overburden were initially removed as "preproduction stripping" concurrent with the construction of project facilities. Most of the overburden was placed in the two waste rock dumps (the Buckskin and Pat Hughes dumps) located adjacent to the pit, although some overburden was used as fill for construction purposes (USFS 1980).

Mining operations generally follow those described in the 1982 Plan of Operations approved by USFS. The ore is accessed by drilling and blasting along 50 foot benches. Drilling is accomplished using Marian electric drills and a typical blast pattern consists of between 30-40 holes. ANFO, a blend of ammonium nitrate and diesel fuel, is used as the blasting agent (10,000 tons of ANFO are used annually). Waste oil has previously been substituted for diesel fuel in the ANFO mixture, however, it is not being used pending MSHA approval. On average, one blast occurs every other day. After fragmentation, ore and waste rock are excavated using P & H electric shovels. Cyprus has two 28 cubic yard shovels, one 17 cubic yard shovel, and two 15 cubic yard shovels. The shovels place the ore and waste rock in 170 ton diesel haul trucks. The ore is then transported to the primary crusher, while the waste rock goes to either the Buckskin or Pat Hughes dump. Information on the specific cutoff grade between waste rock and ore was not obtained.

In 1990, approximately 16.2 million cubic yards of waste rock and 4.5 million tons or ore were generated, a stripping ratio of 4:1 (waste rock:ore). However, over the life of the mine, Cyprus personnel indicated that the average stripping ratio would be closer to 2:1. At the time of the site visit, Cyprus was stripping away waste rock to access additional areas of the orebody and the mill was inactive. As a result, only waste rock was being generated and disposed of.

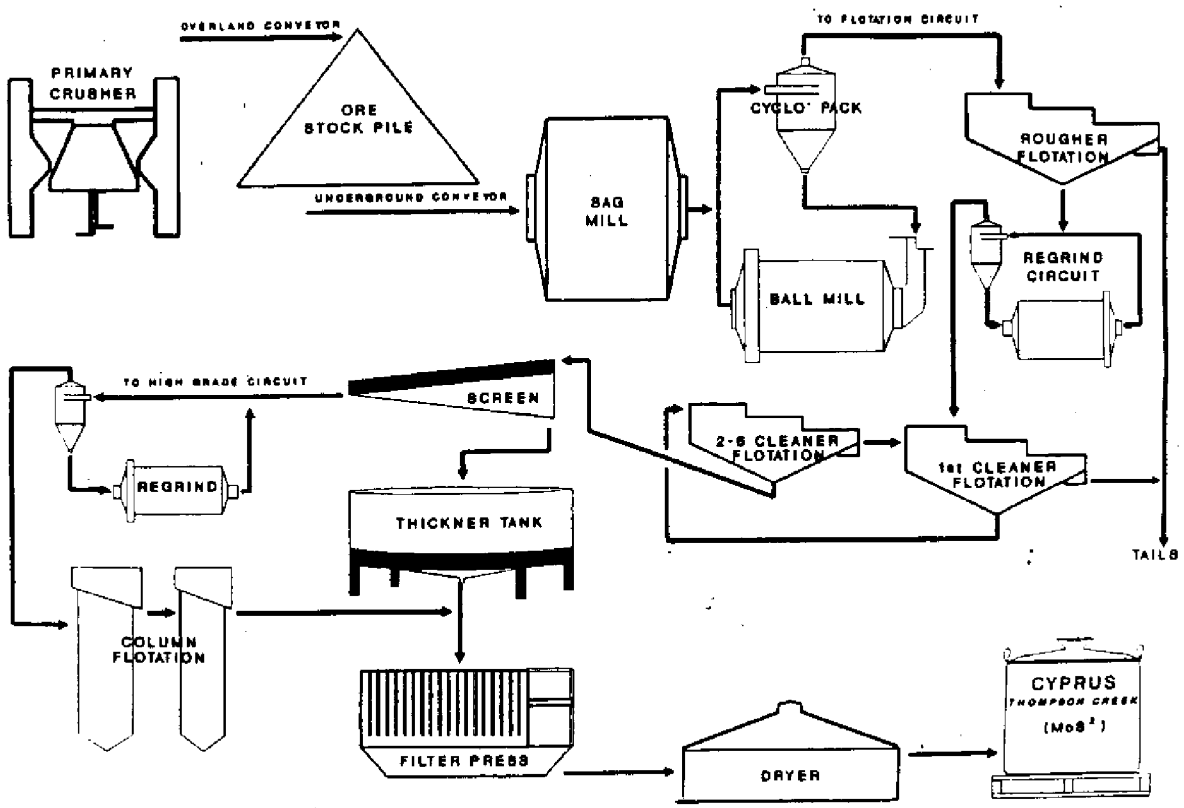
Milling Operations

A flow diagram of the milling operations at the site is presented in Figure 3. Mined ore is first sent through a 60 x 89 inch gyratory primary crusher located near the mine, where the ore is crushed to minus 8 inches. The gyratory crusher is equipped with a baghouse for particulate emissions control.

From the primary crusher, the ore is transported by conveyor to a surge pile, located near the mill. The conveyor belt is 2,350 feet long and 60 inches wide. The surge pile contains approximately 300,000 tons of ore. However, Cyprus personnel indicated that only 75,000 tons of ore comprise the "active" portion of the pile. The remainder of the ore in the pile is stored semi-permanently for beneficiation if conveyor problems disrupt the feed to the pile. Ore is removed from the surge pile by 8 feeders underneath the pile. The ore is then transported to two parallel grinding circuits. In each circuit, the ore initially enters a 32 foot diameter semi-autogenous grinding (SAG) mill. The outputs from the SAG mills are passed over 0.75 inch screens and flow into cyclone separators. The overflows from the cyclones go directly to flotation, while the underflows go to 16.5 foot by 26 foot ball mills for further grinding prior to flotation. Grinding is a wet process and burned lime is added for pH control. In 1990, Cyprus used an average of 0.132 pounds of lime per ton of ore. The grinding circuit product is 35 percent solids.

In the flotation process, the slurry from the grinding circuits is passed into flotation cells (or tanks). Flotation is accomplished by bubbling air through the slurry in a series of mechanically agitated cells. Fuel oil is used as the collector, alcohol is used as the frother, and a Nokes reagent (P_2S_5 and NaOH) is added in the cleaner stages to depress copper and lead. In 1990, Cyprus used an average of 0.117 pounds of fuel oil, 0.025 pounds of alcohol, and 0.011 pounds of Nokes reagent per ton of ore. No cyanide is used in the process. The flotation operation is conducted in several stages (rougher and cleaner). The first rougher stage produces concentrate overflow (approximately 10 percent molybdenum disulfide) that is then reground in a small ball mill. The underflow from the first rougher stage goes directly to the tailings impoundment by pipeline. The effluent from the small ball mill is then subjected to ten additional stages of flotation, called "cleaner" stages, to progressively

Figure 3: Cyprus Thompson Creek Mill Flow Chart



(Source: Cyprus, provided during site visit) upgrade the concentrate. The overflow from each successive cleaner stage flows to the next cleaner stage. The underflow from the first of the ten cleaner stages (identified by Cyprus as "scavenger" flotation) goes directly to the tailings impoundment. The underflows from subsequent cleaner stages are returned to first cleaner/scavenger stage. The final cleaner cells produce crystalline MoS_2 concentrate. The MoS_2 crystals are passed over a screen. The smaller, lower grade particles from cleaner flotation are sent to a holoflyte dryer/"screw conveyor." Heated oil is circulated through the hollow sections of the screw conveyor to provide enough heat to evaporate additional water in the concentrate. The dried concentrate (identified by Cyprus as technical grade concentrate) is 54 to 59 percent molybdenum disulfide with less than 9.0 percent water and 1.0 percent fuel oil. The technical grade concentrate is packaged in 4,000 pound bags and sent by truck to deep water ports or the Cyprus Sierrita facility in Arizona for roasting.

Depending on market conditions, the larger, higher grade particles (those that do not pass through the screen) are either sent to drying and packaging or to Cyprus' High Performance Molybdenum (HPM) plant. In the HPM plant, the crystals are reground and then subjected to either one or two stages of column flotation, again depending upon market requirements. The concentrate, which is 15-18 percent water, is then passed through a filter plate. The filtrate is recycled as process water. The filtered crystals are sent to a separate holoflyte dryer/screw conveyor in the HPM plant.

The dried HPM concentrate is a very fine powder, about 59 percent molybdenum disulfide with less than one percent water and 0.1 percent fuel oil. The HPM concentrate is packaged in 55-gallon drums or other suitable containers for shipment off-site as product.

WASTE AND MATERIALS MANAGEMENT

Types of Waste and Materials

This section describes several of the wastes and materials that are generated and/or managed at the Cyprus Thompson Creek facility and the means by which they are managed. It should be noted that a variety of wastes and other materials are generated and managed by molybdenum extraction and beneficiation operations.

Some, such as waste rock and tailings, are generally considered to be wastes and are managed as such, typically in on-site management units. Even these materials, however, may be used for various purposes (either on- or off-site) in lieu of disposal. Some quantities of tailings, for example, may be used as construction or foundation materials at times during a mine's life. Many other materials that are generated and/or used at mine sites may only occasionally or periodically be managed as wastes. Some materials are not considered wastes at all until a particular time in their life cycles.

The issue of whether a particular material is a waste clearly depends on the specific circumstances surrounding its generation and management at the time. In addition, some materials that are wastes within the plain meaning of the word are not "solid wastes" as defined under RCRA and thus are not subject to regulation under RCRA. These include, for example, mine water or process wastewater that is discharged pursuant to an NPDES permit. It is emphasized that any questions as to whether a particular material is a waste at a given time should be directed to the appropriate EPA Regional office.

The following subsections describe several of the more important wastes (as defined under RCRA or otherwise) and nonwastes alike, since either can have important implications for environmental performance of a facility. Wastes and materials generated at Cyprus Thompson Creek include waste rock, tailings, mine water, and other wastes and materials (e.g., waste oil, grease, spent solvents, sanitary waste, capacitors, and haul road runoff).

Waste Rock

As noted in the previous chapter, approximately 16.2 million cubic yards of waste rock were generated in 1990. During the site visit, when only accelerated stripping operations were underway, Cyprus was generating approximately 2 million cubic yards of waste rock per month. Four types of materials are found in the waste rock. These materials include: metasediment, quartz monzonite, challis volcanics, and clayey rock (i.e., decomposed volcanics). Waste rock is initially classified and segregated by type of material. Types of waste rock are then separately end-dumped in the two on-site waste rock dumps, the Buckskin and Pat Hughes waste dumps (named to correspond with the drainages in which they are located). Cyprus currently determines where to place specific types of materials based on stability requirements (see discussion of stability issues below).

