

# INTEGRATED MINED-AREA RECLAMATION AND LAND USE PLANNING

Volume 3C

A Case Study of Surface Mining and Reclamation Planning:
Georgia Kaolin Company Clay Mines,
Washington County, Georgia

Prepared for the

Resource and Land Investigations (RALI) Program
U. S. Department of the Interior
U. S. Geological Survey

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**ENERGY AND MINERAL RESOURCES** 

ARGONNE NATIONAL LABORATORY

Energy and Environmental Systems Division



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A Case Study of Surface Mining and Reclamation Planning:
Georgia Kaolin Company\* Clay Mines,
Washington County, Georgia

bу

J. Lee Guernsey, Lawrence A. Brown, \*\* and Allen O. Perry

Energy and Environmental Systems Division

February 1978

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Prepared for the Resource and Land Investigations (RALI) Program of the U. S. Department of the Interior with Funds Provided by the U. S. Geological Survey

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#### FOREWORD

This report is one in a ten-volume series prepared by the Energy and Environmental Systems Division of Argonne National Laboratory and the Resource and Land Investigations (RALI) Program of the U.S. Department of the Interior under the sponsorship of the U.S. Geological Survey. Because of the close interrelationship of the ten documents in the series, each volume will be most useful only when its relationship to the other products of the program is considered.

The reports in this series are designed primarily to familiarize professional land use and resource planners with the range of possibilities and effective procedures for achieving integrated mining, reclamation, and land use planning. These reports are based on a research program which included an extensive literature review, the compilation and analysis of case study data, and close coordination and interaction with related government programs.

The first volume in the series, A Guide to Integrated Mined Area Reclamation and Land Use Planning, summarizes the information in the other volumes and presents conclusions and observations drawn from analyses of that information. Volume 2, Methods and Criteria for Land Use and Resource Planning in Surface Mined Areas, examines planning procedures used in several mineral industries and mining regions and discusses problems facing professional planners who must consider surface mine areas in their planning programs.

In Volume 3, A Guide to Mined Area Reclamation Technology for Reclamation and Land Use Planners, the methods used to reclaim land in each of several mineral industries are discussed in relation to the physical and cultural constraints that must be considered in planning a reclamation program. Much of the information for this document was obtained from case studies conducted in several mining districts. The case study sites were chosen after consideration of the following: (a) coverage by commodity of those surface mining activities that disturb the greatest acreages, (b) coverage of a variety of cultural and land use settings, (c) evidence of integration of mining, reclamation, and land use planning, (d) cooperation on the part of operating companies and appropriate planning entities, (e) coverage of a variety of surface mining and reclamation methods, and (f) coverage of a variety of physical settings (geology, physiography, climate, hydrology). After the preliminary case study selection, some sites were changed and others dropped because of a lack of company cooperation. The remaining six case studies all meet the criteria listed above. They are not intended to be perfect examples of reclamation and planning procedures. Rather, they illustrate a variety of procedures utilized in different physical and cultural settings to achieve planning goals under a variety of technological, legal, and economic constraints.

Since the case studies are intended to be used as appendices to Volume 3, they are numbered accordingly. The case study reports include:

Volume 3A: A Case Study of Surface Mining and Reclamation Planning: South Boulder Creek Park Project, Sand and Gravel Operations, Boulder, Colorado.

Volume 3B: A Case Study of Surface Mining and Reclamation Planning: International Minerals and Chemical Corporation, Phosphate Operations, Polk County, Florida.

Volume 3C: A Case Study of Surface Mining and Reclamation Planning: Georgia Kaolin Company, Clay Mines, Washington County, Georgia.

Volume 3D: A Case Study of Surface Mining and Reclamation Planning: Area Strip Coal Mining, Peabody Universal Mine, Universal, Indiana.

Volume 3E: A Case Study of Surface Mining and Reclamation Planning: ASARCO Open Pit Copper Mine, Casa Grande, Arizona.

Volume 3F: A Case Study of Surface Mining and Reclamation Planning: Cannelton Mountain-Top Removal Coal Mine No. 9-S, Cannelton, West Virginia.

Volume 4, A Bibliography of Integrated Mined Area Reclamation and Land Use Planning, with Annotations, includes primarily references pertinent to reclamation planning and plan implementation.

