MINE SITE VISIT:

BREWER GOLD COMPANY

U.S. Environmental Protection Agency
Office of Solid Waste
401 M Street S.W.
Washington, D.C. 20460

2.0 SITE VISIT REPORT: BREWER MINE

2.1 INTRODUCTION

2.1.1 Background

The U.S. Environmental Protection Agency (EPA) is assisting states to improve their mining programs. As part of this ongoing effort, EPA is gathering data related to waste generation and management practices by conducting site visits to mine sites. As one of several site visits, EPA visited Brewer Gold Company's facility near Jefferson, South Carolina on September 24, 1991.

Sites to be visited were selected to represent both an array of mining industry sectors and different regional geographies. All sites visits have been conducted pursuant to RCRA Sections 3001 and 3007 information collection authorities. When sites have been on Federal land, EPA has invited representatives of the land management agencies (Forest Service and/or Bureau of Land Management) to participate. State agency representatives and EPA regional personnel have also been invited to participate in each site visit.

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

In preparing this report, EPA collected information from a variety of sources, including the Brewer Gold Company, the South Carolina Department of Health and Environmental Control (DHEC), the South Carolina Land Resources Commission (LRC), information from telephone conversations with Brewer Gold Company and with DHEC and LRC, and from other published sources. The following individuals participated in the Brewer Gold Company site visit on September 24, 1991:

<u>Brewer Gold Company</u>

Ken Barnes, Mine Maintenance Superintendent	(803) 658-3039
Gary Froemming, Mine Supervisor (803) 658-3039	
R.M. Mattson, General Manager	(803) 658-3039
Jaye Pickards, Plant Supervisor	(803) 658-3039
Scott Wanstedt, Environmental Engineer (803) 658-3039	
Mark Zwaschka, Geologist	(803) 658-3039

S.C. Land Resources Commission, Division of Mining and Reclamation

Craig Kennedy, Assistant Director
(803) 734-9100
Pat Walker, Director (803) 734-9100

S.C. Department of Health and Environmental Control

Ed E. Hart, Facility Evaluator (803) 662-3522
Marion R. Rembert, District Director
(803) 662-3522

U.S. Environmental Protection Agency

Van Housman, Chemical Engineer
(703) 308-8419

Science Applications International Corporation

Jack Mozingo, Environmental Scientist
(703) 734-2513
Jonathan M. Passe, Regulatory Analyst
(703) 821-4831

Participants in the site visit were provided an opportunity to comment on a draft of this report. Comments were submitted by the Brewer Gold Company and the State of South Carolina. Brewer Gold Company comments are presented in Appendix 2-A; State Comments are presented in Appendices 2-B and 2-C. EPA's response to the Brewer Company's and State comments are presented in Appendices 2-D and 2-E.

2.1.2 General Facility Description

The Brewer Gold Mine is located in Chesterfield County, South Carolina, approximately 1.5 miles west of the town of Jefferson (see Figure 2-1

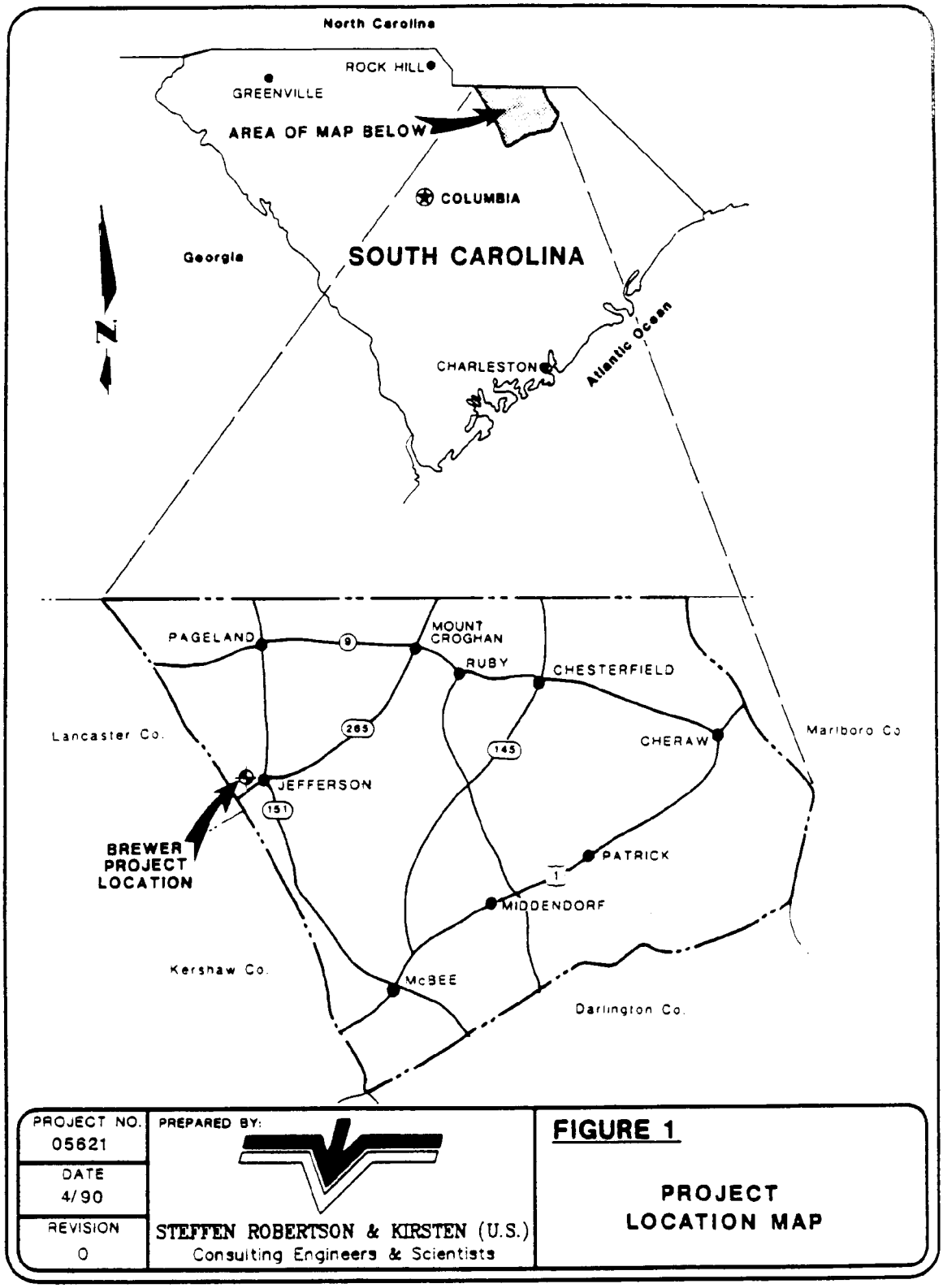


Figure 2-1. Location of Brewer Gold Mine

(Source: Figure 1 in Brewer Gold Company, 1990b)

). The mine site is situated on a ridge between Lynches River on the west and Little Fork Creek (a tributary to Lynches River) to the east. Highway 265 bounds the property on the southern side (Brewer Gold Company Description). The predominant land uses within four miles of the Brewer site include urban (the town of Jefferson), farming, commercial/light industry (poultry), and undeveloped forest area. There is no zoning in Chesterfield County.

The Brewer Gold facility is sited on privately owned lands. The total area disturbed by the facility is estimated to be slightly over 200 acres, with a reserve (currently inactive) of an additional 20 acres. Ore is mined from the Brewer Pit using open pit methods, although the current pit intersects old underground workings. Ore is hauled to on-site crushers, agglomerated, and conveyed to a heap leach pad. The Brewer Gold facility uses a cyanide solution to recover gold from ore that has been crushed and placed on leach pads. Leachate collected from the leach heaps is carbon stripped and gold is then electrowon, electroplated, and melted into dore bars in the facility's crucible furnace.

Gold was first mined at the Brewer site in the late 1820s; by the late 1800s, a substantial operation, including a 40-stamp mill, was underway at the property. Operations ceased in 1941, and significant exploration activity did not restart until the late 1970s, when gold prices sparked renewed interest in the area. The corporate predecessor to Westmont, which was Brewer Gold Company's former parent company, commenced exploration in 1983 and, during the period 1984 through 1986, carried out exploration and engineering feasibility studies, leading to a project go-ahead decision in January 1987. The construction period lasted six months, and the first gold was poured in early August 1987 (Brewer Gold Company, undated).

Between June 1987 and the end of March 1991, Brewer Gold Company removed from its pit a total of 9.2 million tons[1] of combined ore and waste, of which 3.8 million tons were ore that was crushed and beneficiated. Cumulative gold production from the Brewer site prior to the 1980s is estimated at 22,000 troy ounces. Since start-up in 1987, through March 1991, Brewer Gold Company has produced 118,087 ounces. Thus, the estimated total production to date from the Brewer site is estimated to be in excess of 140,000 ounces. Small amounts of silver are also recovered at the facility (Brewer Gold Company, undated).

Production at the Brewer mine was suspended following a cyanide spill caused by a dam failure on October 28, 1990. Production resumed on June 20, 1991. Projected 1991 production was 23,000 troy ounces of gold; projected 1992 production was 38,000 troy ounces. The total life of the mine was originally estimated to be approximately 5 years, with 2 to 2.5 years of known, minable reserves remaining at the time of the site visit. Additional exploration on-site and in nearby areas may extend the life of the mine (EPA, 1991).

2.1.3 Environmental Setting

2.1.3.1 Surface Water

[1]In this report, "tons" refers to short tons (2,000 pounds). "Ounces" refers to troy ounces (1 troy ounce is equal to 0.06857 pound).

The immediate discharge point for the Brewer Gold Company facility is Little Fork Creek. The Creek is designated by the State of South Carolina as a Class B water (i.e., suitable for secondary contact recreation, as a drinking water supply after conventional treatment, and for fishing, agricultural, and industrial uses). The principle use is for cattle watering. The Creek has no significant floodplain since it occupies a relatively narrow valley. Little Fork Creek has several smaller tributaries, including a stream that receives discharge from an adit from the historic workings and which drains the present pit. Little Fork Creek discharges to Fork Creek about two miles downstream from the Brewer site; Fork Creek enters Lynches River about one-half mile below that.

Average monthly stream flows in Little Fork Creek range from 3.9 cubic feet per second (cfs), or 1,743 gallons per minute (gpm), in October to 34.4 cfs (15,456 gpm) in March. In Fork Creek, average monthly stream flow ranges from 6.3 cfs in October to 55.8 cfs in March (Brewer Gold Company, 1991b).

A water quality study was conducted on Little Fork Creek as part of an overall Ecological Assessment performed by a Brewer contractor for the initial mining permit application. The study found pH values in the Creek and its tributaries ranging from 6.49 to 7.35. At sampling point LCF-2A, upstream of Brewer's permitted discharge point but affected by discharge from an adit from the historic mine workings, pH was measured at 3.55. Samples from this location also indicated elevated sulfate levels due to the presence of oxidized pyrite. Concentrations of barium, cadmium, chromium, lead, mercury, selenium, silver, and zinc were at or below detection limits for all creek water samples. Arsenic concentrations were quantifiable, but all were well below EPA's 0.05 mg/L drinking water standard. Copper levels at the mine adit discharge were recorded at 0.26 mg/L and were below the detection limit at all other sampling stations. Iron concentrations at all sampling points in the Creek ranged from 2.10 mg/L to 2.99 mg/L. All measured tributaries, however, exhibited lower iron levels (Environmental and Chemical Services, Inc., 1987).

Subsequent to a release of cyanide solution into the Creek in October 1990, Brewer commissioned a study of macroinvertebrates and fish communities in Little Fork and Fork Creeks (the facility's current NPDES permit requires macroinvertebrate studies twice a year; the permit was being revised at the time of the site visit and the draft permit would require macroinvertebrate studies three times per year). This particular study, conducted in March 1991, indicated that communities downstream of the cyanide spill continued to show signs of impact several months after the spill event. Specifically, taxa richness and number of individuals were reduced downstream of the release point. The study also noted that macroinvertebrate and fish populations in Lynches River had rebounded since the spill incident and that further improvement was expected (Shealy Environmental Services, Inc., 1991).

2.1.3.2 Geology

The Brewer deposit is a crudely formed, crescent-shaped breccia body approximately 1,100 feet long by an average of 300 feet wide. Ore grade material is encountered to depths of over 400 feet. The grade of the deposit averages 0.040 ounces of gold per ton of ore (Brewer Gold Company, undated).

The Brewer mine property lies on the contact between the Piedmont and Coastal Plains geomorphic provinces. The complex geology of the Brewer mine consists of cross-cutting breccia pipes occurring near the contact of the Persimmon Fork formation and the overlying Richtex argillites of the Piedmont. The Brewer breccia is a heterolithic breccia believed to be of multi-episodic hydrothermal origin. Subsequent faulting and folding of this entire rock group has formed a complex ore body (Brewer Gold Company, undated; Scheetz et al., 1991).

The dominant minerals in the breccia are quartz, pyrite, enargite, and topaz. Accessory minerals observed are cassiterite, covellite, bornite, tennantite, bismuth, sphalerite, galena, cinnabar, and gold. The elemental signature for the breccia has been reported to be iron, manganese, copper, molybdenum, arsenic, silver, magnesium, gold, and mercury. The primary gold mineralization is confined to a composite hydrothermal breccia body in which several periods of brecciation and hydrothermal fluid migration can be documented. The gold is thought to have been deposited in the breccia by hydrothermal action (Brewer Gold Company, undated; Scheetz et al., 1991).

A local fractured system is present in the Brewer area. The area is classified by the U.S. Geological Survey as being between a 2 and 3 seismic zone. These zones are based on the distribution of historical, damaging earthquakes, their intensities, evidence of strain release, and distributions of geological structures related to earthquake activity.