The Buckskin dump is considerably larger than the Pat Hughes dump and designed to contain 480 million tons of waste material. No information was obtained for the Buckskin dump on the annual quantity of waste rock disposed or the total amount of material currently contained in the dump. The slope of the Buckskin dump is at the angle of repose of the waste rock (slopes range from 33^{o} to 38^{o}). The dump at the time of the site visit was 1,300 feet high extending from an elevation of 8,100 feet to 6,800 feet. Two 300-foot-wide benches, which enhance stability, are currently situated at the 7,600 foot and 7,900 foot levels, respectively. The maximum depth of material in the dump is planned to be approximately 950 feet (Golder Associates 1980).

The Pat Hughes dump is designed to contain approximately 130 million tons of waste material. No information was obtained for the Pat Hughes dump on the annual quantity of waste rock disposed or the total amount of material currently contained in the dump. The waste material has been placed in the dump progressively from north to south. The slope of the Pat Hughes dump is also at the angle of repose of the waste rock with slopes ranging from 33^{o} to 38^{o}. The dump at the time of the site visit was 800 feet high and will eventually extend from 7,150 to the toe of the dump at elevation 6,300. The maximum depth of material in the dump is planned to be 700 feet (Golder Associates 1980).

In September 1984, the first documented failure of waste rock in the Buckskin dump occurred. The failure involved several hundred feet of slope crest, with a 100 foot wide section sliding up to 100 feet. It was reported that a reason for the failure was excessive dumping of volcanic rock (>100 million cubic yards) between August and mid-September of 1984. Following the dump failure, relatively little waste material was disposed of between October 1984 and June 1986. However, in July 1986, dumping commenced from the 7,750 level. As a result of the continued dumping, the dump again failed on November 11, 1986. A section approximately 80 to 90 feet high along a crest length of 800 to 900 feet failed. Cyprus soon started dumping again but at a different location in the dump. A third large failure occurred on August 27, 1988, which raised serious concerns of the dump's stability (Piteau Associates 1989).

To address these stability problems, Cyprus modified its waste rock dumping practices and began segregating materials. The facility now tries to place the quartz monzonite (intrusive rock) on the outer surfaces of the dumps to "armor" the faces and increase stability.

Facility personnel indicated that the intrusive rocks have high sulfur content (up to 1.13 percent). Therefore, since 1990, Cyprus has been conducting a study of the potential for acid rock drainage (ARD) generation from the waste rock and tailings. (For a more complete discussion of ARD, see U.S. EPA Office of Solid Waste, 1994, *Acid Mine Drainage Prediction*.) According to USFS personnel, the Thompson Creek mine is the only active mine in the area that has had to address ARD rock generation. Static testing has been performed on eight intrusive rock samples collected from the lower benches of the pit. For each sample, Cyprus determined the net neutralization potential (NNP) and the neutralization potential/acid generation potential (NP/AP) ratio. The NNP represents the neutralization potential (the tons of calcium carbonate required to neutralize 1,000 tons of waste rock) minus acid generation potential (calculated based on the total sulfur content). Analyses of the eight samples showed an average NNP of 0.053 with values ranging from -6.26 to 7.31. The NP/AP ratio for these samples was 1.88:1 with values ranging from 0.63:1 to 6.85:1. According to Cyprus personnel, waste rock with an NP/AP ratio in excess of 3:1 may be considered non-acid generating (Steffen Robertson & Kirsten 1991a). According to USFS personnel, a NP/AP ratio of at least 5:1 should be required before a material is determined to be non-acid forming. Thirteen samples of intrusive rock collected from the upper benches of the pit showed an average NNP of 4.93 with values ranging from -0.65 to 11.35, and an average NP/AP ratio of 3.80:1 with values ranging from 0.90:1 to 15.92:1. The difference between intrusive rock samples collected from the upper and lower benches is believed to be caused by a relatively predictable pattern of mineralization and alteration zoning about the ore body. According to Cyprus, the metasedimentary and volcanic rocks do not appear to be sources of ARD. Cyprus has performed static testing on the metasedimentary rock and found average NNP and NP/AP values of 24.95 and 3.11:1, respectively (Steffen Robertson & Kirsten 1991a). It should be noted that, while the metasedimentary rocks are considered non-acid forming by Cyprus (NP/AP greater than 3:1), the average

NP/AP ratio is less than the minimum ratio suggested by the USFS (5:1). According to Cyprus, seventy-six samples of the volcanic rocks have also been analyzed for acid base accounting. All samples showed NP/AP ratios of greater than 31:1.

Prior to commencement of dumping in 1981, Cyprus installed a culvert and drain system in both valley bottoms to convey the creeks underneath the dumps. The underdrain systems are further designed to collect infiltration through dump materials. These systems drain into sediment ponds, which also collect surface runoff from the dump areas. The sediments ponds discharge through NPDES outfalls to Buckskin and Pat Hughes Creeks. The discharge from the Buckskin dump sediment pond is identified as National Pollutant Discharge Elimination System (NPDES) outfall 001, while the discharge from the Pat Hughes dump sediment pond is NPDES outfall 002. During 1989-1990, pH levels in the discharges from outfalls 001 and 002 ranged from 7.0 to 9.2 s.u. and 6.4 to 8.9, respectively. (A complete summary of monitoring results for outfalls 001 and 002 is included in Appendix A) (Cyprus 1991a). As indicated by Cyprus personnel, no evidence of ARD has yet been found in these discharges. A NALCO coagulant is added to the sediment ponds during the spring to help control total suspended solids levels in the discharges (the amount of coagulant added was not obtained). According to Cyprus personnel, no other treatment is required to meet NPDES permit limits.

Tailings

When the mill is operating at full production, tailings are generated at a rate of approximately 7.5 million cubic yards per year. On Cyprus' 10/4 mill operating schedule (10 consecutive days operating/4 days shutdown), about 5.5 million cubic yards of tailings are produced each year. Cyprus continuously monitors the composition of concentrates and tailings generated by each flotation stage to assess mill performance. Samples are collected every 15 minutes and composited for analysis every 24 hours. The results of one recent analysis of a 24-hour composite sample are presented in Table 1. As indicated in the previous section, only the rougher and scavenger tails are sent to the tailings impoundment.

Table 1: Cyprus Thompson Creek Mining Company
Daily Tailings and Concentrate Composite Assays

Report Date: 28/Jan/91

Sample	Molybdenum Percent	Copper Percent	Lead Percent
Rougher Tails	0.009	0.002	0.002
Combined Tails	0.009	0.004	0.003
Scavenger Tails	0.073	0.150	0.051
Rougher Concentrate	8.11	0.130	0.060

1st Cleaner Concentrate	43.40	0.620	0.180
2nd Cleaner Tails	34.10	1.300	0.240

Tailings flow from the mill in a 30-inch diameter high density polyethylene (HDPE) pipeline that extends 7,000 feet north-northeast to the tailings impoundment in the Bruno Creek drainage. The tailings discharged from the mill are approximately 39 percent solids and the pipeline flow is about 10,000 gpm. The pipeline is situated in an unlined ditch along its entire length to provide for secondary containment.

The tailings impoundment covers a total of approximately 150 acres with the embankment covering about 60-70 acres and the tailings pond behind the embankment approximately 90 acres. The embankment is currently about 400 feet high with an eventual planned final height of 600 feet. The impoundment is designed to contain the surface water runoff from a 500-year storm event. In addition, the impoundment was designed with a runoff interceptor system (RIS). When Cyprus determines that it is necessary to reduce the upstream flow of Bruno Creek into the tailings impoundment, the RIS can be used to divert Bruno Creek around the impoundment. The diverted flow is discharged to lower Bruno Creek below the final seepage collection sump described below.

The "centerline" method is the chosen technique for tailings embankment construction. The starter dam was a 35-foot earthen embankment. Tailings fractions are classified by cycloning (as sands or slimes) and distributed to the impoundment by spigotting. The coarse fraction (sands) forms the embankment that retains the slimes. The slimes have formed a "beach" that slopes upstream away from the embankment. Tailings water is kept at the upstream end of the impoundment by the addition of tailings to the upstream face of the dam. Eighty percent of the tailings water is reclaimed by a pumping barge and reused in the mill. The flow of reclaim water to the mill averages 7,000 gallons per minute (gpm). Additional fresh water may be pumped from the Salmon River as needed (this is not continuous, but typically averages 1,000 gpm). Under their water quality monitoring program, Cyprus collects and analyzes tailings pond water at the inflow to the barge pump. At the time of the site visit, Cyprus personnel indicated that the pH of the tailings water was 6.5 to 7.0 s.u. Results of analyses for 1989-1990 are included in Appendix A (see monitoring location TP).

Consolidation of the tailings in the impoundment is promoted by controlled seepage through the dam. Piezometers and open-ended standpipes are used to monitor stability in the impoundment. French drains located under and within the impoundment direct the flow of seepage through the permeable embankment.

The tailings disposal system has been designed to be a zero discharge unit. A seepage return pond was constructed below the embankment to collect the seepage from the tailings impoundment. The clay-lined seepage pond typically contains approximately 20 acre feet of seepage with the capacity to contain up to 100 acre feet (the current area and depth of the pond, and average seepage rates were not determined). The downstream end of the return pond (approximately 850 feet from the tailings embankment) is an earth and rock fill dam, identified by Cyprus as the Seepage Return Dam (SRD). The maximum height of the SRD is

75 feet with an impervious upstream zone and a rock fill downstream zone. The SRD incorporates a positive seepage cutoff by use of a grout curtain in the foundation bedrock. At the time of the site visit, the pH of seepage pond water was 6.2 to 6.5 s.u.

While the SRD was originally planned to contain all seepage from the tailings impoundment, Cyprus personnel subsequently identified seepage downstream of the SRD. Therefore, to ensure no discharge of seepage to Bruno Creek, a lined sump was installed further downstream in Bruno Creek drainage (information on the specific type of liner was not obtained). Under their water quality monitoring program, Cyprus collects and analyzes samples from the inlet to this sump. Results of analyses for 1989-1990 are included in Appendix A (see monitoring location PBS). Seepage collected in both the seepage return pond and the downstream sump is pumped back to the mill for reuse. In 1990, the monthly average pumping rate from the return pond to the mill ranged from 791 gpm (August) to 1352 gpm (November and December) (Cyprus 1991b). The quantity of seepage returned to the mill from the sump was not obtained.