#### ACKNOWLEDGMENTS

The authors gratefully acknowledge those organizations and individuals whose cooperation, assistance and advice have been very helpful in the preparation of this case study report. The staff of Yara Engineering Corporation and Georgia Kaolin Company were particularly helpful, especially the following individuals:

Dr. Wayne Bundy, Vice-President - Research, Georgia Kaolin Company.

Mr. John Smith, Chief Geologist, Yara Research Laboratory.

Mr. Doral Mills, Geologist, Yara Engineering.

Mr. Elmo Bloodworth, Manager of Reclamation, Yara Engineering.

In addition, we would like to thank the following individuals for their review of the draft of this case study report:

Dr. Allen Agnew, The Library of Congress.

Mr. Frank Beal, Illinois Institute for Environmental Quality.

Mr. Denton Carlson, Bureau of Land Management.

Mr. Ralph P. Carter, Argonne National Laboratory.

Dr. Grant Davis, Surface Environment and Mining, U.S. Department of Agriculture.

Mr. James L. Gober, Tennessee Valley Authority.

Mr. Gene Harris, U.S. Environmental Protection Agency.

Mr. Edgar A. Imhoff, Resource and Land Investigations (RALI) Program, U.S. Department of Interior.

Dr. Donald O. Johnson, Argonne National Laboratory.

Ms. Kathryn S. Macal, Argonne National Laboratory.

Mr. Charles Medvick, Illinois Department of Mines and Minerals.

Dr. Meredith E. Ostrom, State Geologist of Wisconsin.

Dr. John F. Tschanz, Argonne National Laboratory.

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#### INTEGRATED MINED-AREA RECLAMATION AND LAND USE PLANNING

Volume 3C: A Case Study of Surface Mining and Reclamation Planning: Georgia Kaolin Company Clay Mines, Washington County, Georgia

Бу

J. Lee Guernsey, Lawrence A. Brown, and Allen O. Perry

#### ABSTRACT

This case study examines the reclamation practices of the Georgia Kaolin's American Industrial Clay Company Division, a kaolin producer centered in Twiggs, Washington, and Wilkinson Counties, Georgia. The State of Georgia accounts for more than one-fourth of the world's kaolin production and about three-fourths of U.S. kaolin output. The mining of kaolin in Georgia illustrates the effects of mining and reclaiming lands disturbed by area surface mining. The disturbed areas are reclaimed under the rules and regulations of the Georgia Surface Mining Act of 1968. The natural conditions influencing the reclamation methodologies and techniques are markedly unique from those of other mining operations. The environmental disturbances and procedures used in reclaiming the kaolin mined lands are reviewed and implications for planners are noted.

#### 1 INTRODUCTION

This case study report focuses upon the reclamation planning and practices of the Georgia kaolin industry centered in Twiggs, Washington, and Wilkinson Counties as well as selected aspects of Georgia Kaolin's American Industrial Clay Company's (AICC) operations (Fig. 1.1). Kaolin is one of the most regionally concentrated mineral industries, with the Georgia-South Carolina district normally being responsible for about 85-90% of the national output.

Although its use is generally associated with the ceramic industry, about one-half of all the kaolin produced is used for various paper products. Paper treated with kaolin has high value due to the mineral properties that impart smoothness, brightness, opacity, gloss, and printability to the surface. Large amounts of the mineral are also used in the manufacture of paint and rubber products. With its unique physical properties, chemical inertness, and relative abundance, kaolin is one of the most versatile of the industrial minerals and new applications of the mineral are occurring frequently.<sup>2</sup>

<sup>&</sup>lt;sup>1</sup>Now American Industrial Clay Co., a Division of Yara Engineering Corporation.

<sup>&</sup>lt;sup>2</sup>Other uses of kaolin utilize relatively small amounts of the mineral. Among These are: adhesives, adsorbents, bleaches, cement, chemicals, cosmetics, crayons, detergents, foundries, floor tiles, food and food additives and coatings, fiberglass, fertilizers, ink, linoleum, medicines, refractories, and textiles.