2.1.3.3 Hydrogeology

The depth to the uppermost aquifer (unnamed) below the Brewer facility ranges from 10 to over 100 feet. Depth to the aquifer is controlled by local topography. The aquifer is estimated to be thicker than 100 feet. The aquifer is classified as a Class II aquifer by EPA (current and potential source of drinking water and having other beneficial uses) and as a Class GB aquifer (similar to EPA's Class II designation) by the State of South Carolina. This aquifer supplies water to the Brewer facility through two main wells that reached water at about 50 feet and are about 250 to 300 feet deep. Other uses of the aquifer were not known. Interconnections between this aquifer and others (e.g., alluvial aquifers) were not described.

Private wells in the area (for agricultural and commercial/industrial usage) use shallow alluvial aquifers associated with surface water bodies. The facility is located between 0.5 and 1 mile from the nearest drinking water well and over 4 miles from the nearest public water system (which was said to probably be in Pageland, S.C., upstream of the site). Nearby drinking water wells were sampled in 1990-1991 and the water was found to be within State standards. The Brewer facility itself uses bottled water for drinking water.

2.2 FACILITY OPERATIONS

The Brewer site, which is named for the original owner of the property, has had a long history of intermittent mining operations, some of which were for minerals other than gold. It has been reported that a miner named Fudge first worked the site, presumably for iron, before the Revolutionary War. Gold was first discovered at the site in 1827 or 1828. Gold was first produced at Brewer in 1828 from placer deposits using gold pans, sluice boxes, and other similar devices that used water and gravity to separate gold from the ore (Brewer Gold Company, undated).

Hydraulic mining began at the site in 1877. In this process, jets of water under high pressure washed loosely consolidated material into sluice boxes where gold was recovered. A five-stamp mill was built in 1885 and enlarged to a 40-stamp mill in 1888. In 1887, an adit, the present drainage tunnel from the bottom of the Brewer pit, was driven westward for approximately 1,000 feet into the hillside under the main ore zone. The mine was opened from below by a raise driven up through the ore body, connecting it to the pit above. It was these workings that were enlarged to create the old Brewer pit. A narrow gauge track was laid in the tunnel and ore was hauled to a mill by a small locomotive. The 40-stamp mill was located on Little Fork Creek downstream from the lower portal of the tunnel (Brewer Gold Company, undated).

Nicor Mineral Ventures and Gold Resources, Inc. entered into a joint venture in September 1983 to conduct exploration and a possible development program for the Brewer gold deposit. Exploration and bulk sampling was conducted between 1984 and 1986, when the feasibility study for a modern project was completed. Also in 1986, Costain Holdings (or a subsidiary, Costain Minerals) acquired Nicor Mineral Ventures and formed a new company known as Westmont Mining, Inc. In March 1987, Westmont Mining began breaking ground for the processing facilities of the Brewer Gold project. The Brewer Gold Company was formed as a subsidiary of Westmont in July 1987 to operate the newly constructed facilities. (In 1991, Brewer Gold became a direct subsidiary of Costain when Westmont was sold to Cambior USA.) Pre-production stripping began in June, ore crushing in July, and the first gold was produced by the Brewer Gold Company in August 1987. Brewer Gold currently employs approximately 104 people in its mine, crushing plant, carbon adsorption plant, on-site laboratory, and administrative office (Brewer Gold Company, undated).

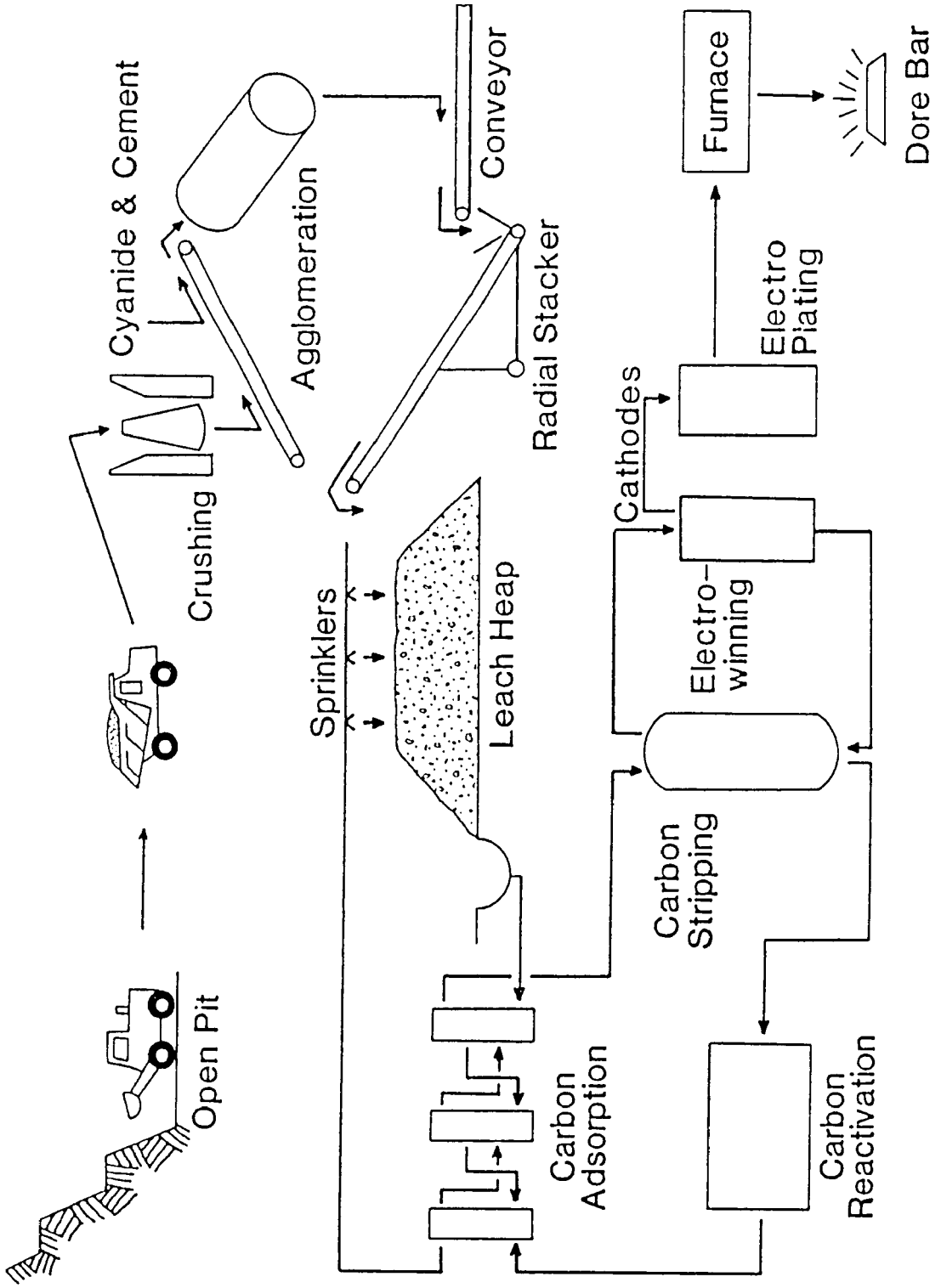
2.2.1 Mining Operations

Mining operations at the Brewer pit remove approximately 5,500 tons of ore per day (tpd) and an additional 6,500 tpd of waste rock for a total production of 12,000 tpd. (Brewer Gold Company, undated). Blastholes with a 6.5-inch-diameter are drilled using a crawler drill (with air compressor) to a depth of 22 feet on a 14-foot by 14-foot pattern. Drill cores or cuttings are assayed to determine the gold content (i.e., whether material is to be leached or considered low-grade ore or waste rock). The holes are filled with ammonium nitrate fuel oil (ANFO) and the rock is blasted. A six cubic yard hydraulic shovel or front-end loader then loads the broken rock into 35-ton haul trucks, which carry the material either to the waste rock and low-grade ore pile or to the 60,000- to 100,000-ton capacity ore surge pile near the crushing circuit (Brewer Gold Company, undated). The facility's unlined waste rock dump covers a 17 acre area and contains 4.5 million

tons of waste rock (waste rock cutoff = 0.017 ounces of gold per ton) as well as 550,000 tons of low-grade ore (i.e., material with from 0.01 to 0.017 ounces of gold per ton). One section of the pile contains 20,000 to 30,000 tons of high sulfide material, which may contain gold values higher than the cutoff grades.

2.2.2 Beneficiation Operations

Ore is fed by a 7.5-cubic-yard front-end loader from the run-of-mine ore stockpile onto a vibrating feeder grizzly (see process flowsheet in Figure 2-2



and site map in Figure 2-3). Oversize from this grizzly feeds a 30-inch by 42-inch primary jaw crusher,

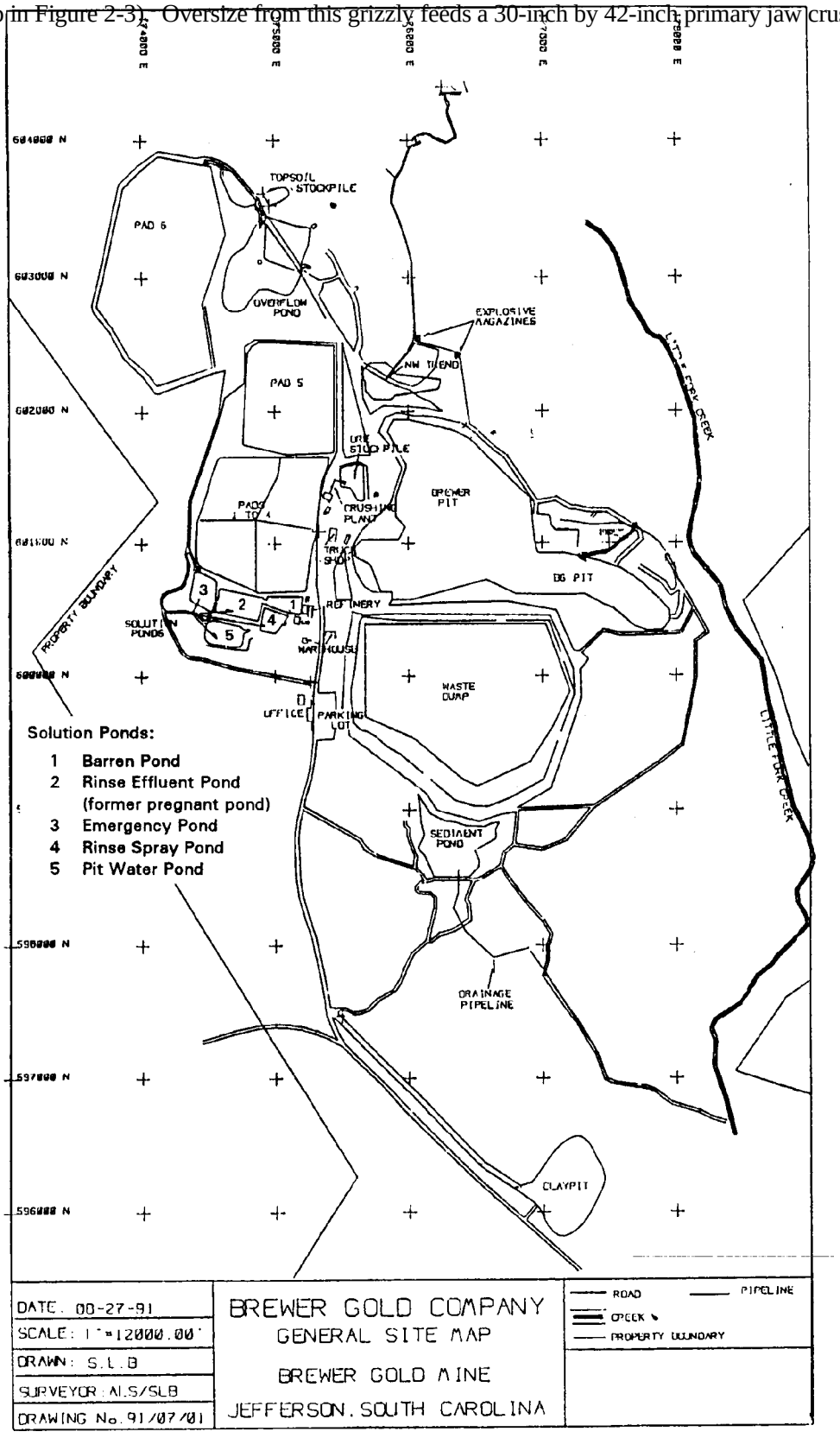


Figure 2-3. Location of Facility Operations, Brewer Gold Mine

which discharges onto a belt feeding a double-neck screen. Material less than one inch in diameter falls through the screen and oversize material enters a secondary cone crusher where it is crushed to less than 1 inch. Ore from the secondary crusher is screened and placed on a 10,000-ton surge pile, from which it is later reclaimed and fed into the agglomerator. As this material is conveyed to the agglomerator, it passes over a weightometer and under a cement silo (capacity = 125,000 pounds), where approximately six pounds of cement per ton of ore is added (the cement serves to bind fine materials to enhance agglomeration). The ore is then fed into a rotating agglomerator drum (10-foot-diameter by 21-foot-long), where barren dilute sodium cyanide solution, a polymer agglomerating aid, and calcium cyanide are added to the ore (rates per ton of ore were not obtained). The agglomerator mixes the material such that the fine particles are either cemented into coarser particles or are rolled into porous balls. When stacked into heaps, this enhances percolation of leaching solutions (Brewer Gold Company, undated).

Agglomerated ore is transferred to the Pad 6 heap via a series of conveyor belts and an ore stacker. The heap is stacked to approximately 35 feet in height using a radial stacker. This heap covers about 1,100,000 square feet and has an ultimate capacity of about 2,400,000 tons of ore. Dilute cyanide solution (200 ppm) is pumped from a double-lined Barren Pond (7-feet deep) located next to the carbon adsorption plant to sprinklers located on top of the Pad 6 heap. The solution is generally applied at a rate of 200 to 250 gpm. This barren solution, containing little or no gold, percolates through the ore heaps, dissolving gold particles with which it comes in contact. The resulting "pregnant solution" (i.e., loaded with gold) is conveyed along the impervious primary liner (60-mil HDPE, which is underlain by twelve inches of compacted clay) and in lined ditches into a sump on one corner of the pad. From the sump, it is pumped to the carbon plant (see site map in Figure 2-3) (Brewer Gold Company, undated). Excess solution (e.g., from rain infiltration) flows through lined ditches to the Pad 6 Overflow Pond, from which it can be pumped to the carbon plant. Leaching has been completed on pads 1 through 5 and 5A and ore is currently being rinsed, as described in section 2.3.3.