During the ongoing acid drainage study, indications of acid generation have been found in the tailings. According to Cyprus personnel, tailings oxidation has been evident for over two years. In October 1990, ten hollow stem auger borings were completed in the tailings embankment. Samples collected from the these borings showed that the average sulfur content of the tailings sands was 0.79 percent and the pH ranged from 3.5 to 7.3 s.u. (Steffen Robertson & Kirsten 1991b). During the site visit, Cyprus personnel further indicated that analyses of tailings sands have shown pH levels as low as 3.0 s.u. According to Cyprus personnel, the tailings pond and the seepage return pond are not currently a problem (pH > 5.7 s.u.). However, in 1991, Cyprus conducted a water quality trend analysis for six surface water quality monitoring locations in the tailings impoundment area. These locations included the main drain of the rock toe, springs located on the left and right abutments of the rock toe, the discharge from the rock toe, the sump below the SRD, and Bruno Creek (immediately downstream of the sump). This analysis found that during the period 1981-1990, pH decreased at four locations (not at the left and right abutment springs), (2) sulfate had increased at all locations, (3) iron had increased at four locations (not at the left and right abutment springs), and (4) no trends in zinc, copper, or arsenic were recognized. The increase in sulfate concentrations was attributed to tailings oxidation and acid generation (Steffen Robertson & Kirsten 1991b).

Cyprus' original plan for reclamation of the tailings impoundment (submitted to the State in 1982) provides for restoration of the Bruno Creek drainage through the impoundment in compliance with State water quality standards. The plan indicates that Cyprus initially anticipated that water quality standards could be met by diluting impoundment seepage with natural runoff. No water treatment beyond sediment control was expected to be required (Steffen Robertson & Kirsten 1982). However, the original reclamation plan did not consider the ARD issue.

According to Cyprus personnel, the ARD problem could extend well beyond the life of the mine and perpetual care/treatment may be necessary. Therefore, Cyprus is currently evaluating remedial alternatives (other than perpetual care) and is preparing to submit a revised tailings pond reclamation plan (as a modification to their operating plan). Alternatives may include installing an additional flotation unit to remove pyrite and/or in-place treatment of tailings with trisodium phosphate as a buffer.

Preliminary flotation tests have been conducted to investigate the possibility of removing sulfides from the tailings prior to disposal in the impoundment. Test results indicate that a high percentage of pyrite may be recovered. Limited static testing performed on a whole tailings sample from which pyrite was recovered indicated a NP/AP ratio in excess of 4:1 compared to an average value of 0.84:1 for all tailings analyses (Steffen Robertson & Kirsten 1991a).

Cyprus also has been testing the spray application of trisodium phosphate (2 percent solution) to buffer tailings sands. The facility has been analyzing the buffered sands and collected leachate. Based on preliminary test results, the trisodium phosphate has been successful in elevating pH levels and reducing iron concentrations in leachate samples. However, because the tailings impoundment unit has no discharge and water from the impoundment, seepage return pond, and pump back system is returned to the mill, the TSP application will cause elevated phosphorus levels in the reclaim water. Cyprus personnel indicated these levels may adversely affect flotation operations and that this issue is being studied (Steffen Robertson & Kirsten 1991a).

According to Cyprus personnel, oxidation has only been found to occur in the top two to three feet of tailings (despite the results of analyses of the 1990 borehole samples that showed oxidation at all depths down to 150 feet, see Steffen Robertson & Kirsten, 1991a). Therefore, an additional alternative under consideration is to encapsulate the tailings. Information on specific types of cover materials was not provided. Additionally, Cyprus is investigating the potential use of wetlands treatment.

Mine Water

Until early 1988, little or no mine water accumulated in the pit except seasonal runon. However, ground water seepage to the pit began in 1988 when the pit reached the 7,300 foot elevation (a depth of about 1,000 feet below the surface). As a result, a collection sump and pumpback system were installed with a capacity to remove 1,200 gpm of mine water. According to Cyprus personnel, an average of 200 gpm of mine water is pumped out of the pit to a booster station and then pumped to the tailings impoundment. Because the mill was shutdown during 1991 spring runoff, mine water was combined with underflow collected from the Pat Hughes dump and discharged through NPDES outfall 002 (after receiving approval from EPA). Under their water quality monitoring program, Cyprus collects and analyzes samples of mine water from the collection sump. The results of mine water analyses for 1989-1990 are presented in Table 2.

Other Materials and Wastes

Other wastes generated at the Cyprus Thompson Creek site include solid waste (i.e., trash), waste oil, grease, and spent solvents). Each of these and their management practices are discussed below. Other materials managed at the facility are also described.

Waste Oil/Grease/Fuel. Diesel fuel usage is approximately 220,000-230,000 gallons per month in the mine trucks and 9,000 gallons per month in the mill. The primary fuel storage tank is a 400,000 gallon tank located north of the machine shop near the pit. There are also a 6,000 gallon tank for auto transmission fluid and a 6,000 gallon tank for antifreeze storage located north of a gas shop, also near the pit. Two 13,000 gallon underground tanks are used for gasoline storage (the locations of these tanks were not obtained). Waste oil is collected in two aboveground 10,000 gallon tanks near the shops. Vehicles generate 90 percent of the waste oil at the site. When vehicle waste oil was used in blasting, all of the vehicle waste oil generated at Cyprus Thompson Creek was recycled on-site (the amount was not determined). Forty percent of the vehicle waste oil was used in blasting and 60 percent was used in the facility's space heating furnaces. Because vehicle waste oil is no longer being used in blasting pending MSHA approval, the management of waste oil not used in Cyprus' space heating furnaces is unknown. The shop generates the remaining 10 percent of the facility's waste oil. Shop waste oil is shipped off-site after analysis for chlorinated hydrocarbons. Grease is manifested and also shipped off-site.

As noted in the facility's SPCC plan (see the following chapter), all of the tanks listed in the preceding paragraph, except the two underground gasoline tanks, have secondary containment (i.e., liners surrounded by berms). None of these tanks have leak detection systems (Cyprus 1990). No information was obtained on whether the two underground gasoline tanks have been leak tested. Cyprus personnel visually inspect all tanks at the site at least monthly.

Solid waste. Solid waste generated at the site is disposed with waste rock materials in the Buckskin dump. The quantity of solid waste generated and disposed was not obtained.

Solvents. In 1989, more than 12,000 pounds of naptha were generated and manifested for off-site management. In 1989, 1,250 pounds of waste chlorinated cleaning solvents were generated and sent to the State of Washington for disposal.

Capacitors. All PCB-contaminated capacitors were manifested and removed from the site in one shipment (information on the removal date and quantity shipped was not obtained). According to Cyprus, there is no remaining PCB-contaminated electrical equipment on the Thompson Creek property.

Facility Runoff. All runoff from disturbed areas at the site (except for runoff from the mine, waste dumps, and tailings impoundment) is collected in ditches, which drain to a sediment control pond adjacent to Squaw Creek below the confluence with Bruno Creek. The site visit team observed a significant algal bloom and aquatic plant life in the sediment pond. The discharge from the pond is NPDES outfall 003.

Table 2. General Surface Water Parameter Concentrations
for Pit Sump (PIT 1, PIT 2, and PIT 3)

Year	Parameter Range Concentrations												
	pH	Arsenic Total µg/l	Barium Total µg/l	Cadmium Total µg/l	Lead Total µg/l	Mercury Total µg/l	Selenium Total µg/l	Silver Total µg/l	Copper Total µg/l	Iron Total µg/l	Manganese Total µg/l	Zinc Total µg/l	Aluminum Total µg/l
PIT 1													
1989	6.8-7.0	10-36	NR	<5.0-27.0	50.0	<0.50	NR	NR	10	2,500	NR	20-27	NR
1990	6.3-6.7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PIT 2													
1989	6.5-7.4	<5.0-77.0	NR	<5.0-68.0	<50.0-150.0	<0.50-19.20[1]	NR	NR	<10-90	460-1,900	NR	<5-302	NR
1990	3.6-6.5	<5.0-19.0	NR	5.0-14.0	60.0	<0.50	NR	NR	50-210	NR	NR	337-1,080	NR
PIT 3													
1989	6.5-7.3	<5.0-129.0	NR	<5.0-5.0	<50.0-80.0	<0.50-50.00[2]	NR	NR	10-30	NR	NR	6-67	NR
1990	5.9-7.0	167	<100	<5.0	<50.0	<0.50	<20.0	<5.00	<10	700	1,300	<5	570

NR = Not Reported

(Source: Cyprus 1991a)

[1]Six of 39 samples showed detectable levels of mercury. Other detected levels ranged from 0.50 µg/l to 1.60 µg/l. According to Cyprus, laboratory contamination is suspected as the source for the anomalous mercury values

[2]Three of six samples showed detected levels of mercury. The other detected levels were 0.50 µg/l and 0.60 µg/l.

REGULATORY REQUIREMENTS AND COMPLIANCE

Cyprus Thompson Creek operates under several permits and/or plans issued by the State of Idaho Departments of Lands and Water Resources and Division of Environmental Quality, as well as approvals from the U.S. Forest Service (USFS) and EPA Region X. In addition, the State of Idaho has established an interagency task force that coordinates regulatory activities related to each major mine site. The interagency task force for the Thompson Creek site meets quarterly and includes representatives of the State Departments of Lands, Water Resources, and Fish and Game; the State Division of Environmental Quality; USFS; and BLM. USFS is the lead agency for the Cyprus task force. Each of Cyprus' major permits and/or plans is discussed in the following sections.

Plan of Operations

Background. Cyprus submitted their initial Plan of Operations to USFS for the Thompson Creek mine on May 25, 1979. This plan, which was approved by USFS and has been modified throughout the life of the mine, describes how the mine is to be operated and the specific activities to be performed at mine closure. A part of the Plan of Operations is the reclamation plan for the site. In addition to USFS approval, the reclamation plan and subsequent modifications are subject to review by the Idaho Department of Lands under the Idaho Surface Mining Act.

Cyprus submits annual reports to the Idaho Department of Lands and USFS on reclamation and tailings impoundment related activities. Cyprus also submits to the State, USFS, and EPA Region X the results of all ground and surface water monitoring. Under the authority of the Surface Mining Act, the Department of Lands coordinates with USFS to enforce the requirements of Cyprus' Plan of Operations. Generally, the Department of Lands and USFS work with Cyprus to address any problems that arise. If formal enforcement action is required, the Idaho Division of Environmental Quality (DEQ) can issue a consent decree. The DEQ also reviews ground water and surface water monitoring data to ensure compliance with State ground and surface water quality standards. BLM's role at the site is limited to participation in the interagency task force.

The Forest Service inspects the site monthly. As noted above, staff from the State Departments of Lands, Water Resources and Fish Game, and the Division of Environmental Quality participate in the Thompson Creek interagency task force, which meets at the site quarterly.

Water Quality Monitoring. As part of their Plan of Operations, Cyprus is required to perform ground and surface water monitoring in the Buckskin, Pat Hughes, Squaw, Bruno, and Thompson Creek drainages, as well as the Salmon River drainage. The ground and surface water monitoring locations (among which are the NPDES permitted outfalls described below) are identified in Table 3 and on the maps presented in Figures 4 and 5. Parameters and monitoring frequencies vary between locations (Cyprus 1991c). Information on the construction and depths of the ground-water monitoring wells was not obtained.