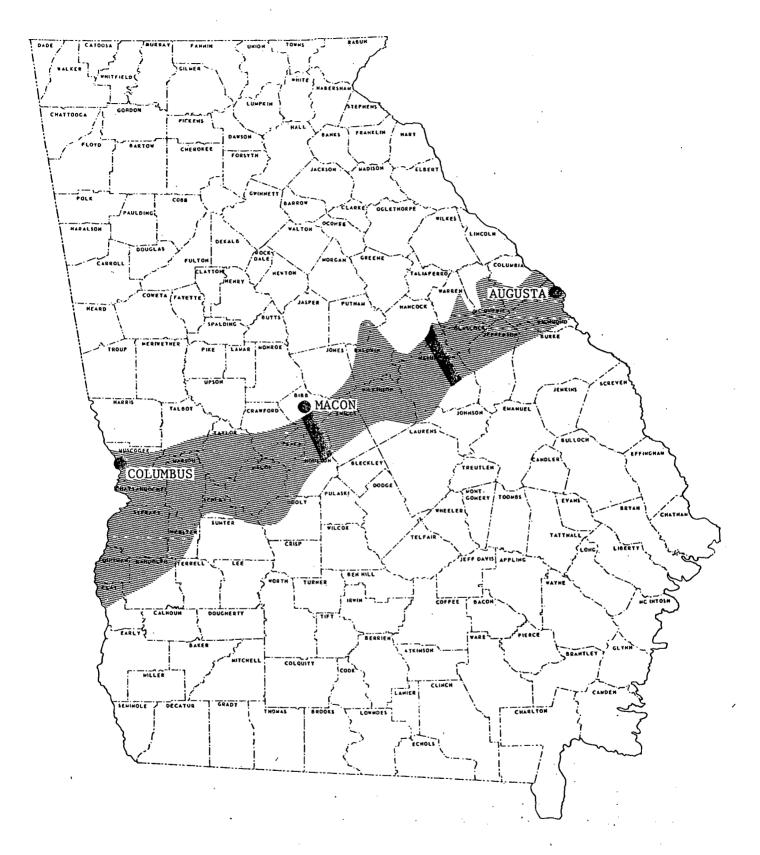


Fig. 1.1. Location of the Georgia Kaolin Belt

The term kaolin, synonymous with the term china clay, is used in reference to a clay-mineral group, a multimineral or rock term, and an industrial mineral commodity. Since most kaolin now marketed is improved, the mineral may be defined as "a clay consisting of substantially pure kaolinite, or related clay minerals, that is naturally or can be beneficiated to be white or near white, will fire white or near white, and is amenable to beneficiation by known methods to make it suitable for use in whiteware, paper, rubber, paint, and similar uses" (Murray, 1977, TAPPI).

Unlike most other surface mining industries, kaolin mining in the Georgia-South Carolina area has a minimally disruptive effect upon the landscape. In many instances, surface mined areas have become more valuable and picturesque, for contours, lakes, etc., are designed according to the specifications of the landowner. In addition, many thousands of acres of woodland have been converted to pastureland and other higher uses.

A new era in the kaolin industry began in 1968 with the enactment of the Georgia Surface Mining Act. As a result of this act and subsequent amended legislation, which became effective July 1, 1976, communications between the various governmental agencies concerned with the mining and processing of minerals and the kaolin industry have contributed to further improvements in reclamation.

#### 1.1 THE WORLD KAOLIN INDUSTRY

The annual world production of kaolin is approximately 15 million tons. Two areas supply more than one-half of the total tonnage produced in the world. The Georgia-South Carolina area is the leading source of the mineral, having an annual output of about 6 million tons; whereas Great Britain's Cornwall district ranks second, producing an annual output of about 3 million tons. Other major producers are Czechoslovakia with some 2 million tons per year and Brazil, which has a rapidly developing industry. Less significant amounts of kaolin are produced in many other nations, including West Germany, East Germany, Spain, France, the Soviet Union, Japan, Korea. the Peoples Republic of China, Australia, India, and Mexico (Murray, 1977, AIME). Increased demand, technological changes, and political factors may well alter the future of the world kaolin market.