In addition to cyanide leaching on Pad 6, Brewer has placed a test pile of high-sulfide ore on a section of the pad. This material is being leached with water, which acidifies and removes copper as it percolates through the ore. The test is intended to determine whether copper recovery is feasible and/or if the copper content of the sulfide ore can be reduced to the point where gold recovery via cyanide leaching is feasible. According to Brewer representatives, copper concentrations had been reduced from 4,000 to 400 ppm (the date when leaching began was not determined).

The carbon adsorption circuit is a closed-loop countercurrent flow system consisting of five gravity flow carbon columns. Each column is 6-foot-diameter by 8-foot-high, has a capacity of just over one ton of carbon (roasted coconut shells), and is designed to a handle a nominal flow of 600 gallons of solution per minute. Carbon particles are advanced through the series as gold (and other metals) is adsorbed on the surface of the activated carbon. Pregnant solution is pumped from the sump on Pad 6 (and/or from the pad 6 overflow pond) via pipeline to the carbon circuit. After the solution has passed through all five stages (columns) of carbon, it is discharged to the double-lined Barren Pond (which is immediately below the circuit), refortified

with cyanide, and pumped back to Pad 6 (Brewer Gold Company, undated). Excess barren solution may be treated with hydrogen peroxide and calcium hypochlorite (for cyanide) and flocculants (for metals) and discharged to the Sediment Pond or used as rinsewater.

When the carbon becomes laden with gold values (up to approximately 100 pounds of gold per ton, or 18 to 24 hours of adsorption time), it is pumped out of the column system and loaded into a stripping vessel. In the stripping process, adsorption is reversed using a three to four percent cyanide/strong caustic (pH = 13.5) electrolyte solution and the gold is electrowon onto steel wool cathodes (Brewer Gold Company, undated).

Typically, Brewer maintains a 4 to 1 ratio of cyanide to copper in the electrolyte solution to improve the dore quality by binding the copper and cyanide. The electrolyte solution is changed weekly and discharged to the facility's Barren Pond (volume was not determined). This solution typically contains 4,000 ppm copper. Sludges are scraped out of the electrowinning cells monthly and sent off-site to recover copper and silver values.

The stripped carbon is first washed with nitric acid to remove organic material and silica that interfere with the reactivation process. The wash from this process is discharged to the Barren Pond and neutralized by the high-pH barren solution (volumes of discharge from the acid wash were not obtained). Carbon regeneration involves treatment with a hot caustic (one percent)/weak cyanide (0.25 - 0.5 percent) solution and heating to 270° F. Regenerated carbon particles are placed back into the carbon adsorption circuit. An average of four percent of the carbon is lost as fines during reactivation. This material is sold to an out-of-state firm that recovers additional gold values.

The gold-loaded steel wool is then transferred to an electrorefining cell, where gold is removed from the steel wool by replating onto stainless steel cathode plates. Gold is then scraped from these plates and melted in a natural gas-fired furnace at a temperature of approximately 2,000 ° F. to produce gold dore bars which are shipped to refiners. The dore bars are composed of approximately 80 to 84 percent gold, copper, silver, and other trace elements. On average, the Brewer Gold Company facility produces 100 troy ounces of dore gold per day.

Furnace slag (about one ton per year) and graphite crucibles from the facility furnace also are sold to an out-of-state firm that recovers additional gold values from the sources. In 1990, approximately 200 troy ounces of gold were recovered from these sources and from the electrowinning sludges and carbon fines discussed above.

2.2.3 Chemical Usage

Table 2-1 summarizes Brewer Gold Company's chemical purchases from January 1, 1991 through September 25, 1991. As noted above, from the beginning of 1991 (actually, from October 1990) through June 20, the facility had suspended the addition of new cyanide to leaching solutions, although leachate (and rinsate) continued to be recirculated through the system.

Table 2-1. Brewer Gold Company Chemical Purchases, January - September 1991

Chemical	Quantity
Caustic soda	45,000 pounds
Hydrated lime	180,880 gallons
Nitric acid	1,540 gallons
Calcium cyanide	476,000 pounds
Sodium cyanide	88,000 pounds
Hydrogen peroxide (50%)	784,000 pounds
Drew Chargepak 5 (floc)	2,090 gallons
Drew MP-3r Amersep. (floc)	1,980 gallons
Exxon Sureflo 7647 (antiscalant)	5,000 gallons

Source: Brewer Gold Company, 1991g

2.3 MATERIALS AND WASTE MANAGEMENT

For purposes of this discussion, materials management practices at the Brewer Gold Company mine are divided into process and waste management units. Process units are those that contain materials that are not considered wastes until after facility closure. Examples of process units (and process materials) are heap leach pads (and spent ore) and the open pit (and mine water in the pit during operation). Waste units are those that contain materials that will undergo no further beneficiation. Examples of these include waste rock piles and wastewater holding ponds.

The following section describes waste and material management at the Brewer Gold Company site. Also included is a discussion of current closure and reclamation plans for each mine component. Actual closure practices and requirements will be determined by the State as the end of the mine's active life approaches.

2.3.1 Mine Pit and Water

The total disturbance of the Brewer pit is approximately 33 acres. From the highest point of 580 feet above sea level, the pit has now reached an elevation of about 400 feet. In addition, Brewer was considering (at the time of the site visit) mining an off-site satellite pit beginning in February 1992, pending the appropriate permits from DHEC and the Land Resources Commission. Ore will be trucked to the present site for beneficiation and processing (the pit is located in adjacent Lancaster County near the town of Kershaw). Upon cessation of operations at the Brewer site, pit dewatering will cease and the water table will be allowed to return to its near-natural level, which will form a small lake in the lower extremities of the pit. The natural water table is approximately the level to which mining has currently reached, so continual dewatering has not

been necessary to date. According to Brewer representatives, the pit will be excavated to some additional depth (estimated to be about 100 feet, to the 300 foot level), so there will be a "lake" in the pit after closure. As more sulfide-bearing minerals are exposed to an oxidizing environment as the pit deepens, acid generation may occur.

Upon closure, reclamation of the pit will involve stabilizing the slopes by dozing and blasting areas determined to be unstable (Brewer Gold Company, 1990b). According to the Land Resources Commission, sloping to a 3H:1V gradient will be required in the upper portions of the pit wall where saprolite and soil exist. After sloping is completed, vegetation will be established. As noted, the pit will contain water upon closure. Upon final reclamation, this water will be required to meet applicable water quality standards for lakes, as promulgated by DHEC. Due to the acid generation potential in the lower portions of the Brewer pit, Brewer has proposed that process solutions may be diverted directly to the pit. This would decrease the time necessary to fill the pit with water, which would minimize the time that sulfide minerals in the pit would be exposed to an oxidizing environment. In addition, because the process solution will have an elevated pH, it could act as a buffering agent for any acid that may have formed in the pit.

Pit water includes any ground water infiltrating into the pit, precipitation directly entering the pit, and any site runoff that flows into the pit. These waters currently drain out of the pit through an old adit previously used in underground mining operations at the site, which also drains underground workings. A.S.C.I. (1990) referred to pH values of 2 and relatively high copper concentrations in adit discharges, but further information on adit or pit water quality was not available.

The facility's NPDES permit, as modified in late 1990, requires the installation and use of a treatment system for pit water prior to its discharge via internal outfall to the Sediment Pond (see discussion of Construction Permits 16,727 and 17,170 in section 2.4 below). With this treatment system, pit water will be pumped from the pit to a double-lined 3.5 million gallon pond near the carbon circuit and treated with lime and flocculants to adjust pH and reduce metals (particularly copper). From there, water will be used to supply the rinse circuit or discharged to the Sediment Pond prior to discharge via existing NPDES outfall 001. Brewer estimates that discharge to the Sediment Pond will average between 75 and 100 gpm. Brewer representatives indicated during the site visit that the treatment system had been completed and was awaiting State approval before being placed in service; according to DHEC, the system obtained an operating permit on February 14, 1992. Brewer representatives also indicated that the old adit, through which pit water was previously discharged, would be plugged at the upstream end (i.e., at the pit). Discussions between Brewer and the State were ongoing concerning the remaining ground-water drainage from the old adit once the upstream end is plugged.

2.3.2 Waste Rock Pile

The stripping ratio of the Brewer Mine is approximately 1.2:1. To date, about 4.5 million tons of waste rock have been disposed in an unlined multi-lift pile covering an area of 17 acres. Site preparation for the waste

pile consisted of compacting native soil. Runoff from the pile, which is located immediately south of and adjacent to the Brewer pit, drains into the facility's Sediment Pond and the mine pit.

Waste rock (cutoff = 0.017 ounces of gold per ton of rock) at the Brewer facility is typically alumina/silica rock containing quartz and one to three percent pyrite. Low-grade ore (0.01 to 0.017 ounces of gold per ton of rock) is placed in a designated area of the pile. There are currently 550,000 tons of low-grade set-aside ore in the waste rock pile. In addition, high sulfide material is segregated in a discrete section of the waste rock pile for potential future use or disposal (oxide and mixed materials have very little buffering capacity, so mixed disposal was determined to have little benefit in mitigating acid potential [A.S.C.I., 1990]). To date, only 20,000 to 30,000 tons of high sulfide material have been removed from the mine, although as the pit extends downward, the percentage of sulfide material may increase. Drainage from this area of the pile flows into the Brewer pit.

Samples of waste rock taken in 1988 (no information was available on locations or types of samples) showed total sulfur values ranging from less than one percent to over 17 percent. Acid generation potential of waste rock, based on humidity cell testing, is described as "moderate" (no definition of "moderate" was provided) (A.S.C.I., 1990).

As described in section 2.4.1.1, Brewer monitors ground water in three wells near the waste rock pile and Sediment Pond.

Closure activities are expected to require special grading and site preparation. Specifically, to minimize erosive forces of runoff, grading of the top portion of the waste will be towards the northeast and away from the side slopes, thus limiting overland flows down the slopes to incidental precipitation. Current plans are to direct the runoff into the mine pit for additional sediment control. Other reclamation may include the installation of an impermeable cap for acid control and a layer of non-toxic material and/or topsoil to support vegetation and maintain the integrity of the cap (Brewer Gold Company, 1990b).

Closure activities for the high sulfide section of the pile are expected to involve grading and in-place encapsulation with either a compacted clay layer or a synthetic layer to restrict water movement through the material to limit oxidation and transport of acid. Other acid control technologies, such as active treatment of sulfide materials with lime or the addition of bacterial inhibitors, are also being evaluated. (Brewer Gold Company, 1990b)

The Land Resources Commission emphasizes that the present closure plan (Brewer Gold Company, 1990b) is preliminary and was based on partial data in order to develop conceptual plans for closure. A final closure plan will be required, with more information derived from operational data and additional test data, and will specify proper closure requirements for the waste rock dump, leach pad(s), acid generation potential, pit water chemistry, and plant process facilities.

2.3.3 Leach Pads and Spent Ore

There are seven heap leach pads, which cover about 53 acres, at the Brewer site. Currently, only Pad 6 is being actively leached. Pads 1 through 5 and 5A are being rinsed to reduce cyanide levels and pH. Pads 1 through 5 and 5A contain about 2.8 million tons of spent ore.

Pads 1 through 4 are contiguous, each measuring approximately 170,000 square feet. They were constructed with a 40-mil HDPE primary liner over 12 inches of compacted "silty clayey colluvial material;" there is no leak detection system between or below the liners (Steffen Robertson & Kirsten, undated). These pads were part of the original facility construction. Pad 5, constructed in 1988, was initially intended to be an on-off leach pad of 425,000 square feet with an asphalt base; the use of asphalt was intended to minimize the risk of liner degradation during ore movement. The on-off plan was subsequently abandoned (in 1989) and spent ore remains on the pad during rinsing until its ultimate fate at closure is determined. Pad 5 asphalt has a permeability of $2x10^{-6}$ to $1x10^{-7}$, with a $1x10^{-9}$ rubber membrane in the center of the asphalt. The asphalt overlies 12 inches of crushed stone with a fabric filter and a french drain leak detection system around the downgradient perimeter. There also is a leak detection sump. Pad 5A covers a 60,000 square foot area between Pads 1-4 and Pad 5. Except for the portions of Pad 5A located on the asphalt apron of Pad 5, Pad 5A has a 60-mil HDPE liner over compacted clay; only the asphalt portion of Pad 5A has leak detection capability.

Active cyanide leaching was concluded on Pads 1 through 5 and 5A prior to 1990, and full-scale rinsing began in mid-1990. Although South Carolina law does not require rinsing to a specific cyanide concentration (levels must be "to the satisfaction of the State"), the State requires Brewer to rinse the spent ore on the heap leach pads until cyanide and metal concentrations in rinsate reach acceptable levels (either NPDES water quality standards or drinking water standards, depending on the ultimate fate of the spent ore). According to DHEC, when the free cyanide concentration reaches 0.2 ppm, it will trigger monthly rinsate testing for NPDES parameters and for free, total, and weak acid dissociable cyanide. The State considers that this will demonstrate that adequate rinsing has been conducted as well as aid in determining specific closure methods for the spent heaps. According to the Land Resources Commission, heaps closed and reclaimed in-place (as these may be, since the decision had not been made) will have to demonstrate that runoff will not adversely affect aquatic life in neighboring streams.