A summary of the 1989 and 1990 monitoring data for each monitoring location is included in Appendix A. Monitoring for pH and metals is required to ensure no degradation of surface and ground water in the Salmon River basin (Cyprus 1991c).

Acid Rock Drainage Study. As noted in the previous chapter, Cyprus has been conducting a study to investigate the potential for the waste dumps and the tailings impoundment to generate ARD. The results of the ARD study of the waste rock and tailings were to be provided to USFS by March 1, 1992. Proposed revisions to the facility's reclamation plan were also to be submitted to USFS. According to USFS personnel who participated in the site visit, the revisions to the Plan of Operations will be subjected to the environmental review requirements of National Environmental Policy Act (NEPA). This review may include preparation of a supplemental Environmental Impact Statement.

Reclamation. As required under their Plan of Operations, Cyprus submits an annual report describing reclamation activities undertaken during the previous year and proposed activities for the following year. The 1990 annual report, for example, described each specific project undertaken (e.g., stabilizing and fertilizing areas of the Buckskin and Pat Hughes dumps, seeding road cuts, and weed control). Overall, Cyprus reported final reclamation of 30.8 acres in 1990 (compared to 6.5 acres originally planned) (Cyprus 1991d).

Bonding. Because of the various agencies responsible for oversight of activities at the Thompson Creek facility, coordinated bonding (including Memoranda of Understanding) has been required to avoid duplication of requirements. Table 4 summarizes the agencies holding bonds, the bond values, and the types of disturbances addressed. Overall, approximately $10,000,000 of bonds are held by the USFS, BLM and the Idaho Departments of Lands and Water Resources for the Thompson Creek Mine.

Table 3: Surface and Ground Water Monitoring Locations

Surface Water Monitoring Locations	
SQ-2	Squaw Creek below confluence with Bruno Creek and 25 feet above second bridge above gate.
SQ-2.5	Squaw Creek 250 feet below confluence with Bruno Creek (at boulder).
SQ-3	Squaw Creek above confluence with Bruno Creek and 100 feet below Redbird mine.
SQ-4	Bruno Creek at the U.S. Gauging Station (USGS) and above guard gate.
TC-1	Thompson Creek 250 feet below confluence with Pat Hughes Creek and one mile above Transfer Pump Sump.
TC-2	Thompson Creek one-fourth mile above confluence with Pat Hughes Creek and below confluence with Unnamed Creek.
TC-3	Thompson Creek above confluence with Unnamed Creek and below confluence with Buckskin Creek.
TC-4	Thompson Creek above confluence with Buckskin Creek and below confluence with Alder Creek.
001	Buckskin Creek sediment dam discharge point.
002	Pat Hughes Creek sediment dam discharge point.
003	Beaver Pond sediment control structure - storm water discharge point on Squaw Creek.
PITS 1-3	Locations in pit sump used for dewatering.
SLMR1	Salmon River, 50 feet below steel ladder bridge (access road). South bank.
SLMR2	Salmon River, at parking flat directly above concrete bridge. South bank.
SLMR3	Salmon River, 50 feet above mouth of Thompson Creek.
TP	Tailings pond (barge).
MD	Main drain (lower center) of rock toe.
LA	Left abutment of rock toe.
RA	Right abutment of rock toe.
PBS	Pumpback system, inlet to sump on lower tailings road south of Seepage Return Dam.
DS-1	First downstream spring 100 feet below pumpback system and 25 feet below monitoring well on Bruno Creek (east bank).
SP-1	Sediment pond at elevation 6,640 feet on Squaw Creek
RB-1	Redbird Creek tributary to Squaw Creek one mile above Redbird Mine.
Ground Water Monitoring Locations	
MW-1	Monitoring well located approximately 100 feet below Seepage Return Dam.
BC-3	Former production well on lower Bruno Creek at Pope John Boulevard.
LA-2	Monitoring well located on left abutment above centerline of tailings impoundment.
RA-2	Monitoring well located on right abutment (west edge) of tailings impoundment and one-half mile off of upper mine (motivator) road.

Table 4: Bond Amounts Required of Cyprus Thompson Creek
Through December 31, 1993

Agency Holding Bond	Disturbance Type	Area Acres	Base Rate Cost/Acre	Portion Covered by Other Bonds Lands	Water	USFS	BLM	Adj. Rate Cost/Acre	Total ($)
Dept. of Water Resources	Tailings Deposition	219.2	28,800	750				28,050	7,517,455
Dept. of Lands	Dumps	8	2,000	1,800				--	$14,400
Total Bonds = $1,393,150	Roads & Utilities	23	1,500					--	34,500
	Laydown & Shops	112	1,000					--	112,000
	Remaining	1,643	750					--	1,232,250
USFS	Mine	37.5	250	750				(500)	--
Total Bonding = $468,125	Dumps	343	2,000	750				1,250	$428,750
	Tails - Deposition	199.5	28,800	750	28,050			--	--
	Tails - Nondeposition	41	1,500	750				750	30,750
	Borrow	--	750	750				--	--
	Roads & Utilities	11.5	1,500	750				750	8,625
	Laydown & Shops	--	1,000	750				250	--
BLM	Mine	173	250	750				(500)	
Total Bonding = $549,300	Dumps	308.5	2,000	750				1,250	385,625
	Tails - Deposition	19.2	28,800	750	28,050			--	--
	Tails - Nondeposition	30.3	1,500	750				750	22,725
	Borrow	17	750	750				--	--
	Roads & Utilities	165	1,500	750				750	123,750
	Laydown & Shops	68.8	1,000	750				250	17,200
Total									9,928,030

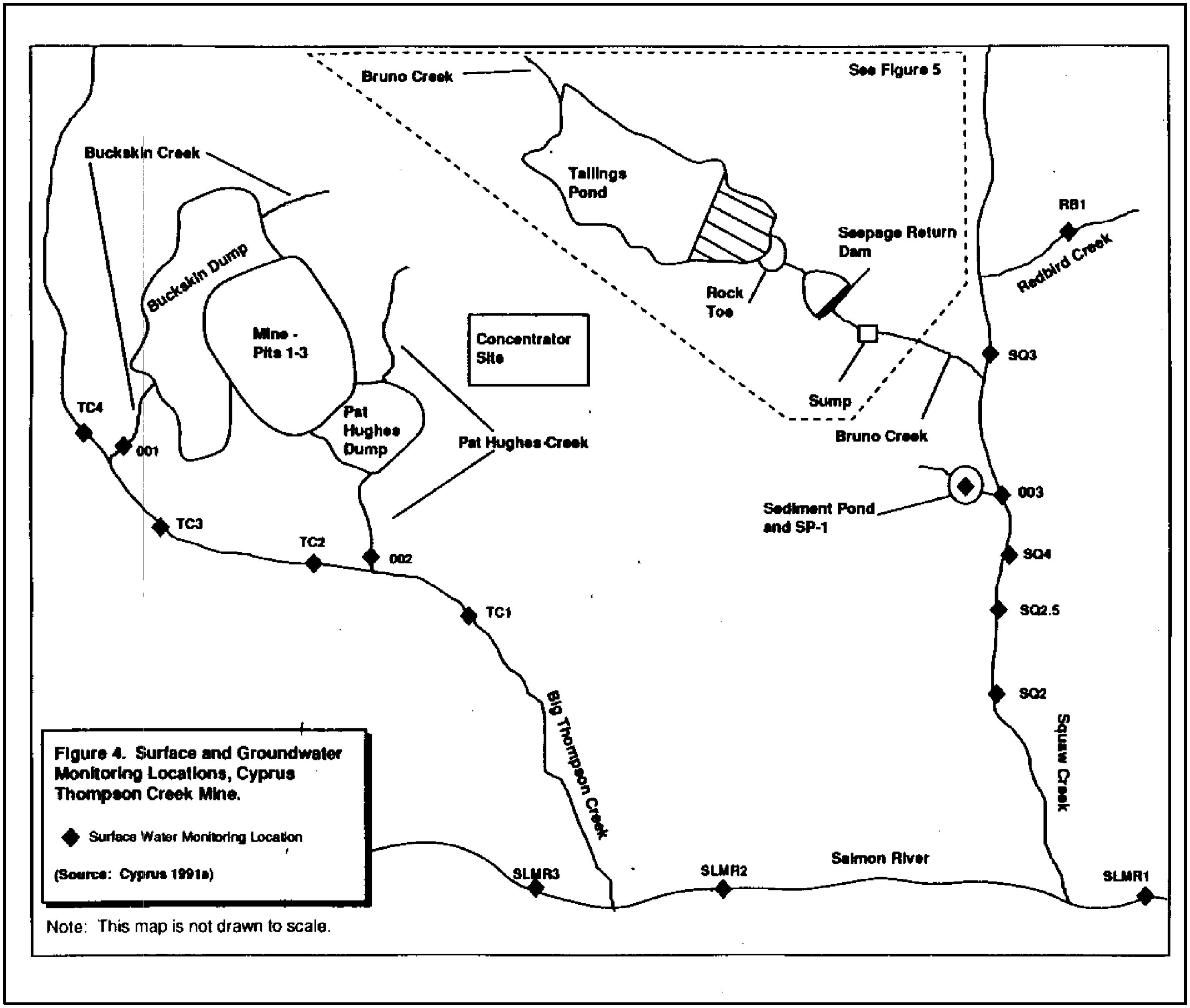


Figure 4. Surface and Groundwater Monitoring Locations, Cyprus Thompson Creek Mine.

(Source: Cyprus 1991a)

Note: This map is not drawn to scale.