#### 1.2 GEORGIA'S ROLE IN THE U.S. KAOLIN INDUSTRY

Kaolin production in the United States began during the 1740s when the Georgia deposits were first mined (Patterson and Murray, 1975). The first market for Georgia-South Carolina kaolin was the English ceramic industry, which received its first shipment of kaolin in 1766. The success of the fledgling industry was short-lived, however, due to the discovery of clay at

<sup>&</sup>lt;sup>1</sup>Technically, kaolin encompasses "any of a group of clay minerals, including kaolinite, nacrite, dickite, and anauxite, with a two-layer crystal in which silicon-oxygen and aluminum hydroxyl sheets alternate; approximate composition is  $Al_2O_3-2$   $SiO_2-2H_2O$ ." Kaolinite, the most common of the kaolin group minerals, has the theoretical composition: 46%  $SiO_2$ , 40%  $Al_2O_3$ , and 14%  $H_2O$  (Murray, 1977, TAPPI).

Cornwall in 1768. As a result, kaolin production in the United States ceased until 1876 when mining was resumed in the Augusta-Aiken district. The industry has operated continuously since that time (Murray, 1976).

Georgia has always been the leading area of production in the American kaolin industry. Although production data are only approximate, about 3 million tons of the mineral were mined in Georgia by the early 1930s (Kesler, 1956). In 1937, Georgia accounted for approximately 66% of the nation's output with some 504 thousand tons valued at more than \$3.5 million; South Carolina, traditionally the second ranking producer, for 129 thousand tons, with a value of slightly more than \$1.0 million. Both production and value of the mined clay increased slowly until World War II (Kesler, 1963). During World War II, the industry grew more rapidly and created a trend that has continued during the postwar years.

As with many of the industrial minerals, the early to mid-1970s brought unprecedented growth to the kaolin industry. After a record 6.4 million tons in 1974, U.S. production declined to 5.3 million in 1975, rising slightly to 5.7 million in 1976. The value of kaolin mined in 1976 was a record \$266 million (USBM, 1977). Inflation and rapidly escalating energy costs are contributing heavily to the increased value of the mineral.

Georgia's 1976 production totaled 4.3 million tons or 75% of the nation's output and more than that of any country. The \$224 million value of the state's 1976 output represents an average value of about \$60 per ton as compared to the U.S. average of slightly less than \$47 per ton, because of the high inherent quality of Georgia kaolin, which is reflected in the value of the marketed products. South Carolina continued as the second leading source with the production of some 700,000 tons valued at \$13.9 million (USBM, 1977).

#### 1.3 LOCATION OF THE GEORGIA KAOLIN BELT

The kaolin belt in Georgia has been divided traditionally into three separate districts (Fig. 1.2). The northeastern district, called the Wrens District, contains relatively recent major discoveries of kaolin that boosted Georgia's kaolin reserves by at least tenfold. The district appears to have enormous reserves, estimated at 3.5 billion tons, under conditions amenable to large-scale mining, with an average overburden of about 60 feet and an ore thickness of from 30-35 feet. A much larger reserve estimate for this area may be obtained by extending down to 200 feet or more of overburden. The average overburden to kaolin thickness ratio in the district is close to 3:1 (Ward and Husted, 1976).

Another district (the Sandersville District) of the Georgia Kaolin Belt extends from about Sandersville on the east to the western Twiggs County

Although only some 12-15% of the clay sold or used in the U.S. is kaolin, the mineral represents almost one-half of the value of all clay materials. The primary commercial classification of clay includes, in addition to kaolin: bentonite, fuller's earth, ball clay, and fire clay. Collectively, these clay materials account for approximately 80% of the value, but only for about 25% of the annual tonnage.

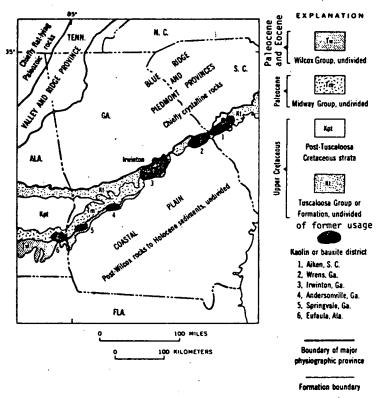


Fig. 1.2. Kaolin and Bauxite Districts in the Coastal Plain of Southeastern United States (Patterson, 1977)

border on the west. This district has been the traditional heart of the kaolin mining belt of Georgia, particularly for high-grade paper-coating clays. Large tonnages of clays that now serve for paper coating or filler grades also have alumina content and should serve as ores for future aluminum manufacturing. However, clays unsuitable for paper coating and for various filler uses, but possibly usable for aluminum, have not been delineated as clearly as those in the Wrens District. The estimate of two billion tons of kaolin in this district consists, for the most part, of clays not suitable for present markets and in some instances may comprise clays in the overburden over high-grade clays suitable for paper coating or fillers.