Brewer Gold Company received a permit to modify its calcium hypochlorite treatment system by adding hydrogen peroxide treatment in May 1990 (DHEC, 1990d). The system is intended to treat rinsate as well as other cyanide-bearing waters prior to re-use in rinsing or discharge to the Sediment Pond. (The extent to which the system had been used for rinsate by early 1991 was not clear. Brewer's "Status Report and Schedule for Rinsing" [Brewer Gold Company, 1991e] indicates at one point that rinsing through June 1991 involved "no treatment whatsoever." At another point, the report indicates that the hydrogen peroxide solution treatment system "has been successfully utilized for the production of clean rinse solution since its installation.") In any event, the treatment system previously involved the use of calcium hypochlorite for cyanide destruction. The new system involves the addition of hydrogen peroxide to the rinse solution. A

flocculent may also be added to the treated solution prior to settling (Steffen Robertson and Kirsten, 1990). Rinsate is generally applied to the heaps at 600 gpm. Brewer estimated in March 1991 that rinsing of Pads 1 through 5 and 5A would take an additional 661 days for cyanide concentrations to reach the levels required; as of March 1991, cyanide concentrations had decreased from about 300 ppm to 10 ppm or less (Brewer Gold Company, 1991e).

Rinsate from Pad 5 collects in a sump on the pad and is either pumped to the treatment plant or re-applied without treatment. Rinsate from pads 1 through 4 collects in a common sump or drains to a double-lined rinse effluent pond (the former pregnant pond for pads 1 through 4). After peroxide treatment (and flocculation), the solution is stored in a double-lined rinse settling/reclaim pond, from which it is recirculated to the pads under rinse or used as cyanide leachate makeup and applied to Pad 6. Excess rinsate is treated and discharged to the Sediment Pond. (Steffen Robertson and Kirsten, 1990; EPA, 1991)

Pad 6 covers an area of between 1 and 1.2 million square feet and has an ultimate ore capacity of about 2.4 million tons of agglomerated ore. Most of Pad 6 now contains a single 35-foot lift of ore, and only a small portion of liner remained uncovered at the time of the site visit (a larger area of liner was exposed during heavy rains in October 1990, which contributed to water management problems at that time). A second 35-foot lift was expected to be added to Pad 6 beginning in late 1991 (EPA, 1991). Pregnant solution is collected in a sump at one corner of Pad 6 before being pumped to the carbon adsorption circuit. Excess solution from infiltration of rainfall and runoff drain via lined ditches that surround the heap to the Pad 6 overflow pond (see section 2.3.5 below) prior to being pumped to the carbon circuit.

As described in section 2.4.1.1, Brewer monitors ground water in four wells near Pad 6. Results of monitoring are presented in that section.

When cyanide leaching is completed, Pad 6 also will be rinsed to reduce cyanide and metal concentrations. Brewer estimates that one year of rinsing at 1,600 gpm, beginning in 1993 or 1994, will be sufficient to achieve cyanide levels below 0.2 ppm (Brewer Gold Company, 1991e). No information was available on the ultimate fate of the high sulfide ore being water-leached on a small area of Pad 6 at the time of the site visit.

Samples of spent ore were tested for Extraction Procedure (EP) Toxicity and were found not to demonstrate this hazardous characteristic (sources and numbers of samples, dates, and other information on this sampling were not available). Tests in 1988 for acid production potential/acid neutralization potential (in tons of $CaCO_3$/kTon) indicated that the "acid generation potential is high." It also was not known if lime that is added to ore for pH control will prevent long-term acid generation (A.S.C.I., 1990).

Once rinsing is completed on the various pads, Brewer will have several options for managing the spent ore, depending on the quality of rinsate and solid sample tests. In general, the option ultimately selected by Brewer and approved by the State will depend on the success of rinsing in reducing pH and concentrations of cyanide and copper and other metals and on the quality of rinsate. Options include:

- If concentrations in rinsate and solid samples meet NPDES water quality-based limits, spent ore may be off-loaded, subject to erosion and sediment control requirements of the Land Resources Commission

- If rinsate meets drinking water standards but not water quality-based limits, spent ore may be off-loaded to a pit with no surface water discharge

- If neither drinking water standards nor water quality-based limits are met, the material may have to be encapsulated to prevent discharge to either surface or ground water and would be subject to applicable requirements of DHEC's Bureau of Solid and Hazardous Waste.

Heap reclamation activities will involve grading of side slopes to an overall slope of 3H:1V and revegetating, with added provisions for runoff control and stabilization, as heap slumping has been a problem at the facility in the past (Brewer Gold Company, 1990b). Problems with slumping and excess sediment in rinse ponds had led to a temporary suspension of rinsing on pads 1 through 4; these pads were being regraded and reshaped to a slope of 3H:1V and revegetated before rinsing was continued (Brewer Gold Company, 1991f). This is intended to stabilize the slopes and enhance percolation. During the site visit, it was observed that some slopes of pads 1 through 4 had well-established grasses.

Brewer has proposed that at closure, intermediate bench slopes be graded to control surface runoff and erosion. All final slopes will be covered with topsoil, fertilized, and revegetated. In addition, the leachate collection pond will be maintained to collect subsequent leachate from heaps due to incidental precipitation. The pond will be graded to provide gravity flow to the treatment plant or provided with a pumping system. The treatment plant will be operated and the leachate monitored until such time as water quality of the leachate allows other options to be used (Brewer Gold Company, 1990b).

2.3.4 Sediment Pond

The Brewer operation is intended to be a closed system. However, the facility is periodically faced with excess water resulting from precipitation. This water, which can be runoff or excess process water, is treated in a cyanide destruct unit (as noted above, originally a calcium hypochlorite system and now involving hydrogen peroxide treatment and flocculation as well) before being directed to the Sediment Pond. From the Sediment Pond, water can re-enter the process or rinsing circuits or be discharged via NPDES permit.

The Sediment Pond dam is about 55 feet high with a crest elevation of 420 feet above sea level. The upstream and downstream faces are sloped at 2.5:1 and 3:1, respectively. A 15-foot wide bench, at an elevation of approximately 388 feet, was included in the downstream face of the dam. The dam is a zoned earthen structure constructed with a clay core set into a shallow trench, compacted silty gravelly shells, and chimney and blanket drains. An emergency spillway was cut through bedrock to the east of the left abutment (Steffen Robertson & Kirsten, 1987). The pond was permitted at 846,000 gallons (DHEC, 1987a) and is unlined.

At the pond, lime is used to adjust pH and flocculants are added to reduce the levels of metals in the water. When necessary, treated water is discharged via a pipeline to a permitted outfall (designated outfall 001 in the facility's NPDES permit). Discharge is not continuous; treatment and batch discharges occur when excess process water and storm water accumulate. Approximately 32 million gallons of excess water were said to be treated and discharged from the Brewer Mine annually (EPA, 1991).

Table 2-2 presents flows to (outfall 002) the Sediment Pond and from (outfall 001) and concentrations of selected parameters from March through August 1991. Data were taken from Brewer's monthly NPDES discharge monitoring reports (Brewer Gold Company, 1991c).

Table 2-2. Concentrations of Selected Parameters in Discharges from Outfalls 001 and 002 [1]

(all concentrations in milligrams per liter except pH)

Parameter	Month (1991)					
	March	**April**	**May**	**June**	**July**	**August**
Outfall 001: Sediment Pond discharge to Little Fork Creek						
Total Flow (10^6 gallons)	13.199	No discharge	13.237	No discharge	13.733	4.331
pH (s.u.)	8.5[2]		8.9[2]		8.4[2]	8.8[2]
Cyanide	0.120		0.134		0.035	0.107
Copper	0.048		0.084		0.183[2]	0.026
Mercury	< 0.0002		< 0.0002		< 0.0002	0.00036
Outfall 002: Cyanide Destruct Unit discharge to Sediment Pond						
Total flow (10^6 gallons)	4.041	4.256	1.206	5.400	4.134	2.160
pH (s.u.)	10.2	10.72	10.35	11.05	10.58	11.42
Cyanide	6.13	7.68	2.4	4.35	4.28	7.21
Copper	132.	148.	36.9	40.	47.3	35.5
Mercury	0.0011	0.0011	0.0103	0.006	0.0144	0.0009

1. See Table 4 for effluent limits in NPDES Permit SC0040657 on outfall 001.
2. Value shown is highest value reported (n = 2).

Source: Brewer Gold Company, 1991c.

As noted previously, Brewer's draft revised NPDES permit calls for effluent from the pit water treatment system to be discharged to the Sediment Pond through internal outfall 002 prior to its discharge through outfall 001. According to Brewer representatives, this will begin upon State approval of the system (which, according to the State, was obtained in early 1992).

As described in section 2.4.1.1, Brewer monitors ground water in three wells near the waste rock pile and Sediment Pond. Results of monitoring are presented in that section.

Upon closure, remaining solutions will be treated and discharged as required in the facility's NPDES permit. Treatment will likely involve hydrogen peroxide cyanide destruction and flocculation to further decrease metals (particularly copper). The pond itself will remain after closure.

At the time of the site visit, Brewer Gold Mining Company was searching for a market for the process sludge that may be recovered, which was expected to be rich in copper. If a market could not be found, the sludge was to be geochemically immobilized with cement and encapsulated in place or moved to an alternative site for disposal (Brewer Gold Company, 1991f). During the site visit, Brewer representatives indicated that less than an inch of sludge had accumulated to date. No information was available on sludge characteristics.

2.3.5 Pad 6 Overflow Pond

In December 1989, Brewer Gold Company obtained a permit to construct what is now Heap Leach Pad 6 (DHEC, 1989b). This construction permit included provisions for an overflow pond associated with the pad. The pond had a capacity of 17.5 million gallons, and was double-lined, with a leak detection sump. The pond received excess solution from Pad 6. The pond was located in a natural drainageway just below Pad 6.

The original dam failed in October 1990, as described in more detail below. Following the failure, Brewer received new construction permits numbers 17,027 and 17,052 (DHEC, 1991b and 1991c; see Table 2-5) for pond redesign and reconstruction, respectively. The new pond's dam is an earthfill structure with a seal zone on the upstream face. A chimney drain connects to a horizontal toe drain. Permit 17,052 also required the construction of three movement monuments as well as two standpipe piezometers and three vibrating wire piezometers.

The pond itself has a 18.9 million gallon capacity and is lined (clay seal overlain by 60-mil HDPE primary and 40-mil HDPE secondary liners) with a geonet leak detection/recovery system between the HDPE liners. Underneath the liners is a network of drains (clean gravel with slotted pipe) to collect ground water. There is also a lined (60-mil HDPE) emergency overflow ditch that leads to an 18,000 gallon reinforced concrete outlet sump just below the dam, which also receives underdrain discharge and any water collected in the leak detection system.

As described in section 2.4.1.1, Brewer monitors ground water in one well near the pad 6 overflow pond as well as from the underdrains beneath the pond (the pond also has a leak detection sump that is monitored). Results of monitoring are presented in that section.

2.3.6 Solution Ponds

In addition to the Sediment Pond and Pad 6 Overflow Pond described above, the Brewer Gold facility currently operates a number of other solution ponds, all at the southern foot of Pads 1-4 near the carbon plant (see Figure 2-3). These ponds are described below.

Barren Pond. This 900,000 gallon pond (DHEC, 1987b), part of the original construction, is about seven feet deep with 2:1 side slopes. Like the rinse effluent pond described below, it was constructed with 40-mil HDPE and 20-mil PVC liners over 12 inches of compacted silty-clayey material. A leak detection system of polyethylene Gundnet and geofabric was installed between the synthetic liners (Steffen Robertson & Kirsten, 1987). Barren solution enters this pond directly from the carbon circuit. Because it is located immediately below Pads 1 through 4 and receives runoff from heaps and from the carbon plant, it also has received sediment from erosion (Brewer Gold Company, 1991f). Barren solution, according to a number of spill and leak reports, contains sodium cyanide at concentrations of 600 ppm or more. Solution from this pond is typically made-up with additional cyanide and re-applied to Pad 6, but may be treated and then discharged to the Sediment Pond or used as rinsewater.

Rinse Effluent Pond. This pond, the original pregnant pond for Pads 1 through 4, was permitted at 1,999,000 gallons (DHEC, 1987b). This pond is about seven feet deep with 2:1 side slopes. Like the barren pond, it was constructed with 40-mil HDPE and 20-mil PVC liners over 12 inches of compacted silty-clayey material. A leak detection system of polyethylene Gundnet and geofabric was installed between the synthetic liners (Steffen Robertson & Kirsten, 1987). It receives rinsate directly from Pads 1 through 4. As noted in section 2.3.3, problems with sedimentation in this pond and fines in the rinse treatment circuit had led, at the time of the site visit, to a cessation of rinsing of Pads 1 through 4 while the pads were being regraded, resloped, and revegetated. During the site visit, it was noted that significant amounts of sediment had accumulated in this pond. According to Brewer, the sludge/sediment in this pond is coarser than in other ponds (up to 1.5 inches in diameter). Should removal of the sediment/sludge be necessary, it would be placed back on one of the pads being rinsed (Brewer Gold Company, 1991f). Analytical data on sediment quality were not available.

Rinse Reclaim Pond (or Rinse Spray Pond). This pond (formerly the Rinse Pond) was also part of the original facility. It was apparently permitted at 8,900 gallons [DHEC, 1987b] but appeared during the site visit to have a capacity of several hundred thousand gallons. It is lined with 40-mil HDPE and 20-mil PVC over 12 inches of compacted silty-clayey material. A leak detection system of polyethylene Gundnet and geofabric was installed between the synthetic liners (Steffen Robertson & Kirsten, 1987). The pond receives treated water from the cyanide destruct unit prior to re-application to pads under rinse. As of January 1991, it contained about 4.1 inches of sludge with a 23 percent solids content. Sludges are metal hydroxides, primarily copper hydroxide: the sludge is approximately 15 percent copper (Brewer Gold Company, 1991d).