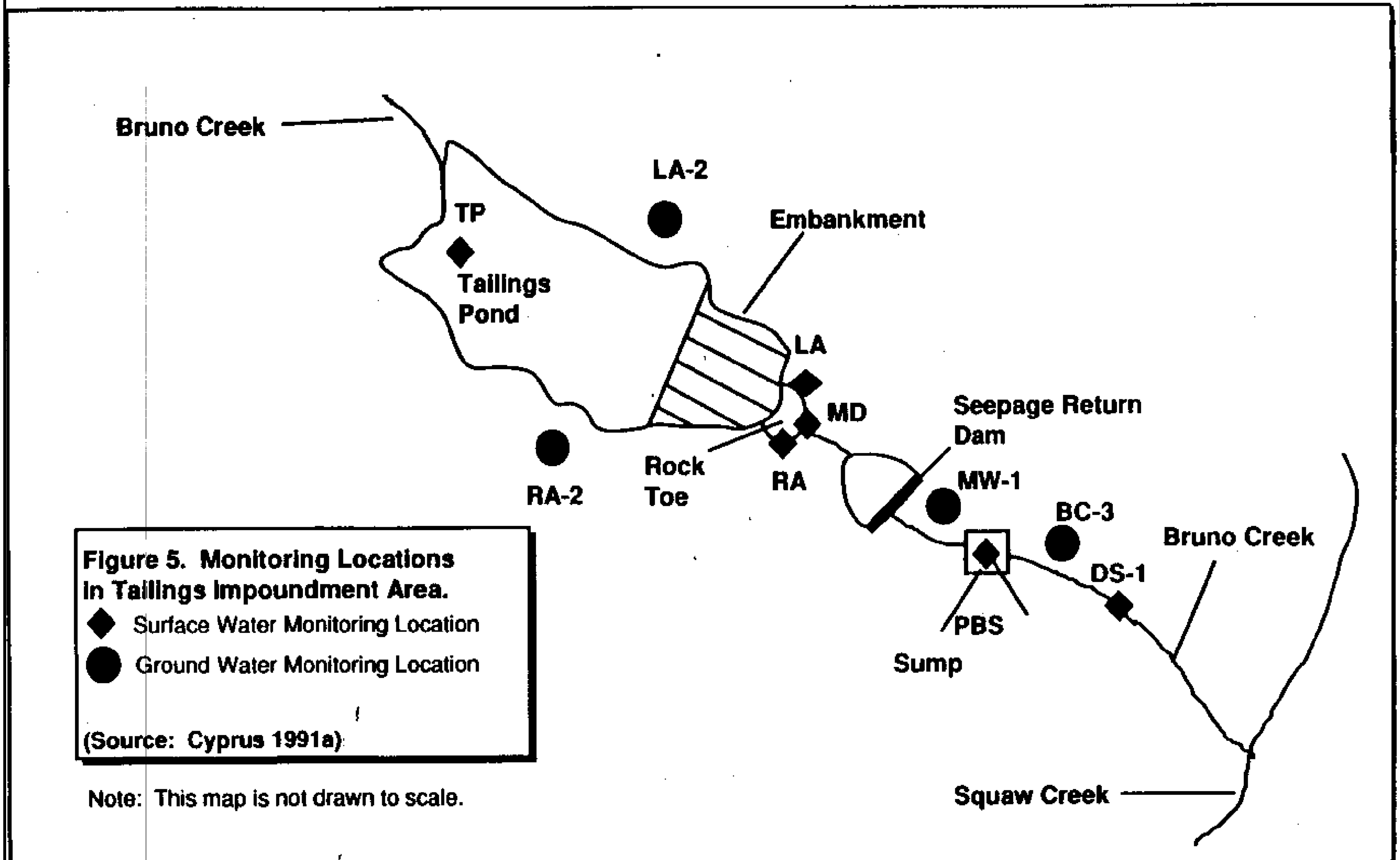


Figure 5. Monitoring Locations in Tailings Impoundment Area.

(Source: Cyprus 1991a)

Note: This map is not drawn to scale.

Old Tungsten Mill Tailings Remediation. As indicated previously, an abandoned mill associated with an old tungsten mine is located beside Thompson Creek 10 miles downstream of the mine site (not on Cyprus' property). The tailings from the mill were disposed in and around the creek drainage. These tailings have been shown to have acid generation potential (pH approximately 2.9 s.u.) and high metals concentrations which could affect Thompson Creek. Although the abandoned mill tailings are not on Cyprus' property, their potential impact on the Creek affects Cyprus' nearby operations. Therefore, it is to Cyprus' benefit to assist in remediation of the site. In a joint effort, Cyprus has been working with the USFS to remediate problems associated with the tailings. Tailings are being removed from the Creek and placed on other tailings away from the drainage. They are then covered from top to bottom with layers of lime, topsoil, sewage sludge, and additional topsoil. Cyprus is providing the equipment and operators, while USFS is providing funding, expertise, and additional manpower.

NPDES Permit

The State of Idaho has not been delegated NPDES permitting authority under the Clean Water Act. Therefore, the five-year NPDES permit for the Cyprus Thompson Creek site was issued by EPA Region X on August 1, 1988. The permit specifically addresses the discharges from NPDES outfalls 001 (the discharge from the Buckskin dump) and outfall 002 (the discharge from the Pat Hughes dump). For these outfalls, the permit establishes limits and monitoring requirements for: pH (monitored weekly), total suspended solids (weekly), arsenic (monthly), cadmium (monthly), lead (monthly), mercury (monthly), copper, (monthly) and zinc (monthly). Permit limits are based on ensuring compliance with the applicable State water quality standards. However, the permit provides alternative limitations for the metals (except arsenic) to allow for elevated levels of pollutants in background water quality (USEPA 1988).

As noted previously, Cyprus collects runoff from all areas (other than the pit, waste dumps, and tailings impoundment) in unlined channels that convey runoff to a sediment pond located adjacent to Squaw Creek downstream of the confluence with Bruno Creek. This pond discharges to Squaw Creek at NPDES outfall 003. Cyprus is required to monitor Squaw Creek upstream and downstream of this outfall for turbidity. Weekly monitoring is required between February 1 and June 30 and monthly during other months. The permit only requires turbidity monitoring, no limits are provided (USEPA 1988).

The NPDES permit also requires Cyprus to continue to implement the comprehensive water quality monitoring program described under the operating plan above. Cyprus submits quarterly reports on water quality monitoring to both EPA Region X and DEQ. EPA Region X's Water Quality Branch conducts a compliance inspection at the facility once per year.

Cyprus personnel indicated that the water quality in the receiving waters was generally "very good," including pH levels (see Appendix A). To further determine whether mining activities have impacted surface waters, Cyprus conducted an aquatic biological survey of Thompson and Squaw Creeks. The results of this 1988 study indicated that mining was having no discernable effect on aquatic life in Thompson Creek. The invertebrate populations in Squaw Creek were shown to have experienced changes in species composition and relative density. However, the cause of these changes was unknown and continued monitoring was recommended (Chadwick & Associates 1989). Annual aquatic life monitoring is now required under Cyprus' water quality monitoring program (no additional data was obtained). During the site visit, Cyprus personnel noted that in 1986, one of the waste dump ponds stratified, confining higher temperature (lower oxygen) water at depths in the pond. Because of this effect, the decreasing level of oxygen caused fishkills.

Air Permit

The State of Idaho has issued an air emissions permit for the Thompson Creek site that addresses the following sources:

- Baghouses located at the crusher, at the turning point of the conveyor, at the lime bin, at the product package area, and at the HPM plant,
- Discharges from the two boilers in the mill,
- Portable crusher used to generate gravel for roads; water is sprayed at the base of this crusher to control particulate emissions,
- Technical grade concentrate holoflyte dryer/rotary kiln stack,
- HPM plant holoflyte dryer/rotary kiln stack.

Dust collected from the baghouses is recycled to the mill. All of the above sources are required to meet 20 percent opacity limits and the particulate size limit for each source is either 0.02 or 0.5 grains/dry cubic foot. In addition, the fuel feed to the mill boilers must be less than one percent sulfur. The State conducts air permit compliance inspections once per year. Magnesium chloride is used for dust suppression on haul roads.

Dam Safety Permit

As required under Idaho State law, Cyprus Thompson Creek has a dam safety permit issued by the Department of Waste Resources for the main tailings embankment and the SRD. This permit was not reviewed by the site visit team.

Other Regulatory Requirements

In accordance with 40 CFR Part 112 of the Clean Water Act, Cyprus has implemented a spill prevention control and countermeasure (SPCC) plan for the Thompson Creek mine site, primarily because of the project's location adjacent to and near a number of tributaries to the Salmon River. The SPCC plan is designed to help prevent spills and to minimize the risk of injury to human health and the environment in the event that a spill should occur. Cyprus's SPCC plan specifically: (1) provides the locations of all aboveground storage tanks at the site, (2) describes their contents and volumes, and (3) identifies spill prevention and control measures. As noted previously, all of the aboveground tanks at the site have secondary containment and are visually inspected monthly. According to Cyprus personnel, the two underground gasoline storage tanks at the site are in full compliance with Underground Storage Tank program requirements.

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APPENDIX A

WATER QUALITY MONITORING DATA

Monitoring Results for Surface Water Stations in Squaw Creek (SQ-2, SQ-2.5, SQ-3, and SQ-4)

	Concentration Ranges												
Year	**pH**	**As Total µg/l**	**Ba Total µg/l**	**Cd Total µg/l**	**Pb Total µg/l**	**Hg Total µg/l**	**Se Total µg/l**	**Ag Total µg/l**	**Cu Total µg/l**	**Fe Total µg/l**	**Mn Total µg/l**	**Zn Total µg/l**	**Al Total µg/l**
SQ-2													
1989	6.9-8.5	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10-10	<10-120	<10-10	<5-15	<100
1990	6.1-8.0	<5.0	<100	<5.0	<50.0	<0.50	<5.0	<5.00	<10	90-190	<50	<5-13	<100
SQ-2.5													
1989	6.9-8.1	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
1990	7.8	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
SQ-3													
1989	6.8-8.3	<5.0	<100	12.0	<50.0	<0.50	<2.0	<5.00	<10	50-140	<10-10	20	<100
1990	6.4-8.1	<5.0	<100	<5.0	<50.0	<0.50	<5.0	<5.00	20	100-150	<50-50	<5	<100
SQ-4													
1989	6.6-8.6	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	10	<10-80	<10	13	100
1990	7.5-8.3	<5.0	200	<5.0	140.0	0.50	<5.0	<5.00	NR	50-110	<50	12-15	270

NR = Nonreporting

Monitoring Results for Surface Water Stations: Downstream Spring (DS-1), Left Abutment (LA), Pumpback System Inflow (PBS), Right Abutment (RA), Redbird Creek (RB-1), and Sediment Pond (SP-1)

Year	Concentration Ranges												
	pH	As Total µg/l	Ba Total µg/l	Cd Total µg/l	Pb Total µg/l	Hg Total µg/l	Se Total µg/l	Ag Total µg/l	Cu Total µg/l	Fe Total µg/l	Mn Total µg/l	Zn Total µg/l	Al Total µg/l
DS-1													
1989	6.4-8.0	<5	<100	<5.0	<5	<.5	<2	<50	<10	20-290	<10-10	<5-12	200
1990	5.3-7.9	<5	<100	<5.0	60	<.5	<5	<5	NR	60-170	<50	<5-11	400
LA													
1989	6.4-7.1	<5-6	170-700	5-9	<50-110	<.5-2.4	<2	<5-10	<10-30	200-820	260-770	11-65	<100-490
1990	6.7-6.8	<5	<100-150	<5-10	60-70	<.5	<5	6-8	20-30	150-210	140-310	14-71	<100-110
PBS													
1989	6.5-7.0	<5-6	100-1,900	5-28	60-90	<1	<2	<5-8	<10-10	40-180	<10-20	12-64	<100
1990	6.2-7.2	<5-19	<100-130	6-11	50-110	<.5-.6	<5	7-11	<10-10	50-130	<50	9-49	<100-300
RA													
1989	4.2-8.2	<5	<100-1,100	<5-15	<50-80	<1	<2-4	<5-6	<10-50	550-58,000	20-10,700	21-360	300-15,600
1990	6.9-7.8	<5	<100	<5-10	<50-110	<.5-.5	<5	<5-10	<10-10	190-1,100	<50-8,000	21-50	<100-550
RB-1													
1989	8.5	<5	<100	<5	<50.0	<.5	<2	<5.00	<10	80	<10	9	200
1990	6.8-8.1	<5	<100	<5	<50.0	<.5	<5	<5.00	10	50	<50	<5	430
SP-1													
1989	7.1-8.8	<5	<100	<5	<50.0	<.5	<2	<5.00	<10	10-80	<10	44	<100
1990	6.2-8.6	<5	<100	<5	70.0	<.5	<5	<5.00	NR	50-70	<50	34-37	250