Emergency Pond (or Effluent Settling Pond). This 3,000,000 gallon pond receives overflow from the rinse effluent pond (the former pregnant pond) and may also be used to store other excess waters. Details on its construction were not available, although Brewer indicated it is double-lined with a leak detection system. The only information on cyanide concentrations came from an incident in January 1989, when there was significant leakage into the pond's french drain. At that time, sodium cyanide concentrations averaged about 300 ppm, and pH averaged about 10 (Brewer Gold Company, 1989).

Pit Water Treatment Pond. This 3,500,000 gallon pond was constructed in 1990-1991. The original construction permit (issued October 29, 1990) authorized a 1,000,000 gallon pond and a pit water treatment system. With the permit in place, a lined pond was constructed after the failure of the Pad 6 Overflow Pond (see sections 2.3.5 and 2.4.4.14) to provide emergency storage for solution from Pad 6 and storm water. This pond was constructed with a 3,500,000 gallon capacity, a primary liner of 60-mil HDPE, a secondary liner of 20-mil VLDPE over one foot of compacted clay, and a leak detection sump between the liners. The pond was to receive process wastewater until the Pad 6 overflow pond was rebuilt. This pond, with increased capacity and a revised pit water treatment system, was reissued a construction permit, which superseded the original permit, on October 29, 1991. (Because this permit was in preparation at the time of the site visit and was issued shortly thereafter, it was not examined by the site visit team; rather, it was described by DHEC in comments on a preliminary draft of this report).

The pond will receive water from the pit water treatment system once that system is placed in operation (as noted previously, the system received its operating permit in early 1992). Water from the pond will feed the rinse circuit or be discharged to the Sediment Pond. Sludges are expected to contain high levels of copper and iron hydroxides (over 15 percent copper) and Brewer anticipates finding a market for the sludges before closure (Brewer Gold Company, 1991f).

Carbon Fines Pond. This small pond is used to settle carbon fines. Details on the pond were not obtained. As noted previously, fines are periodically removed for precious metals recovery.

As described in section 2.4.1.1, Brewer monitors ground water in four wells near the solution ponds. Results of monitoring are presented in that section.

A number of options for sludge disposal at or before closure are being considered. Brewer will search for markets for metal-laden sediments. Alternatively, sludges may be enveloped in the plastic liners and heat-sealed or they may be geochemically immobilized (by fixation in cement). Brewer's tentative reclamation plans for ponds included folding and burying of liners and backfilling or breaching of pond areas. (Brewer Gold Company, 1990b and 1991d) According to the Land Resources Commission, Brewer will be required to remove all pond liners at closure to allow for proper disposal at a licensed waste disposal site.

2.3.7 Other Wastes and Materials

Table 2-3 lists other wastes and materials generated at the Brewer Gold Company facility and the means by which they are managed.

Table 2-3. Other Materials and Management Practices, Brewer Gold Company

Waste	Management Practice
Spent Carbon	Sent off-site for additional gold recovery by an outside firm (calculated to be approximately 1,500 tons per year)
Sanitary Sewage	Managed in an on-site leach field
Solid Waste	Local "trash" collection pickup
Used Oils	Stored in on-site tanks and sent off-site via purchaser or recycler (approximately 1,500 gallons per month, but varies with facility production rates)
Laboratory Wastes	Liquid lab wastes are added to the process water circuit at the rinse or barren stage; solid lab wastes (e.g., broken glass) are disposed with solid waste. Management of cuttings and drill cores was not determined.
Spent Solvents	Safety-Kleen supplies and picks up solvents used for metal cleaning (quantities not determined)

2.4 REGULATORY REQUIREMENTS AND COMPLIANCE

A number of State agencies are responsible for regulating various aspects of Brewer Gold's operations. These agencies, permits they have issued to Brewer, and the permits' major requirements, are described below.

2.4.1 South Carolina Department of Health and Environmental Control

2.4.1.1 Bureau of Water Pollution Control

The Bureau of Water Pollution Control (WPC) within DHEC is charged with protecting surface and ground waters of the State. With respect to the Brewer facility, the Bureau's authority stems from the Clean Water Act (CWA) and the South Carolina Pollution Control Act (PCA). Applicable regulations include: SC Regulation 61-9 (NPDES Permits), SC Regulation 61-68 (Preparation and Submission of Engineering Reports); SC Regulation 61-68, -69 (Water Classification and Standards); and SC Regulation 61-71 (Well Standards and Regulations).

The Bureau's authority over the facility extends as long as there are potential impacts to surrounding waters, from construction through post-closure. The Bureau's program is implemented through permitting systems, violations of which can result in the issuance of consent orders or administrative orders as well as civil and

criminal actions. The Bureau has issued an NPDES permit to Brewer Gold Company for surface water discharges, as well as construction permits for facility components, which include ground-water monitoring requirements. These permits and their major requirements are discussed below.

NPDES Permit SC0040657 (DHEC, 1986 and 1990c). Brewer Gold Company's NPDES permit was originally issued in November 1986, with an expiration date in November 1991. Modifications to the permit were to be effective December 1, 1990; the expiration date was to be November 30, 1995. As noted below, however, Brewer adjudicated certain provisions of the modified permit, which stayed their effectiveness. According to DHEC, a revised draft permit was in its final stages of revision at the time of the site visit and was expected to be issued in the near future.

Table 2-4. Effluent Limits[1] in Brewer Gold Company NPDES Permit SC0040657

(units in milligrams per liter except pH)

Parameter[2]	NPDES Permit Effective December 1, 1986		Revised Draft Permit (to be issued in near future)			
	Daily Average	Daily Maximum	Monthly Average	Daily Maximum	Monthly Average	Daily Maximum
	mg/L		lbs/MG[4]		mg/L	
TSS	20	30	-	-	20	30
Oil and Grease	10	15	-	-	10	15
Total Residual Chlorine	0.352	0.608	0.835	1.67	0.5	1.0
Cyanide	0.166	0.332	0.0835[3]	0.167[3]	0.65[3]	1.2[3]
Arsenic	6.0	11.5	0.417	0.835	-	-
Copper	0.150	0.300	0.0835	0.167	0.15	0.30
Lead	0.050	0.084	0.417	0.835	0.3	0.6
Mercury	0.00038	0.00076	0.00167	0.00334	0.001	0.002
Zinc	0.75	1.5	0.392	0.784	0.75	1.5
Cadmium	0.021	0.042	0.0835	0.167	0.05	0.10
Silver	0.038	0.076	0.25	0.5	-	-
Molybdenum	22	44	2.09	4.18	-	-
Aluminum	-	-	0.726	6.26	-	-
pH (s.u.)	6.0 - 9.0		6.0 to 9.0		6.0 to 9.0	

1 Although the 1986 permit did not specify species for parameters, Discharge Monitoring Reports did require totals. Limits in the revised draft permit are on totals (e.g., total cyanide, total copper).

2 Monitoring requirements specify grab samples taken once per discharge, up to two samples per month. The revised draft permit requires weekly samples.

3 Brewer has petitioned to have cyanide limits reflect weak acid dissociable cyanide. Limits on total cyanide were stayed pending resolution. The revised draft permit requires analysis for total cyanide.

4 MG = million gallons streamflow in Little Fork Creek.

Sources: DHEC, 1986 and 1990c.

The original (and the new draft) permit authorizes a discharge of process wastewater and stormwater from the Sediment Pond to Little Fork Creek. In the original permit, the volume of discharge permitted is dependent on the differential between the annual precipitation falling on the facility and the drainage area contributing to surface runoff to the treatment facility, and annual evaporation. To this end, Brewer is required to report, on an annual basis, the total amount of effluent discharged, the total volume of precipitation, and the evaporation for the preceding year (the capacity of the treatment system is about 600 gpm, which effectively limits discharges to that level). Table 2-4 shows effluent limits in the original permit. The revised draft NPDES permit is based on a controlled discharge of poundage per million gallons of streamflow in Little Fork Creek (i.e., so many pounds of a pollutant per million gallons of streamflow). In addition, monthly discharge monitoring reports are submitted to DHEC. These reports include flow measurements as well as effluent monitoring data.

The revised draft permit also was to establish a second permitted NPDES outfall (002). This is an internal outfall located at the point where plant process water is discharged to the Sediment Pond. Under the permit, the facility is required to monitor outfall 002 and report monthly on levels of the following parameters: Flow, TSS, Copper (Total), Lead (Total), Mercury (Total), Zinc (Total), Cadmium (Total), Cyanide (Total), pH, floating solids, visible foams, and visible sheen (DHEC, 1990c).

Other major alterations in the revised draft permit include changes in effluent limits, as shown in Table 2-4. In addition, Brewer was required to install a high rate diffuser (in lieu of acute toxicity testing of effluent) and conduct macroinvertebrate studies in Little Fork Creek three times per year. Brewer must record streamflow, effluent flow, and the ratio during discharges to verify compliance (DHEC, 1990c). The facility has a U.S. Geological Survey gaging station in Little Fork Creek to make these measurements.

Brewer petitioned DHEC to reconsider two of the requirements in the 1990 modifications to the NPDES permit: the dilution factor, which DHEC had established at less than 75 to 1 (i.e., the instantaneous ratio of streamflow to effluent discharge would have had to be 75 or greater--Brewer requested that it be lower during periods after heavy precipitation conditions); and the discharge limits for cyanide, which were based on total cyanide (Brewer requested that it be based on weak acid dissociable cyanide). As noted above, these provisions of the modified permit were stayed pending resolution; because the dilution factor affected essentially the entire permit, the existing (1986) permit was effective pending resolution of the revised draft permit (DHEC, 1990c; Haynsworth, Baldwin, Johnson and Greaves, 1990; Brewer Gold Company, 1990i and 1991d). According to DHEC, the dilution factor issue has been addressed in the revised draft NPDES permit by changing to a basis of poundage per million gallons of streamflow in Little Fork Creek and the method for analysis for cyanide has remained total cyanide.

If Brewer's monthly discharge monitoring reports show that effluent limits in the NPDES permit have been exceeded by a small amount, DHEC requires the facility to explain the excursion and the reasons (e.g., laboratory error, operator error). If there are significant violations or continuing violations that are not brought under control, DHEC may require sampling and possibly take enforcement actions.

Construction Permits. In addition to the NPDES permit, the Bureau of Water Pollution Control has issued 11 construction permits to Brewer Gold Company. Table 2-5 below lists these permits, the activity or facility component/operation covered, and major permit requirements.

Table 2-5. Construction Permits Issued to Brewer Gold Company

Permit Number	Issue Date	Nature of Permit	Major Requirements
13,135	4/87	Sediment Pond (846,000 gallon capacity)	N/A
13,172	5/87	Original Facilities (600 gpm hypochlorite cyanide treatment system, 54,000 gallon treated water holding pond, and recirculated process system: 1,999,000 gallon pregnant pond, 901,000 gallon barren pond, 8,900 gallon rinse water pond, four 180,000 feet leach pads and associated piping)	• Submit BMP plan, maintain O&M manual onsite • Monitor cyanide wastewater treatment system once per discharge for 13 parameters[a] • Monitor leak detection sumps of barren, carbon, and pregnant ponds for liquid, pH, and total cyanide • Pipe underdrain discharges from closed-out leach pads to Sediment Pond • Sample groundwater monitoring wells quarterly for 32 parameters[b] • Sample emergency spillway discharge, if any, from rinsewater pond for 13 parameters[a] • Submit QA plan for installation of liner system • Allow no overspray of cyanide process solution out of heap leach containment area • Submit plan for approval prior to rinsing heap leach pad for closure
14,217	5/88	Pad 5 (Add 780 feet by 545 feet on-off asphalt-lined leach pad with French drain leak detection system, two 1,000 gallon two stage solution sumps, leak detection sump, 3.6 million gallon pregnant pond, associated piping and appurtenances).	• Monitor pregnant pond leak detection sump for liquid, pH, and total cyanide • Obtain DHEC approval before placing spent ore from Pad 5 on Pads 1-4 • Submit closure plan for pad at least six months prior to end of operations • Install groundwater monitoring well near pregnant pond • Monitor leak detection sumps of barren, carbon, pregnant, rinse, and emergency ponds weekly for the life of the project for presence of liquid, pH, and total cyanide

[a]Including pH, total cyanide, cyanide, thiocyanate, total residual chlorine, copper, zinc, lead, mercury, cadmium, TSS, flow, and ammonia.

[b]Including pH, conductivity, hardness (as $CaCO_3$), alkalinity, carbon, TKN, ammonia, nitrite, nitrate, phosphorus, chloride, turbidity, mercury, potassium, manganese, calcium, iron, sodium, magnesium, aluminum, barium, cadmium, chromium, copper, silver, zinc, arsenic, lead, selenium, TDS, sulfate, and total cyanide.

Table 2-5. Construction Permits Issued to Brewer Gold Company (continued)

Permit Number	Issue Date	Nature of Permit	Major Requirements
15,697	9/89	Pad 5A (Post-construction approval for 60,000 square feet leach pad and modification of Pad 5 from a reusable leach pad to a dedicated leach pad).	• Submit QA/QC plan for construction and installation of Pad 5A • Submit closure plan for Pad 5A within 6 months of permit issuance • Allow no overspray of cyanide process solution out of heap containment area
15,699	9/89	Sediment Pond Flocculation System (Flocculation system for the sediment pond: one 1,000 gpm (60 hp) pump, piping, metering pumps, 1,250 gallon steel mixing tank with mixer).	• Water pumped from pond for use in dust control must comply with NPDES permit effluent limits • Submit closure plan for pond within six months of permit issuance
15,869	12/89	Pad 6 (1,100,000 square foot heap leach pad with leak detection sump and 10,000 gallon collection sump and associated pumps and piping, and 17.5 million gallon pond and leak detection sump and associated pumps and piping).	• Update BMP plan • Monitor leak detection sumps of Pad 6 and Pad 6 overflow weekly for the life of the project for liquid, pH, and total cyanide • Sample groundwater monitoring wells and underdrain quarterly for 32 parameters[2] • Submit "worst case" contingency closure plan for Pads 1-5A and Pad 6 • Operate so as to avoid discharge from pond spillway • Minimum standards for sampling of heaps after rinsing during heap closure and reclamation • Install groundwater monitoring wells • Place ore for leaching on Pad 6 no closer than 20 feet from perimeter berms and/or solution ditches
16,255	5/90	Hydrogen Peroxide Rinse System (Modification of the chlorine rinsewater treatment system consisting of an existing 20,000 gallon carbon steel tank modified with internal baffles, hydrogen peroxide storage and metering system and associated piping and appurtenances).	• Submit sludge disposal plan within six months of permit issuance • Maintain O&M manual for waste treatment plant onsite • Update BMP plan

Table 2-5. Construction Permits Issued to Brewer Gold Company (continued)

Permit Number	Issue Date	Nature of Permit	Major Requirements
16,727 Superseded by 17,170	10/90 10/91	Pit Water Treatment System and Pond (permit 17,170) (Existing 3,500,000 gallon pond with 60-mil HDPE primary liner, 20-mil VLDPE secondary liner on one-foot compacted clay base, and leak detection system between liners; pit water treatment system equipment and piping.	• Maintain O&M Manual for treatment plant on site • Submit updated BMP plan • Submit deactivation plan prior to temporary cessation of mining activity • Maintain daily log on use of pit water for dust control • Report any overflows from spillway
17,027	4/91	Pad 6 Overflow Pond Redesign (Leak collection and recovery system including construction of a concrete pipe encasement with 6" and 10" diameter HDPE pipe, two concrete cutoff collars, portion of clay backfill which supports encasement and portion of toe drain which supports encasement).	N/A
17,052	5/91	Pad 6 Overflow Pond Reconstruction (Rehabilitation and reconstruction of the Pad 6 Overflow Pond: 1) zoned earthfill structure with seal zone on an upstream face, with chimney drain connected to horizontal toe drain; (2) impoundment with storage capacity of 18,900,000 gallons, emergency spillway, liner system [clay seal zone beneath 60 mil HDPE primary liner and 40 mil VLDPE secondary liner, with geonet leak collection and recovery system between secondary and primary liners, extra layer of 60 mil HDPE placed at the outflow of the overflow ditch, and leak detection sump consisting of clean gravel between 60 mil and 40 mil liners with volume of approximately 5,400 gallons]; (3) network of groundwater drains under liner system [clean gravel surrounded by geotextile, with slotted diameter pipe with minimum cross-section of 10 square feet, and removal and backfill with clay of some of previous pond groundwater drains]; (4) relining with 60 mil HDPE section of existing overflow ditch from Pad 6 to Overflow pond; (5) reinforced 10,000 gallon concrete outlet sump outlet piping, pump with 2" diameter HDPE piping encased in 4" diameter CPT pipe; (6) three movement monuments, two toe monuments, two standpipe piezometers, and three vibrating wire piezometers; and (7) associated piping and appurtenances).	• Update BMP plan • Monitor leak detection sumps of Pad 6 and overflow pond weekly for the life of the project for liquid, pH, and total cyanide • Monitor groundwater underdrainage weekly for pH, flow, and free cyanide • Maintain emergency generator onsite • Maintain O&M for waste treatment plant onsite

These permits, as can be seen, have authorized construction and operation of all facility components. They typically require submission of various engineering, operating, and maintenance reports and studies. These construction permits also require monitoring of ground water near each major facility component and closure plans for facility components. Altogether, there are 13 ground-water monitoring wells: three for the Sediment Pond and waste rock piles, four for the solution ponds, four for Pad 6, one for the Pad 6 overflow pond (underdrainage from this pond is also monitored), and one to the west of Pads 1-5. Locations of monitoring wells are shown in Figure 2-4. Background water quality was established by sampling the

original monitoring wells prior to the initiation of leaching operations. Results of ground-water monitoring

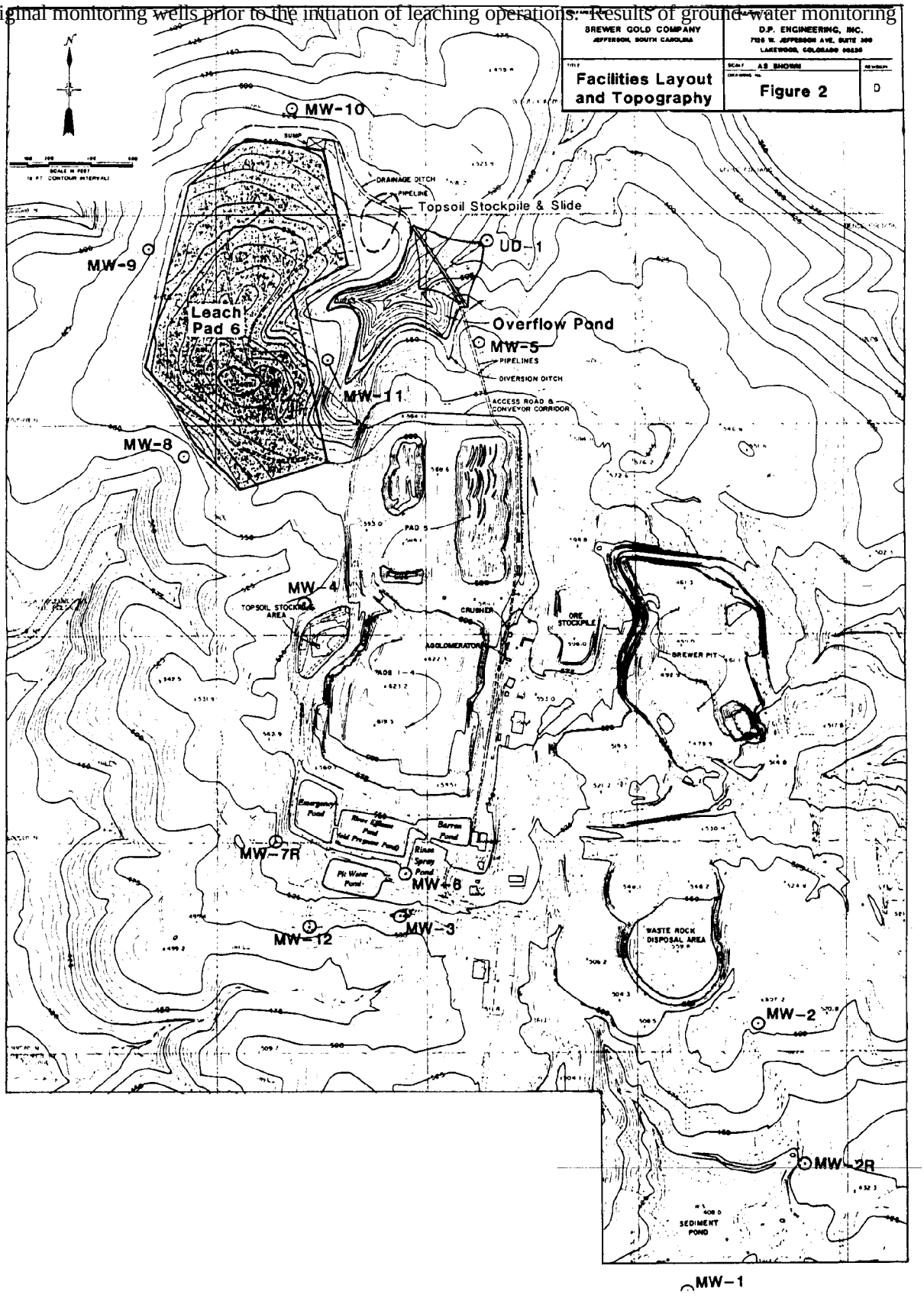


Table 2-5. Monitoring Data From Well Located Near Pad 6 Overflow Pond and From Pad 6 Overflow Pond Underdrain

Monitoring Well/ Parameter	Minimum and Maximum Concentrations Detected (ppm, Except as Noted)			
	1988	1989	1990	1991
MW-5	n = 4	n = 4	n = 4	n = 2
pH (s.u.)	4.0 - 4.7	4.65 - 6.18	3.89 - 4.25	4.29 - 3.98
Total Cyanide	<0.01 - <0.01	<0.05 - <0.01	<0.01 - <0.01	<0.01 - 0.043
Cadmium	<0.01 - <0.01	<0.01 - <0.01	<0.01 - 0.01	<0.001 - 0.004
Copper	<0.1 - <0.1	<0.03 - 0.14	0.09 - 0.84	0.13 - 1.51
Mercury (ppb)	<2 - <2	<0.2 - <2	0.38 - 5.45	0.5 - 0.8
UD-1	n = 0	n = 0	n = 4	n = 2
pH (s.u.)	N/A	N/A	4.33 - 4.95 (n = 3)	4.79 - 5.2
Total Cyanide	N/A	N/A	<0.01 - 89.3	<0.01 - 0.094
Cadmium	N/A	N/A	<0.01 - 0.0001 (n = 3)	<0.001 - <0.001
Copper	N/A	N/A	0.96 - 1.59 (n = 3)	0.112 - 0.378
Mercury (ppb)	N/A	N/A	<0.2 - 1.3 (n = 3)	0.3 - 0.5

Source: Compiled from Brewer Gold Company, 1991a.

from 1988 to 1991 for five selected parameters are presented in Tables 2-6

Table 2-6. Monitoring Data From Wells Located Near Sediment Pond and Waste Rock Disposal Area

Monitoring Well/ Parameter	Minimum and Maximum Concentrations Detected (ppm, Except as Noted)			
	1988	1989	1990	1991
MW-1	n = 4	n = 4	n = 4	n = 2
pH (s.u.)	4.7 - 5.9	4.48 - 4.9	3.08 - 4.67	3.99 - 4.26
Total Cyanide	<0.01 - <0.01	<0.05 - <0.01	<0.01 - <0.01	<0.01 - <0.01
Cadmium	<0.01 - <0.01	<0.01 - <0.01	0.0001 - <0.01	<0.001 - 0.002
Copper	<0.1 - <0.1	<0.03 - <0.1	<0.03 - <0.05	0.1 - 0.139
Mercury (ppb)	<2 - <2	<0.2 - 4	<0.2 - 1.55	<0.2 - 0.6
MW-2	n = 4	n = 4	n = 1	n = 0
pH (s.u.)	3.8 - 4.2	4.06 - 4.14	3.9	N/A
Total Cyanide	<0.01 - <0.01	<0.01 - <0.05	<0.01	N/A
Cadmium	<0.01 - <0.01	<0.01 - <0.01	<0.01	N/A
Copper	<0.1 - <0.1	<0.03 - <0.1	<0.03	N/A
Mercury (ppb)	<2 - 6.1	<0.2 - <2	<0.2	N/A
MW-2R	n = 0	n = 0	n = 3	n = 2
pH (s.u.)	N/A	N/A	5.6 - 5.89	5.54 - 6.43
Total Cyanide	N/A	N/A	<0.01 - <0.01	<0.01 - <0.01
Cadmium	N/A	N/A	0.0001 - <0.01	<0.001 - <0.001
Copper	N/A	N/A	<0.03 - <0.05	0.003 - 0.013
Mercury (ppb)	N/A	N/A	0.16 - 0.18	0.21 - 0.36

SOURCE: Compiled from Brewer Gold Company, 1991a.

through

Table 2-7. Monitoring Data From Wells Located Near Solution Ponds

Monitoring Well/ Parameter	Minimum and Maximum Concentrations Detected (ppm, Except as Noted)			
	1988	1989	1990	1991
MW-3	n = 4	n = 4	n = 4	n = 2
pH (s.u.)	4.1 - 4.6	4.06 - 4.73	4.19 - 4.67	4.33 - 4.57
Total Cyanide	<0.01 - <0.01	<0.05 - <0.01	<0.01 - <0.01	<0.01 - <0.01
Cadmium	<0.01 - <0.01	<0.01 - <0.01	<0.0001 - <0.01	<0.001 - <0.001
Copper	<0.1 - <0.1	<0.03 - 0.04	<0.03 - <0.05	0.023 - 0.155
Mercury (ppb)	<2 - 2	0.2 - <2	<0.2 - 1.43	0.5 - 0.6
MW-6*	n = 0	n = 0	n = 0	n = 0
MW-7R	n = 0	n = 0	n = 4	n = 2
pH (s.u.)	N/A	N/A	3.89 - 4.88	5.54 - 6.43
Total Cyanide	N/A	N/A	<0.01 - <0.01	<0.01 - <0.01
Cadmium	N/A	N/A	<0.010 - 0.0001	<0.001 - <0.001
Copper	N/A	N/A	<0.03 - 0.04	0.004 - 0.009
Mercury (ppb)	N/A	N/A	3.5 - 7.7 (n = 3)	1.2 - 5.2
MW-12	n = 0	n = 0	n = 0	n = 1
pH (s.u.)	N/A	N/A	N/A	4.39
Total Cyanide	N/A	N/A	N/A	<0.01
Cadmium	N/A	N/A	N/A	<0.001
Copper	N/A	N/A	N/A	0.017
Mercury (ppb)	N/A	N/A	N/A	2.6

* Well has remained dry since construction.