NR = Nonreporting

Monitoring Results for Surface Water Stations
Tailings Pond (TP) and Main Drain (MD)

Year	Concentration Ranges												
	pH	As Total µg/l	Ba Total µg/l	Cd Total µg/l	Pb Total µg/l	Hg Total µg/l	Se Total µg/l	Ag Total µg/l	Cu Total µg/l	Fe Total µg/l	Mn Total µg/l	Zinc Total µg/l	Al Total µg/l
TP													
1989	6.4-8.7	<5.0	200-400	<5.0-12.0	90.0-160	<0.50-1.00	4.0-7.0	<5.0-9.0	<10-60	240-2,000	410-3,400	11-34	480-1,220
1990	5.7-7.1	<5.0	<100-120	<5.0-14.0	<50.0-70.0	<0.50-0.50	4.0-9.0	<5.0-6.0	10-20	170-400	270-950	<5-112	<100-550
MD													
1989	5.8-7.1	<5.0	200-800	5.0-8.0	70.0-100.0	<0.50-1.00	<2.0	6.00-9.00	10-20	3,500-5,000	1,200-1,600	9-124	<100-880
1990	5.2-7.7	<5.0	<100-460	5.0-10.0	<50.0-130.0	<0.50-0.80	<2.0-<5.0	<5.00-10.00	10-20	2,700-9,400	910-9,600	26-42	<100-650

NR = Nonreporting

Monitoring Results for Surface Water Station in Salmon River (SLMR 1, SLMR 2, and SLMR 3)

Year	Concentration Ranges												
	pH	As Total µg/l	Ba Total µg/l	Cd Total µg/l	Pb Total µg/l	Hg Total µg/l	Se Total µg/l	Ag Total µg/l	Cu Total µg/l	Fe Total µg/l	Mn Total µg/l	Zn Total µg/l	Al Total µg/l
SLMR 1													
1989	6.5-8.2	<5.0	<100	<5.0	<50.0	<0.50-0.70	<2.0	<5.00	<10-10	40-470	<10-20	11-22	<100-510
1990	7.3	<5.0	110	<5.0	<50.0	0.60	<5.0	<5.00	20	<50	<50	<5	100
SLMR 2													
1989	6.5-8.1	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10	20-520	<10-20	10-11	<100-550
1990	7.0	<50	110	<5.0	<50.0	<0.50	<5.0	<5.00	<10	50	<50	<5	<100
SLMR 3													
1989	6.8-7.6	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10	90-350	10-20	5-14	<100-410
1990	6.7	<5.0	<100	<5.0	<50.0	<0.50	<5.0	<5.00	<10	2,000	<50	<5	210

NR = Nonreporting

Monitoring Results for NPDES Permitted Discharges to Buckskin Creek (001), Pat Hughes Creek (002), and Bruno Creek (003)

Year	Concentration Ranges													
	pH	As Total µg/l	Ba Total µg/l	Cd Total µg/l	Pb Total µg/l	Hg Total µg/l	Se Total µg/l	Ag Total µg/l	Cu Total µg/l	Fe Total µg/l	Mn Total µg/l	Zn Total µg/l	Al Total µg/l
001													
1989	7.0-9.2	<5.0	NR	4.0-<5.0	<50.0	<0.20-24.00	NR	NR	<10-<20	60	NR	4-27	NR
1990	7.1-8.9	<5.0	NR	<5.0	50.0	0.40-0.80	NR	NR	<10	NR	NR	8-19	NR
002													
1989	6.6-8.9	<5.0	NR	<5.0-9.0	<50.0-44,000[3]	<0.20-10.90	NR	NR	<10-20	50-80	NR	<5-172	NR
1990	6.4-8.9	<5.0	<100	<5.0-8.0	<50.0-70.0	<0.20-5.00	<5.0	<5.00	<10-20	70	<50	<5-65	300
003													
1989	6.6-8.3	<5.0	<100	<5.0	<50.0	<0.50	<2.0	5.00	10	50	30	20	<100
1990	6.3-8.1	<5.0	<100	<5.0	60.0	2.00	<5.0	<5.00	<10	110	70	10	130

NR = Nonreporting

[3] This value may be inaccurate because the results of analysis of all other samples collected from outfall 002 showed lead levels of 90 µg/l or less. No other information was available.

Monitoring Results for Surface Water Stations in Thompson Creek (TC-1, TC-2, TC-3, and TC-4)

Year	Concentration Ranges												
	pH	As Total µg/l	Ba Total µg/l	Cd Total µg/l	Pb Total µg/l	Hg Total µg/l	Se Total µg/l	Ag Total µg/l	Cu Total µg/l	Fe Total µg/l	Mn Total µg/l	Zn Total µg/l	Al Total µg/l
TC-1													
1989	6.6-8.1	<5.0-6.0	<100	<5.0-27.0	<50.0	<0.50-2.60	<2.0	<5.00	<10-20	20-30	10	<5-21	<100
1990	6.2-7.8	<5.0	<100	<5.0	<50.0	<0.50	<5.0	<5.00	<10	100	<50	<5	380
TC-2													
1989	6.7-7.7	<5-11	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10-<20	130	10	11-25	<100
1990	6.3-7.9	NR	NR	NR	<50.0	<0.50	<5.0	<5.00	<10	<50	<50	NR	NR
TC-3													
1989	6.8-7.8	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10-<20	40	<10	6-18	<100
1990	6.1-8.0	NR	NR	NR	<50.0	<0.50	<5.0	46.00	<10	230	<50	NR	NR
TC-4													
1989	5.9-7.9	<5.0	<100	<5.0-9.0	<50.0	<0.50-6.80	<2.0	46.00	<10-20	20-400	<10	<5-166	<100
1990	6.2-7.9	<5.0	<100	<5.0-6.0	<50.0-70.0	<0.20-2.90	<5.0	<5.00	<10-20	140	<50	<5-18	190

NR = Nonreporting

General Surface Water Parameter Concentrations for Pit Sump (PIT 1, PIT 2, and PIT 3)

Year	Parameter Range Concentrations													
	pH FLD	Arsenic Total µg/l	Barium Total µg/l	Cadmium Total µg/l	Lead Total µg/l	Mercury Total µg/l	Selenium Total µg/l	Silver Total µg/l	Copper Total µg/l	Iron Total µg/l	Mangns Total µg/l	Zinc Total µg/l	Aluminum Total µg/l
PIT 1													
1989	6.8-7.0	10-36	NR	<5.0-27.0	50.0	<0.50	NR	NR	10	2,500	NR	20-27	NR
1990	6.3-6.7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
PIT 2													
1989	6.5-7.4	<5.0-77.0	NR	<5.0-68.0	<50.0-150.0	<0.50-19.20	NR	NR	<10-90	460-1,900	NR	<5-302	NR
1990	3.6-6.5	<5.0-19.0	NR	5.0-14.0	60.0	<0.50	NR	NR	50-210	NR	NR	337-1,080	NR
PIT 3													
1989	6.5-7.3	<5.0-129.0	NR	<5.0-5.0	<50.0-80.0	<0.50-50.00	NR	NR	10-30	NR	NR	6-67	NR
1990	5.9-7.0	167	<100	<5.0	<50.0	<0.50	<20.0	<5.00	<10	700	1,300	<5	570

NR = Nonreporting

Cyprus Thompson Creek Mining Company

Concentrator Daily Tailings Composit Assays

Report Date: 28/Jan/91

Sample	Molybdenum Percent	Copper Percent	Lead Percent
Rougher Tails	0.009	0.002	0.002
Combined Tails	0.009	0.004	0.003
Scavenger Tails	0.073	0.150	0.051
Rougher Concentrate	8.11	0.130	0.060
1st Cleaner Concentrate	43.40	0.620	0.180
2nd Cleaner Tails	34.10	1.300	0.240

Surface Water Monitoring Locations:

SQ-2:

Squaw Creek below the confluence with Bruno Creek and 25 feet above the second bridge above the gate.

SQ-2.5:

Squaw Creek 250 feet below the confluence with Bruno Creek (at boulder).

SQ-3:

Squaw Creek above the confluence with Bruno Creek and 100 feet below Redbird mine.

SQ-4:

Bruno Creek at the U.S. Gauging Station (USGS) and above the guard gate.

TC-1:

Thompson Creek 250 feet below the confluence with Pat Hughes Creek and one mile above the Transfer Pump Sump.

TC-2:

Thompson Creek one-fourth mile above the confluence with Pat Hughes Creek and below the confluence with Unnamed Creek.

TC-3:

Thompson Creek above the confluence with Unnamed Creek and below the confluence with Buckskin Creek.

TC-4:

Thompson Creek above the confluence with Buckskin Creek and below the confluence with Alder Creek.

001:

Buckskin Creek sediment dam discharge point.

002:

Pat Hughes Creek sediment dam discharge point.

003:

Beaver Pond sediment control structure - storm water discharge point on Bruno Creek.

PITS 1-3:

Locations in pit sump used for dewatering.

SLMR1:

Salmon River, 50 feet below steel ladder bridge (access road). South bank.

SLMR2:

Salmon River, at parking flat directly above concrete bridge. South bank.

SLMR3:

Salmon River, 50 feet above mouth of Thompson Creek.

TP:

Tailings pond (barge).

MD:

Main drain (lower center) of the rock toe.

LA:

Left abutment of the rock toe.

RA:

Right abutment of the rock toe.

PBS:

Pumpback system, inlet to sump on lower tailings road south of the Seepage Return Dam.

DS-1:

First downstream spring 100 feet below pumpback system and 25 feet below the monitoring well on Bruno Creek (east bank).

SP-1:

Sediment pond at elevation 6,640 feet on Bruno Creek, one-half mile below pumpback system.

RB-1:

Redbird Creek tributary to Squaw Creek one mile above Redbird Mine.

Ground Water Monitoring Locations:

MW-1:

Monitoring well located approximately 100 feet below the Seepage Return Dam.

BC-3:

Former production well on lower Bruno Creek at Pope John Boulevard.

LA-2:

Monitoring well located on the left abutment above the centerline of the tailings impoundment.

RA-2:

Monitoring well located on the right abutment (west edge) of the tailings impoundment and one-half mile off of the upper mine (motivator) road.

Ground Water Monitoring Results for Bruno Creek Artesian Well (BC-3), Tailings Left Abutment Well (LA-2), SRD Monitoring Well (MW-1), and Tailings Right Abutment Well (RA-2)

	Concentration Ranges												
Year	pH	As Total µg/l	Ba Total µg/l	Cd Total µg/l	Pb Total µg/l	Hg Total µg/l	Se Total µg/l	Ag Total µg/l	Cu Total µg/l	Fe Total µg/l	Mn Total µg/l	Zn Total µg/l	Al Total µg/l
BC-3													
1989	6.9-7.9	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10	6,500-7,400	140-170	80	<100
1990	6.6-7.6	<5.0	<100	<5.0	<50.0	<0.50	<5.0	<5.00	NR	4,200-7,200	100-130	<5-34	<100
LA-2													
1989	6.7-7.2	<5.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10-10	350-530	60-100	8-18	150-300
1990	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
MW-1													
1989	6.6-7.7	<5.0-23.0	300	<5.0-32.0	<50.0-190.0	<0.50-3.30	<2.0	<5.00	<10-120	2,100-14,000	100-890	20-11,800	44,000
1990	6.7-8.0	<5.0	<100	7.0	60.0	<0.50	<5.0	<5.00	NR	1,800-2,000	70-90	68-137	420
RA-2													
1989	6.4-6.8	8.0-17.0	<100	<5.0	<50.0	<0.50	<2.0	<5.00	<10-<20	1,400-5,300	150-440	<5-36	600-1,400
1990	5.8	<5.0	130	<5.0	<50.0	<0.50	<5.0	<5.00	<10	210	<50	17	600

NR = Nonreporting

APPENDIX B

CYPRUS MINERALS COMPANY COMMENTS

Cyprus Comments on EPA's Thompson Creek Mine Report

June 5, 1992

The following comments on EPA's MINE SITE VISIT: CYPRUS THOMPSON CREEK (draft) dated April 1992 are presented in accordance with the reports organization.

INTRODUCTION

Background

Page 1, at the bottom of the page, the correct titles and company names are:

Cyprus Minerals Company

Les Darling, Director, Environmental Affairs *(303) 643-5325*

Cyprus Copper Company

Jamie Sturgess, Manager, Environmental Affairs, *(303) 643-5782*

Page 2, at the top of the page, the correct titles and company names are:

Cyprus Thompson Creek *(208) 838-2200*
Bert Doughty, Supervisor, Environmental Affairs
Don Hilleary, Chief Engineer
Jim Kopp, Operations Supervisor
Marvin Harmer, Chief Metallurgist
Turk Terrill, Mine Superintendent

Dave Bergby

General Facility Description

Page 2, first paragraph, last sentence should read:

> *The active facility is located on nearly 1,935 acres of mixed ownership including: private lands (521 acres), Bureau of Land Management administered federal land (781 acres), and USFS administered federal land (633 acres of the Challis National Forest).*

Page 2, first paragraph, the following sentence should be added to the end of the paragraph (above):

> *Cyprus controls a mineral claim block of about 16,000 acres around the Thompson Creek Mine.*

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page 2

Page 2, second paragraph, first sentence should read:

> *The mine is located in Custer County, approximately 35 miles southwest of Challis, the county seat of Custer County.*

Page 4, second full paragraph, first sentence should read:

> *The Cyprus Thompson Creek Mine site currently consists of (1) an open pit mine and two associated waste rock dumps, (2) a primary crusher, (3) a mill that includes grinding, concentration by flotation, and (4) a tailings impoundment.*

Environmental Setting

Page 5, Figure 2.: The figure shows a non-existing "unnamed creek" flowing from the pit to the Salmon River between Pat Hughes Creek and Buckskin Creek. It also shows a settling pond on this unnamed and non-existing drainage. This Figure should be corrected.

Page 7, third paragraph: Delete the last sentence as it duplicates the penultimate sentence.

Page 8, first incomplete paragraph, last sentence should read:

> *Other than the on-site wells, the nearest drinking water well is at the Red Bird Mine three miles from the mine site.*

Facility Operations

Page 9, first paragraph, fourth, fifth and sixth sentences should read:

> *In 1986, the mill was shut down for one month. The mill was also inactive from October 1987 to March 1988, when only minor stripping operations (i.e., removal of overburden and waste rock) were underway. Again, from May 1991 to November 1991 the mill was not operated but waste rock and overburden stripping operations in the mine continued to access additional ore.*

Mining Operations

Page 9, second paragraph, second to the last sentence should read:

> *The pit currently extends down to the 7,050 foot level, with plans to expand down to an elevation of 6,400 feet (i.e., to a depth of 2,000 feet).*

Page 9, third paragraph, second to the seventh sentence should read:

> *The ore is accessed by drilling and blasting along 50 foot benches. Drilling is accomplished using Marion electric drills and a typical blast pattern consists of*

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between 30-40 holes. ANFO, a blend of ammonium nitrate and diesel fuel, is used as the blasting agent (10,000 tons of ANFO is used annually). (Waste oil has been substituted for diesel fuel in the ANFO mixture, however, it is currently not being used pending MSHA approval.) On average, one blast occurs every other day. After fragmentation, ore and waste rock are excavated using P & H electric shovels. Cyprus currently has two 28 cubic yard shovels, one 17 cubic yard shovel, and two 15 cubic yard shovels.

Page 10, continuation of previous page paragraph, first sentence should read:

The stripping ratio is approximately 2:1 (waste rock:ore).

Milling Operations

Page 10, second paragraph, third and fourth sentence should be replaced with:

The gyratory crusher is equipped with a bag house for controlling particulate emissions.

The water sprays are on the portable crusher which is intermittently used for gravel production.

Page 10, third paragraph, second sentence should read:

The conveyor belt is 2,350 feet long and 60 inches wide.

Page 10, third paragraph, fourth sentence should read:

2 Separate dryers

However, Cyprus personnel indicated that 75,000 tons of ore comprise the "active" portion of the pile.

Page 10, third paragraph, sixth sentence to the end of the paragraph should read:

Ore is removed from the surge pile by eight feeders underneath the pile. The ore is then transported to two parallel grinding circuits. In each circuit, the ore initially enters a 32 foot diameter semi-autogenous grinding (SAG) mill. The outputs from the SAG mills is passed over 0.75 inch screens and flows into cyclone separators. The overflow from the cyclones goes directly to flotation, while the underflows go to 16.5 foot by 26 foot ball mills for further grinding prior to flotation. Grinding is a wet process and burned lime is added for pH control. In 1990, Cyprus used an average of 0.132 pounds of lime per ton of ore. The grinding circuit product is 35 percent solids.

Page 10, last paragraph, third and fourth sentences should read:

Fuel oil is used as the collector, alcohol is used as the frother, while a Nokes

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reagent (P_2S_5 & NaOH) is added in the cleaner stages to depress copper and lead. In 1990, Cyprus used an average of 0.117 pounds of fuel oil, .025 pounds of alcohol, and 0.011 pounds of Nokes reagent per ton of ore.

Page 10, last paragraph, last sentence should read:

The effluent from the small ball mill is then subjected to ten additional stages of flotation, called "cleaner" stages, to progressively upgrade the concentrate.

Page 12, first paragraph, third sentence should read:

The larger particles (those that don't pass through the screen) are sent to Cyprus' High Performance Molybdenum (HPM) plant.

Page 12, first paragraph, after the fourth sentence the following should be added:

The higher grade (screen oversize) reports to either the high grade flotation plant or the drying and packaging plant, depending upon market requirements. In the high grade plant the moly is reground and subjected to either one or two stages of column flotation, again dependent upon market conditions.

Page 12, first paragraph, the sentence after the addition directly above should read:

The concentrate, which is 15-18 percent water, is then passed through a filter press. The filtrate....

Page 12, second paragraph, beginning with the second sentence to the end of the paragraph should read:

When dry, the concentrate is a very fine powder, about 54 to 59 percent molybdenum disulfide with less than 9.0 percent water and 1.0 percent fuel oil. The concentrate is packaged in 4,000 pound bags and sent by truck to deep water ports or the Cyprus Sierrita facility in Arizona for roasting.

Page 12, last paragraph, first and second sentences should read:

The "higher grade" larger crystals from the final cleaner stages go to a filter. They are then separately filtered and dried in the holoflyte dryer/rotary kiln.

Page 12, last paragraph, a sentence should be added at the end that reads:

This product is ≈ 59 percent Mo with less than one percent water and 0.1 percent fuel oil.

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Waste Management - Waste Rock

Page 13, second paragraph, first sentence should read:

As noted in the previous chapter, approximately 16.2 million cubic yards of waste rock were generated in 1990, with the stripping ratio typically about 2:1 (waste:ore).

Page 13, third paragraph, fourth and fifth sentences should read:

The dump is currently ~~800~~ 1306 feet high and is planned to eventually extend from an elevation of 8,100 feet to 7,600 feet. A 300-foot-wide bench, which enhances stability, is currently situated at the 7,600 elevation. 6,800 – 9,100 1900 permanent

Page 14, last paragraph, delete the last sentence and replace it with the following:

Seventy-six volcanic samples were run for acid base accounting with NP/AP ratios of over 31:1.

Page 15, first paragraph, penultimate sentence should read:

A NALCO coagulant is added to the sediment ponds during the spring to help control total suspended solids levels in the pond discharges.

Tailings

Page 15, second paragraph, the paragraph section above the table should read:

When the mill is operating at full production, tailings are generated at a rate of approximately 7.5 million cubic yards per year. On a 10/4 mill operating schedule, about 5.5 million cubic yards of tailings are produced each year. Cyprus continuously monitors the composition of concentrates and tailings generated by each flotation stage to assess mill performance. Samples are collected every 15 minutes and composited for analysis every 24 hours. The results of one recent analysis of a 24-hour composite are presented in Table 1. As indicated in the previous section, only the rougher and scavenger tails are sent to the tailing impoundment.

Page 16, first paragraph, first sentence should read:

Tailings flow from the mill in a 30-inch diameter high density polyethylene (HDPE) pipeline that extends 7,000 feet north-northeast to the tailings impoundment located in the Bruno Creek drainage.

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Page 16, first paragraph, last sentence should read:

> *The pipeline is placed in a ditch along its entire length to provide secondary containment.*

Page 16, third paragraph: Strike the tenth sentence: "Cyprus personnel indicated that approximately 120 gpm of tailings water is lost to infiltration." We are unsure of the meaning of this sentence. Infiltration to what? Water that seeps through the tailing impoundment is captured in the seepage collection ponds below the impoundment. We have no evidence that there is any tailing water lost to groundwater flows out of the drainage area.