SOURCE: Compiled from Brewer Gold Company, 1991a

Table 2-8. Monitoring Data From Wells Located Near Leach Pad 6

Monitoring Well/ Parameter	Minimum and Maximum Concentrations Detected (ppm, Except as Noted)			
	1988	1989	1990	1991
MW-8	n = 0	n = 0	n = 4	n = 2
pH (s.u.)	N/A	N/A	4.67 - 5.69	4.53 - 4.67
Total Cyanide	N/A	N/A	<0.01 - 0.04 (n = 5)	<0.01 - <0.01
Cadmium	N/A	N/A	<0.010 - <0.0001	<0.001 - <0.001
Copper	N/A	N/A	<0.03 - <0.05	0.005 - 0.01
Mercury (ppb)	N/A	N/A	<0.2 - 0.26	<0.2 - 0.3
MW-9	n = 0	n = 0	n = 4	n = 2
pH (s.u.)	N/A	N/A	4.7 - 4.9	4.61 - 4.68
Total Cyanide	N/A	N/A	<0.01 - <0.01	<0.01 - <0.01
Cadmium	N/A	N/A	<0.010 - 0.0001	<0.001 - <0.001
Copper	N/A	N/A	<0.03 - <0.05	0.005 - 0.015
Mercury (ppb)	N/A	N/A	<0.2 - 1	<0.2 - <0.2
MW-10	n = 0	n = 0	n = 4	n = 2
pH (s.u.)	N/A	N/A	4.59 - 4.72	4.48 - 4.58
Total Cyanide	N/A	N/A	<0.01 - <0.01	<0.01 - <0.01
Cadmium	N/A	N/A	<0.010 - 0.0001	<0.001 - 0.002
Copper	N/A	N/A	<0.03 - <0.05	0.003 - 0.004
Mercury (ppb)	N/A	N/A	<0.2 - 0.4	<0.2 - 0.7
MW-11	n = 0	n = 0	n = 4	n = 2
pH (s.u.)	N/A	N/A	4.33 - 4.66	4.4 - 4.7
Total Cyanide	N/A	N/A	<0.01 - <0.01	<0.01 - <0.01
Cadmium	N/A	N/A	<0.010 - 0.0001	<0.001 - 0.001
Copper	N/A	N/A	<0.03 - <0.05	0.004 - 0.072
Mercury (ppb)	N/A	N/A	<0.2 - 0.5	<0.2 - <0.2

SOURCE: Compiled from Brewer Gold Company, 1991a

2-10. Background data were not available.

Should ground-water monitoring reveal a continuing violation of State drinking water standards (one-time excursions would be verified before formal action was taken), DHEC could impose civil or criminal penalties and/or require source control or remediation action. This has not been necessary to date.

Sewage Treatment and Disposal System Permit . In addition to the permits discussed above, DHEC's Bureau of Environmental Health, Division of On Site Waste Management also issued, in July, 1987, Sewage Treatment and Disposal System Permit No. 13-62778 for a domestic sewage drain field. This permit was not examined by the site visit team.

2.4.1.2 Bureau of Air Quality Control

DHEC's Bureau of Air Quality Control issues and enforces Air Emissions Permits under the South Carolina Pollution Control Act and State Regulation 61-62.1. The Brewer Gold Company facility has been issued a five-year operating permit (March 1989 - March 1994) and a construction permit. Brewer's Permit No. 0660-0026, effective from March 20, 1989 through March 31, 1994, authorizes operation of the following units (DHEC, 1989c):

- ID No. 01: 400 ton/hour primary, secondary, and agglomerating plant. The permit required Brewer to install water sprays for dust control in these areas.

- ID No. 02: 40 ton capacity cement storage silo with fabric sock or bin vents.

- ID No. 03: 1,000 gpm sodium cyanide leaching process for gold recovery with pH controlled to greater than 10.5. Hydrogen cyanide concentrations may not exceed 250 micrograms per cubic meter at the plant boundary on a 24-hour basis.

- ID No. 04: 15 pound/hour propane fired melting furnace for dore production.

Table 2-11 shows emission limitations established by the permit for these units. In addition to these limits, the permit makes the facility subject to applicable New Source Performance Standards for Metallic Mineral Processing (40 *CFR* Part 60, Subpart LL). The permit also requires that dust from haul roads and turnaround areas be controlled by water sprays and water trucks and that stockpiles or waste rock piles be sprayed with water when wind erosion creates excessive emissions (DHEC, 1989c).

Table 2-9. Emission Limits Established by Permit 0660-0066

Unit ID	Pollutant	Emission Limitation
01	PM	22.4 pounds/hour or 98.11 tons/year
	Opacity	10 percent
02	PM	10.125 pounds/day or 1.85 tons/year
	Opacity	20 percent
03	Opacity	20 percent
04	Mercury	0.0003 pound/hour or 0.0013 ton/year
	Arsenic	0.01 pound/hour or 0.0044 ton/year
	Opacity	20 percent

Source: DHEC, 1989c.

Permit No. 0660-0026-CE, issued in July 1990 and expiring after one year, authorized the construction of a 100-ton silo for storage of calcium cyanide to be pneumatically unloaded by trucks and controlled by a bin vent fabric filter and an in-line disposal cartridge filter. Table 2-12 shows the emission limitations for the storage silo (DHEC, 1990e). Operation of the silo requires an operating permit, which may have been issued about the time of the site visit (the silo was operating at the time of the visit).

Table 2-10. Emission Limits Established by Permit 0660-0026-CE

Pollutant	Emission Limitation
PM	0.0009 pound/hour or 0.004 ton/year
Hydrogen cyanide (HCN)	2.10 pounds/hour or 9.2 tons/year
Opacity	20 percent

Source: DHEC, 1990e.

The Bureau of Air Quality Control is authorized to seek civil and/or criminal penalties when permit requirements are violated by a facility. Formal facility inspections are conducted by DHEC's Florence District Office on an annual basis.

2.4.2 Land Resources Commission

2.4.2.1 Division of Mining and Reclamation Mining Permit 671

Under the South Carolina Mining Act (Section 48-20 of the State Code), the Division of Mining and Reclamation of the Land Resources Commission (LRC) is charged with ensuring that lands and waters involved in mining are protected and restored to the "greatest practical degree." LRC's responsibilities include issuing mining and reclamation permits, reviewing and approving reclamation plans, collecting reclamation bonds, and inspecting facilities to ensure compliance. LRC coordinates its activities with and supplements the regulatory activities of DHEC.

On July 16, 1986, LRC issued Mining Permit 671 for the Brewer facility (LRC, 1986); the permit has been modified a number of times since to reflect changes in facility components and operations. Table 2-13

Table 2-11. Major Requirements Established by Mine Permit 671

Facility/Operational Component	Major Requirements
Original Permit 671: July 16, 1986	
Ground water	• Characterize existing groundwater (depth, quality, etc.) • Establish background quality prior to leaching • Sample monthly and report to LRC
Leach Pads and Ponds	• Install dual liners for pads: 40-mil primary, 18-inch secondary with permeability < 1×10^{-7} • Pregnant and barren ponds: HDPE primary liner, ditches, etc.
Waste Rock	• Submit plan for acid-base testing • Establish alternative site for rock with acid generation potential
Cyanide Neutralization	• Reduce free cyanide in heaps to 0.2 ppm
Reclamation	• Outline study to project post-reclamation quality of pit water • Work with LRC on revegetation
Contingency Plans	• Develop plan to verify/locate/correct leaks if cyanide detected in groundwater • Develop plan for mitigation of heavy rainfall and high winds from hurricanes and storms
Notification	• Notify LRC of pad leaks or cyanide detected in groundwater
May 13, 1988 Modification: Pad 5	• Approval of asphalt pad for 10-cell on-off Pad 5 • Monitor leak detection sumps for free cyanide, pH, gold
September 15, 1989 Modification: Pads 5 and 5A	• Change Pad 5 to dedicated Pad, construct Pad 5A
October 23, 1989 Modification: Pads 5 and 5A	• Stack second lift (to 70 feet) on Pads 5 and 5A • Submit closure plan with six months • Begin rinsing Pads 1 through 5A by July 1, 1990, submit status report by September 15, 1990
November 7, 1989 Modification: Pad 6	• Clear Pad 6 area • Requirements to control runoff/sedimentation from construction area
December 8, 1989 Modification: Pad 6	• Construct Pad 6 • Submit wildlife hazing plan, fence Pad 6 pond

Source: LRC 1986, 1988a, 1989a, 1989b, 1989c, 1989d.

summarizes the requirements of Mining Permit 671. To ensure compliance, representatives of LRC make half-day inspections of the Brewer Gold Company facility on a monthly basis and longer inspections periodically.

Mining Permit 671 authorizes operation of the Brewer mine from July 1987 through September 1996. Initially, LRC required a reclamation bond of $170,000 (based on $1,000 per acre disturbed). This was raised to $230,000 in November 1989 because of increased land disturbance associated with Pad 6. Based on a subsequent Brewer estimate of the cost of completing its reclamation/closure plan, the bond was being raised to $500,000 (LRC, 1989a through d).

Brewer submitted a reclamation plan to LRC prior to operation. At the time, the S.C. Mining Act did not specify reclamation as a part of closure. As amended in 1990, the Act now states clearly that reclamation requirements for a mine facility are part of closure. Brewer's closure plans to date (Brewer Gold Company, 1990b) are conceptual in nature; a final closure plan will be required prior to actual closure.

Annual reclamation reports are required by LRC and are also required through construction permits issued by DHEC. General reclamation/closure activities required of Brewer by LRC include the following:

- Waste Rock Dump: sloping (3:1), revegetation of sides and tops with grasses interspersed with trees, and seepage/runoff pH testing
- Leach Pads: sloping (3:1), removal of solution lines, revegetation with grasses (may also require trees in the future)
- Ponds: removal of liners and bulldozing
- Physical Plants and Building Structures: removal
- Mine Pit: sloping of pit walls, revegetation, allowed to fill with water.The S.C. Mining Act, as amended in 1990, gives the LRC authority to assess civil penalties for noncompliance with the approved reclamation plan or schedule of reclamation. Penalties up to $1,000 per day per violation are authorized. In addition, LRC works closely with DHEC, which has additional authorities (as described above).

2.4.2.2 Engineering Division Dam Construction and Repair Permits

The LRC Engineering Division implements the Dam and Safety Reservoirs Act (section 49-11 of the State Code). LRC has issued Brewer three dam construction permits and one dam repair permit. These permits and the activity or facility component/operations covered are listed in Table 2-14. These permits were not examined by the site visit team.

Table 2-12. Dam Construction and Repair Permits Issued to Brewer Gold Company

Permit Number	Date Issued	Nature of Permit
13-447-P394	7/87	Sediment Pond Construction
13-537-P475	3/90	Overflow Pond Construction
13-527-P522	5/91	Pit Water Treatment Pond Construction
13-602-P522	6/91	Overflow Pond Dam Repair

2.4.3 Other Regulatory Agencies and Permits

The following permits have also been issued to the Brewer Gold Company:

- South Carolina Fire Marshal Blasting Permit No. 91-177
- U.S. Department of the Treasury - Bureau of Alcohol, Tobacco, and Firearms High Explosives License No. 1-SC-013-33-1L-92336

These permits were not examined by the site visit team.

2.5 REFERENCES

A.S.C.I. 1989 (September 13). Review of Cyanide Rinse and Neutralization Data: Brewer Gold Mine Heap Leach, S.C. Letter from A.S.C.I. to W. Rose, Brewer Gold Company. Appendix B of Mine Closure Plan (Brewer Gold Company, April 1990a).

A.S.C.I. 1990 (April). Abatement Plan for Potential Acid Mine Drainage Associated with Closure of the Brewer Mine. Prepared for Brewer Gold Company. Appendix A of Mine Closure Plan (Brewer Gold Company, April 1990a).

Brewer Gold Company. Undated. "Brewer Gold Mine." Unpublished brochure providing history and description of Brewer Gold Mine.

Brewer Gold Company (Westmont Mining Inc.). 1987a (March 27). Letter from R.J. McGregor, Brewer Gold Company to N. Weatherup, S.C. DHEC, RE: Response to March 24, 1987 letter from N. Weatherup, DHEC.

Brewer Gold Company. 1987b (December 23). Letter from W.T. Lyman, Brewer Gold Company to G. Stowe, S.C. DHEC, RE: Heap Pile Mud Flow, December 16, 1987.

Brewer Gold Company. 1988 (February 10). Letter from R.J. McGregor, Brewer Gold Company to J.W. Wilkinson, S.C. DHEC, RE: Request for extension of Consent Order 87-113-W, section 5 deadline.

Brewer Gold Company. 1988a (February 15). Letter from R.J. McGregor, Brewer Gold Company to N. Weatherup, S.C. DHEC, RE: leak detection system report.

Brewer Gold Company, 1988b (April 7). Letter from R.J. McGregor, Brewer Gold Company, to C. Kennedy, S.C. LRC, RE: Heap leach pad rinsing (remove Pad 1 from recirculation to begin rinsing).

Brewer Gold Company. 1988d (April 4 and 5). Letters from L. Harnage, Brewer Gold Company to R. Kinney, S.C. DHEC, RE: cyanide spill on March 31, 1988.

Brewer Gold Company. 1988e (April 22). Letter from R.J. McGregor, Brewer Gold Company, to E. Hart, S.C. DHEC, RE: Calculations on March 31 and April 5, 1988 spills of 600 ppm cyanide solution.

Brewer Gold Company. 1988f (June 24). Letter from J.J. Harrington, Brewer Gold Company to E. Hart, S.C. DHEC, RE: June 24, 1988 incident report.

Brewer Gold Company. 1989 (February 17). Letter from D. Williams, Brewer Gold Company, to E. Hart, S.C. DHEC, RE: Emergency Pond leak.

Brewer Gold Company. 1989a (February 27). Letter from J.B. Pautler, Brewer Gold Company to E. Hart, S.C. DHEC, RE: February 26, 1989 incident report.

Brewer Gold Company. 1989b (April 26). Memorandum to file from W.L. Rose, Brewer Gold Company; submitted to S.C. DHEC. Subject: Sediment pond discharge (and events surrounding).

Brewer Gold Company. 1989c (April 26). Letter from W.L. Rose, Brewer Gold Company, to N. Weatherup, S.C. DHEC, RE: response to DHEC letter dated 4/7/89 that requested information on rinsewater pond overflow, cyanide destruction system).

Brewer Gold Company. 1989d (July 20). Letter from J.B. Pautler, Brewer Gold Company to J. Wilkinson, S.C. DHEC, RE: report of spent ore slide and cyanide spill on July 16, 1989.

Brewer Gold Company. 1989e (July 28). Memorandum to file from W.L. Rose, Brewer Gold Company; submitted to S.C. DHEC. Subject: Sediment pond water treatment (including plant history), request for treatment and discharge.