Page 16, fourth paragraph, second sentence should read:

> *Piezometers and open-ended standpipes are used to monitor stability in the impoundment.*

Page 17, second paragraph, second sentence should read:

> *Therefore, to ensure no discharge of seepage to Bruno Creek, a lined sump was installed further downstream in the Bruno Creek drainage.*

Page 17, second paragraph, fifth sentence should read:

> *Seepage collected in both the seepage return pond and the downstream sump is pumped back to the reclaim water head tank at the mill.*

Page 18, second paragraph, last sentence should read:

> *Limited static testing performed on a whole tailings sample from which pyrite was recovered indicated a NP/AP ratio in excess of 4:1 compared to an average value of 0.84:1 for all tailings analyses (Steffen Robertson & Kirsten 1991a).*

Mine Water

Page 18, last paragraph, second sentence should read:

> *However, groundwater seepage to the pit began in 1988 when the pit reached the 7,300 foot elevation (a depth of about 1,000 feet below the surface).*

Page 18, last paragraph, fourth sentence should read:

> *According to Cyprus personnel, an average of 200 gpm of mine water is pumped out of the pit to a booster station and pumped to the tailings pond.*

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Page 18, last paragraph, after above fourth sentence the following sentence should be added:

Because the mill was down during spring runoff of 1991, mine water was combined with underflow collected from Pat Hughes Waste Rock dump and discharged through NPDES outfall 002 after receiving approval from EPA.

Page 19, second footnote at the bottom of the page, the following sentence should be added:

Laboratory contamination of the sample bottles is suspected as a source for the anomalous mercury values.

Other Materials and Wastes--Waste Oil/Grease/Fuel

Page 20, second paragraph, fourth sentence should read:

Two 13,000 underground tanks are used for gasoline storage. Waste oil is collected in two above ground 10,000 gallon tanks near the shops.

Capacitors

Page 20, last paragraph, should read:

Capacitors. Only one shipment of PCB contaminated capacitors was manifested and shipped off-site since startup of the mine. According to Cyprus there is no remaining PCB- contaminated electrical equipment on the Thompson Creek Mine property.

Regulatory Requirements and Compliance

Page 22, first paragraph, first sentence should read:

Cyprus Thompson Creek operates under several permits and/or approvals issued by the State of Idaho Department of Lands, Division of Environmental Quality, and Water Resources as well as approvals from the U.S. Forest Service (USFS) and EPA Region X.

Page 22, first paragraph, third sentence should read:

The interagency task force for the Thompson Creek site meets quarterly and includes representatives of the State Departments of Lands, Fish and Game, Department of Water Resources, and Divison of Environmental Quality, USFS, and BLM.

Page 22, fourth paragraph, delete the second sentence that states:

> *However, because of the proximity of their offices, USFS personnel are at the site almost daily.*

Water Quality Monitoring

Page 23, second paragraph, second sentence should read:

> *Monitoring for pH and metals is required to ensure no degradation of surface and ground water in the Salmon River basin (Cyprus 1991c).*

Acid Rock Drainage Study

Page 23, third paragraph, last sentence should be replaced with the following two sentences:

> *According to USFS personnel who participated in the site visit, the revisions to the Plan of Operations will be subjected to the environmental review requirements of the National Environmental Policy Act (NEPA). This review may include the preparation of a supplemental Environmental Impact Statement.*

Bonding

Page 23, fifth paragraph, last sentence: Delete "and insurance." Cyprus has met its bonding requirements through the posting of an appropriate surety bond. Our insurance status has nothing to do with bonding.

NPDES Permit

Page 28, third paragraph, the second and third sentences should read:

> *This pond discharges to Squaw Creek at NPDES outfall 003. Cyprus is required to monitor Squaw Creek upstream and downstream of this outfall for turbidity.*

Air Permit

Page 29, first bullet under Air Permit section should read:

> *Baghouses are located at the crusher, at the turning point of the conveyor, at the lime bin, at the product package area, and at the HPM plant,*

Page 29, fourth bullet, change the period at the end of the bullet to a comma.

Page 29, after fourth bullet, add fifth bullet stating:

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Holoflyte/Rotary kiln stack on HPM plant.

Dam Safety Permit

Page 29, third paragraph, first sentence should read:

As required under Idaho State law, Cyprus Thompson Creek has a dam safety permit issued by the Department of Water Resources for the main tailings embankment and the SRD.

APPENDIX C

EPA RESPONSES TO CYPRUS MINERALS COMPANY COMMENTS ON DRAFT SITE VISIT REPORT

EPA RESPONSES TO CYPRUS MINERALS COMPANY JUNE 5, 1992, COMMENTS ON DRAFT MINE SITE VISIT REPORT: CYPRUS THOMPSON CREEK MINE

A copy of the draft *Mine Site Visit: Cyprus Thompson Creek Mine* was provided to Cyprus Minerals Corporation for their review. EPA has addressed the comments submitted by Cyprus Thompson Creek (See Appendix C) in the revised report as described below:

Comment 1:Cyprus provided clarifications of the titles and corrected telephone numbers for several of the individuals who participated in the site visit.

Response:The text has been changed accordingly.

Comment 2:Cyprus clarified the ownership of specific areas of the property and indicated that the mine is 35 miles from Challis, ID.

Response:The text has been changed accordingly.

Comment 3:Cyprus clarified the general descriptions of the operations at the site.

Response:The text has been changed accordingly.

Comment 4:Cyprus indicated that the draft report described a surface water body, Unnamed Creek, that is not found at the site.

Response:References to Unnamed Creek have been deleted from the text and figures.

Comment 5:Cyprus indicated that the nearest drinking well is located at the Redbird Mine (3 miles from the site) not at the Ranger Station (6 miles from the site).

Response:The text has been changed accordingly.

Comment 6:Cyprus clarified the history of operations including indicating that milling operations resumed in November 1991.

Response:The report has been edited to reflect these change, including a parenthetical reference to the restart of milling operations after the site visit in November 1991.

Comment 7:Cyprus provided a corrected elevations for the current and planned depths of the pit.

Response:The text has been changed accordingly.

Comment 8:Cyprus clarified the description of mining operations, indicating that waste oil was no longer being used in the ANFO mixture (pending MSHA approval).

Response:

The text has been changed accordingly.

Comment 9:

Cyprus commented that while the stripping ratio was 4:1 in 1990, the average stripping ratio over the life the time is expected to be closer to 2:1.

Response:

The report has been edited to indicate an average stripping ratio of 2:1 over life of the mine.

Comment 10:

Cyprus provided clarification of the description of milling operations, including specific information about the HPM plant and the compositions of the high and lower, technical grade products. Cyprus further indicated that there are two separate dryers (a dryer for the HPM concentrate and a dryer for the technical grade concentrate). Cyprus noted that the gyratory crusher is equipped with a baghouse to control dust emissions (not water sprays). Water sprays are used to control dust emission from the portable crusher used to produce gravel.

Response:

The text has been changed accordingly.

Comment 11:

For the Buckskin dump, Cyprus provided corrected elevations for the top and bottom of the dump. In their written comments, the elevation of the bottom of the Buckskin was inadvertently listed as 7,600 feet. Cyprus was subsequently contacted telephone to clarify this information. Cyprus personnel indicated that the Buckskin dump currently extends from 8,100 feet down to 6,800 feet. In addition, Cyprus personnel noted that the has a second 300 foot wide bench at the 7,900 foot level. Cyprus further indicated that the NALCO coagulant is added to the sedimentation ponds located downstream of the waste rock piles to control TSS (not TDS).

Response:

The text has been changed accordingly.

Comment 12:

Cyprus summarized available acid base accounting data for the volcanic rocks.

Response:

The text has been changed accordingly.

Comment 13:

Cyprus clarified the annual quantity of tailings generated (based on full production and the current 10/4 mill operating schedule). Cyprus also corrected the frequency of concentrate and tailings analyses.

Response:

The text has been changed accordingly.

Comment 14:

Cyprus commented that the tailings pipeline is located in a ditch along it entire length to provide for secondary containment.

Response:

The report has been edited to reflect this comment. The revised report continues to indicate that the ditch is unlined.

Comment 15:

Cyprus requested deletion of the sentence "Cyprus personnel indicated that approximately 120 gpm of tailings water is lost to infiltration."

Response:

This sentence has been deleted from the report.

Comment 16:

Cyprus indicated that open-ended standpipes are used along with piezometers to monitor stability in the tailings impoundment.

Response:

The report has been edited to include this information.

Comment 17:

Cyprus indicated that the pumpback sump is lined (but not concrete) and that seepage collected in the SRD and the sump are returned directly to the mill (not the tailings impoundment).

Response:

The text has been changed accordingly.

Comment 18:

Cyprus provided corrected data on acid base accounting of tailings from which pyrite was recovered.

Response:

The text has been changed accordingly.

Comment 19:

Cyprus clarified mine water generation and management, specifically indicating that mine water is generally pumped to the tailings impoundment. Only during Spring 1991 (when the mill was shutdown), mine water was combined with the underflow from the Pat Hughes Dump and discharge through outfall 002 (with EPA's prior approval).

Response:

The text has been changed accordingly.

Comment 20:

Cyprus requested that the Footnote 1 in Table 2 indicate that Cyprus suspects that the "anomalous" mercury values were caused by laboratory contamination.

Response:

The footnote now reflects Cyprus' suggestion that the elevated levels were caused by laboratory contamination.

Comment 21:

Cyprus provided corrected volumes for several tanks. Cyprus further indicated that, during the life of the mine, there has been only one shipment of PCBs manifested and disposed off-site. According to Cyprus, there is no longer any PCB-contaminated electrical equipment at the site.

Response:

The text has been changed accordingly.

Comment 22:

Cyprus clarified the names of several State agencies that participate in the interagency Task Force, and requested deletion of the reference to USFS personnel visiting the site "almost daily."

Response:

The report has been edited to include the correct agency names and the reference to almost daily visits by USFS personnel has been deleted.

Comment 23:

Cyprus changed a reference from the Salmon Creek basin to the Salmon River basin.

Response:

The text has been changed accordingly.

Comment 24:

Cyprus indicated that the revisions to the Plan of Operations to address acid rock drainage will require NEPA review and may require a supplemental EIS.

Response:

The text has been changed accordingly.

Comment 25:

Cyprus indicated that their insurance status has no relation to their bonding.

Response:

The text has been changed accordingly.

Comment 26:

Cyprus clarified that the storm water sediment pond discharges to Squaw Creek, not Bruno Creek, and that monitoring is required above and below the pond discharge in Squaw Creek.

Response:

The text has been changed accordingly.

Comment 27:

Cyprus indicated that their air permit addresses a total of five emission sources, including the stacks of both holoflyte dryers/rotary kilns.

Response:

Both dryers have been identified as separate emission sources in the report. In addition, the section now indicates that water sprays are used to control emissions from the portable crusher.

Comment 28:

Cyprus clarified that the Department of Water Resources is the issuing agency for their dam safety permit.

Response:

The text has been changed accordingly.