Brewer Gold Company. 1990 (March 12). Letter from S. Wanstedt, Brewer Gold Company, to E. Hart, S.C. DHEC, RE: "Barren Pond Leakage" into leak detection sump.

Brewer Gold Company. 1990a (March 22 and April 3). Letters from S. Wanstedt, Brewer Gold Company, to K. Terry and E. Hart, S.C. DHEC, respectively, RE: Update on Pad 5 leakage. Includes memorandum to files from S. Wanstedt submitted to S.C. DHEC.

Brewer Gold Company. 1990b (April). Mine Closure Plan, Brewer Gold Mine, Chesterfield County, South Carolina. Submitted to S.C. DHEC.

Brewer Gold Company. 1990c (April 27). Letter from S. Wanstedt, Brewer Gold Company, to C. Kennedy, S.C. LRC, RE: Pad 6 slope failure preliminary report.

Brewer Gold Company. 1990d (April 27). Letter from S. Wanstedt, Brewer Gold Company, to B. Ruiter, S.C. DHEC, RE: "Use of hypochlorite...in the control of ... cyanide present in the clay liner due to the Pad 6 slope failure."

Brewer Gold Company. 1990e (August 22). Letter from S. Wanstedt, Brewer Gold Company, to J. Wilkinson, S.C. DHEC, RE: Incident report for August 20, 1990, cyanide spill.

Brewer Gold Company. 1990f (May 24). Letter from S. Wanstedt, Brewer Gold Company, to E. Hart, S.C. DHEC, RE: Notification of end of incident involving leakage from Pad 5 sumps.

Brewer Gold Company. 1990g (October 19). Letter from S. Wanstedt, Brewer Gold Company, to E. Hart, S.C. DHEC, RE: "Discharges from the Rinse and Sediment Pond emergency spillways" on October 10, 1990, and Summary of Events leading to discharges.

Brewer Gold Company. 1990h (October 26). Letter from S. Wanstedt, Brewer Gold Company, to G. Stowe, S.C. DHEC, RE: Description of leakage in leak detection system since October 10-11 storm.

Brewer Gold Company. 1990i (November 14). Letter from R.S. Mattson, Brewer Gold Company, to M.D. Jarrett, S.C. DHEC, RE: Request for administrative adjudicatory hearing raised by NPDES Permit No. SC0040657.

Brewer Gold Company. 1990j (November 27). Letter from S. Wanstedt, Brewer Gold Company, to J. Wilkinson, S.C. DHEC, RE: Discharges during October 1990 under NPDES Permit SC0040657 (letter accompanying October 1990 Discharge Monitoring Report).

Brewer Gold Company. 1991a. Compilation of ground-water monitoring data, 1988-1991. Provided as attachment of letter from S. Wanstedt, Brewer Gold Company, to J. Mozingo, SAIC, September 28, 1991 (Brewer Gold Company, 1991g).

Brewer Gold Company. 1991b (April 22). Brewer Project Site Hydrological Assessments. Submitted to S.C. Department of Health and Environmental Control.

Brewer Gold Company. 1991c. NPDES Permit SC0040657, Discharge Monitoring Reports for March, April, May, June, July, and August 1991. Submitted to S.C. Department of Health and Environmental Control, Water Quality Assessment and Enforcement Division.

Brewer Gold Company. 1991d (May 14). Letter from R.C. Walish, Brewer Gold Company to B. McDade, S.C. DHEC, RE: response to April 26, 1991, letter requesting details of Brewer Gold Company's appeal to draft NPDES permit.

Brewer Gold Company. 1991e (June 17). "Brewer Rinsing Status Report and Schedule." Submitted by R. Walish, Brewer Gold Company, to J. Wilkinson, S.C. Department of Health and Environmental Control.

Brewer Gold Company. 1991f (July 12). "Treatment Pond Sludge Status Report and Sludge Disposal Schedule." Submitted by S. Wanstedt, Brewer Gold Company, to J. Wilkinson, S.C. Department of Health and Environmental Control.

Brewer Gold Company. 1991g (September 28). Letter from S. Wanstedt, Brewer, to J. Mozingo, SAIC, on chemical purchases by Brewer Gold Mine.

Cargo, D.N. and B.F. Mallory. 1977. *Man and His Geologic Environment*. Second Ed. Addison-Wesley Publishing Company. Reading, Mass. 581 pp.

Environmental and Chemical Services, Inc. 1987. "An Ecological Assessment of the Brewer Mine Site, Chesterfield County, S.C." Prepared for Nicor Mineral Ventures. Submitted to S.C. Land Resources Commission as Appendix B of Application for Permit to Mine.

Haynsworth, Baldwin, Johnson and Greaves, P.A. 1990 (December 18). Petition for Revision of NPDES Permit [No. SC0040657], submitted to S.C. DHEC on behalf of Brewer Gold Company.

Scheetz, J.W., J.M. Stonehouse, and M.R. Zwaschka. 1991 (January). "Geology of the Brewer Gold Mine in South Carolina." *Mining Engineering*, pp. 38-42.

Shealy Environmental Services, Inc. 1991 (May). "A Macroinvertebrate and Fish Assessment Conducted for Brewer Gold Mining Company, Chesterfield County, Jefferson, South Carolina." Prepared for Brewer Gold Mining Company. Revision of March 1991 Report.

Sirrine Environmental Consultants. 1990 (November 29). Removal Action Plan, Brewer Gold Company, Jefferson, South Carolina. Submitted to U.S. Environmental Protection Agency Region IV on behalf of Brewer Gold Company.

Sirrine Environmental Consultants. 1991 (April 8). Removal Action Assessment, Brewer Gold Company, Jefferson, South Carolina. Submitted to U.S. Environmental Protection Agency Region IV on behalf of Brewer Gold Company.

State of South Carolina, Department of Health and Environmental Control. Undated. General Mine Information (fact sheet on Brewer Gold Mine).

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1986. Water Pollution Control Permit issued to Westmont Mining, Inc. (NPDES Permit SC0040657, effective December 1, 1986).

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1987a (April 14). Construction Permit 13,135 issued to Westmont Mining, Inc., Brewer Project (for construction of 846,000 gallon sedimentation pond).

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1987b (May 4). Construction Permit 13,172, with special conditions, issued to Brewer Mine (for construction of treatment tanks, 54,000 gallon holding pond, and recirculation process system [1,999,000 pregnant pond, 901,000 barren pond, 8,900 gallon rinse pond, four 180,000 square foot leach pads and associated piping]). Modified by permit special conditions in DHEC letter dated August 12, 1988 and in Construction Permit 16,255, issued May 24, 1991.

State of South Carolina, Department of Health and Environmental Control. 1987c (November 25). Consent Order 87-113-W; IN RE: Westmont Mining Inc./Brewer Gold Mine, NPDES No. SC0040657, Chesterfield County.

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1988b (May 16). Construction Permit 14,217, with special conditions, issued to Brewer Gold Company (for construction of asphalt leach pad [425,100 square feet] with french drain leak detection system, two 1,100 gallon two-stage solution pumps, leak detection sump, and 3,600,000 gallon pregnant pond with piping/appurtenances). Includes modifications to permit special conditions issued August 12, November 4, and December 14, 1988.

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1989a (September 26). Construction Permit 15,699, with special conditions, issued to Brewer Gold Company (for construction of flocculation system for sediment pond [and associated pumps, tanks, etc.]).

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1989b (December 8). Construction Permit 15,869, with special conditions, issued to Brewer Gold Company (for construction of Pad no. 6 [1,100,000 square feet, with leak detection sump, 10,000 gallon sump, associated pumps/piping]; and 17,500,000 gallon overflow pond and leak detection sump with associated pumps/piping.)

State of South Carolina, Department of Health and Environmental Control, Bureau of Air Pollution Control. 1989c (March 20). Operating Permit 0660-0026 issued to Brewer Gold Company.

State of South Carolina, Department of Health and Environmental Control. 1990a. Spill Report and Emergency Response Investigation (on spill of October 28, 1990).

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1990c. Water Pollution Control Permit issued to Brewer Gold Company (NPDES Permit SC0040657, effective December 1, 1990). Modifications to 12/1/86 NPDES Permit (DHEC, 1986).

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1990d (May 24). Construction Permit 16,255, with special conditions, issued to Brewer Gold Company (for modification to chlorine rinsewater treatment system [modification to permit 13,172]).

State of South Carolina, Department of Health and Environmental Control, Bureau of Air Pollution Control. 1990e (July 18). Construction Permit 0660-0026-CE issued to Brewer Gold Company.

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1990f (September 22). Construction Permit 15,697, with special conditions, issued to Brewer Gold Company (for construction of Pad 5A [60,000 square feet] and modification of Pad 5 from reusable to dedicated leach pad.]

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1990g (October 29). Construction Permit 16,727, with special conditions, issued to Brewer Gold Company (for construction of pit water treatment system [as described]).

State of South Carolina, Department of Health and Environmental Control, Water Pollution Assessment and Enforcement Division. 1991a (April 9). Notice of Enforcement Conference, NPDES Permit SC0040657, and Findings of Fact.

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1991b (April 12). Construction Permit 17,027, with special conditions, issued to Brewer Gold Company (for construction of leak detection and recovery system associated with redesigned Pad 6 overflow pond.)

State of South Carolina, Department of Health and Environmental Control, Bureau of Water Pollution Control. 1991c (May 13). Construction Permit 17,052, with special conditions, issued to Brewer Gold Company (for redesigned Pad 6 overflow pond and dam).

State of South Carolina, Department of Health and Environmental Control. 1991d (June 6). Consent Order 91-30-W; IN RE: Brewer Gold Company, NPDES SC0040657, Chesterfield County.

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1986 (July 16). Brewer Mine, Permit No. 671, Additional Terms and Conditions.

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1988a (May 13). Approval and conditions for Brewer Gold Company application to modify permit 671 (modify leach pad liner from clay and synthetic liner and to deposit leached, rinsed ore on existing pads).

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1988b (July 28). Letter from C. Kennedy, S.C. LRC to J. Harrington, Brewer Gold Company, RE: Mining permit 671, Release of process solution from Pad no. 3 (500-600 gallons of 600-700 ppm pregnant solution).

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1989a (September 15). Approval and conditions for Brewer Gold Company application to modify permit 671 (construct new pad 5A).

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1989b (October 23). Approval and conditions for Brewer Gold Company application to modify permit 671 (second lift on pads 5 and 5A).

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1989c (November 7). Approval and conditions for Brewer Gold Company application to modify permit 671 (Prepare for construction of pad 6: clearing, grubbing, sediment control, clay removal).

State of South Carolina, Land Resources Commission, Division of Mining and Reclamation. 1989d (December 8). Approval and conditions for Brewer Gold Company application to modify permit no. 671 (construct pad 6).

Steffen Robertson & Kirsten (Colorado) Inc. Undated (1987). "As-Built Report and Plans for the Brewer Gold Project, Chesterfield County, South Carolina." Prepared for Westmont Mining, Inc., and Brewer Gold Company.

Steffen Robertson and Kirsten (U.S.) Inc. 1990 (April). "Interim Rinse and Treatment System Application for Permit to Construct Sewage and Industrial Waste Treatment System, Brewer Project, Chesterfield County, South Carolina." Prepared for Brewer Gold Company.

U.S. Environmental Protection Agency, Region IV. 1990. Administrative Order (EPA Docket 91-06-C). Issued to Brewer Gold Mine (following October 1990 dam failure)

APPENDIX 2-A

COMMENTS SUBMITTED BY BREWER GOLD COMPANY
ON DRAFT SITE VISIT REPORT

[Comments not reproduced for this electronic draft. Copies may be obtained from U.S. EPA, Office of Solid Wastes, Special Waste Branch.]

APPENDIX 2-B

COMMENTS SUBMITTED BY SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL ON DRAFT SITE VISIT REPORT

[Comments not reproduced for this electronic draft. Copies may be obtained from U.S. EPA, Office of Solid Wastes, Special Waste Branch.]

APPENDIX 2-C

COMMENTS SUBMITTED BY
SOUTH CAROLINA LAND RESOURCES COMMISSION
ON DRAFT SITE VISIT REPORT

[Comments not reproduced for this electronic draft. Copies may be obtained from U.S. EPA, Office of Solid Wastes, Special Waste Branch.]

APPENDIX 2-D

EPA RESPONSES TO BREWER GOLD COMPANY COMMENTS ON DRAFT SITE VISIT REPORT

EPA Response to Brewer Gold Company's
Comments on Draft Site Visit Report

Comment: Brewer, in its February 11, 1992, comments (see Appendix 2-A), stated that the report's inclusion (on pages 49 and 50 of the draft report, pages 52 and 53 of the present report) of violations listed in the April 9, 1991, Notice of Enforcement Conference gave a misleading impression of the company's operations and compliance record. Brewer indicated that the resolution of the issues on June 6, 1991 [in Consent Order 91-30-W] was not mentioned in the draft report and that some of the listed violations were without basis, were cleared up once miscommunications were discovered, or the intent on Brewer's part to protect the environment were made clear. Brewer requested that the list of violations be deleted.

Response: EPA believes the list of violations alleged in the Notice is relevant, since a finding of the Consent Order was that violations had occurred "on several occasions." However, EPA notes that the Consent Order did not cite any specific violations. As a result, EPA has deleted the discussion of the Notice and the Order from the report.

APPENDIX 2-E

EPA RESPONSE TO COMMENTS SUBMITTED BY
SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
AND SOUTH CAROLINA LAND RESOURCES COMMISSION
ON DRAFT SITE VISIT REPORT

EPA Response to Comments Submitted by
South Carolina Department of Health and Environmental Control
and South Carolina Land Resources Commission
on Draft Site Visit Report

EPA has revised the report to incorporate all of the comments submitted by DHEC (see Appendix 2-B) and LRC (see Appendix 2-C). In some cases, EPA made minor changes to wording suggested by DHEC and/or LRC in order to attribute the changes to the State or to enhance clarity.