The third district (Andersonville-Springvale) in Georgia extends from the western border of Twiggs County to the Chattahoochee River. Kaolin bodies in this district have not been as well defined by drilling as those of the other two. Part of the district is located in the vicinity of Andersonville, an area of high alumina clays from which refractory products are made. The best estimate obtainable at present for this district is a 50% probability of one billion tons of 30% Al<sub>2</sub>O<sub>3</sub>(Ward and Husted, 1974).

More than 80% of the 6000 people employed in the various dimensions of the U.S. kaolin industry reside in Georgia. Kaolin companies headquartered in Washington County employ more than 1000 individuals and provide some 1500 additional jobs in the various service industries.

Neighboring Wilkinson County is similarly affected by the kaolin industry. The kaolin industry contributes some \$80 million to the economy of the State of Georgia and accounts for almost 3% of the state's total payroll.

#### 1.4 GEORGIA KAOLIN COMPANY, A DIVISION OF YARA ENGINEERING CORPORATION

Georgia Kaolin began operation in 1901 and is the oldest company in operation today. During the early days of the industry numerous small concerns mined and shipped air-dried crude kaolin to markets in the northeastern states. Economies-of-scale factors, including the ever-expanding infrastructure required to maintain viability, forced most of the smaller operations out of business during the 1930s and 40s. Other major producers of kaolin in the Georgia district are Englehard Minerals and Chemical Corp., J. M. Huber Corp., Freeport Kaolin, Thiele Kaolin Co., Champion Paper Co., Anglo-American Clay Corp. (a British concern), Mullite Corporation of America, Cyprus Corp. (United Sierra), Nord Resources Corp., and several smaller operations. Most of the larger corporations have extended their operations over larger areas in recent years with the combined effects of increased production and the depletion of traditional mining areas. At present, there is no formal marketing arrangement among the various producers. However, trade-offs of mineral-bearing lands and other symbiotic practices are common.

In addition to being the oldest, the Georgia Kaolin Company is also one of the largest producers of kaolin in the free world. More than 850 people are employed on a full-time basis: about 250 of these at the company's American Industrial Clay Co. (AICC) division and its exploration and mining arm, Yara Engineering Corporation. Corporate and research headquarters for Georgia Kaolin are located at Elizabeth, New Jersey, with major producing and control facilities at Dry Branch (near Macon) and Deepstep, Georgia. Both mining and processing facilities have reclamation and environmental specialists who supervise plant and field operations as well as onsite research projects.

#### 1.5 FUTURE OF THE INDUSTRY

The long-range outlook for Georgia kaolin is basically a function of the interactions of the four following factors: (1) technological advances that would allow greater efficiency in the utilization of the mineral; (2) the extent of increasing costs, especially in relation to substitute materials; (3) the potential utilization of kaolin as a source of aluminum; and (4) changes that may occur in the existing pattern of domestic and foreign suppliers of kaolin.

Since 1930, the market for kaolin has increased almost tenfold, and the number of applications of the mineral has increased at an even greater rate. Since 1965, the rate of increase has been less, but current projections indicate at least a doubling of production during the last three decades of the twentieth century. A major portion of the increase in demand is expected to be generated by the growth of the foreign paper industry (Buie, 1972). Cooper (1970) estimates a five- to six-fold increase in the demand for U.S. kaolin by the year 2000. His projection, however, anticipates the utilization of prodigious quantities of the mineral kaolin in the production of aluminum.

Buie (1972) has also extrapolated the potential implications of a continuing increase in the demand for Georgia kaolin. His scenarios include the following assumptions:

- 1. An intensification in the search for more efficient methods of beneficiation.
- 2. A concerted effort by the industry to find an economical method of modifying high-viscosity kaolin for use as paper coating.
- 3. An increased level of exploration for new sources of the mineral in the U.S. and abroad.
- 4. Further research into the geological factors responsible for the accumulation of commercial deposits of kaolin.
- 5. Some increase in price relative to other industrial minerals as well as substitutes for kaolin.

The changes anticipated above would have a dramatic impact upon the kaolin-producing regions of Georgia and South Carolina including:

- 1. The utilization of lower-grade resources with an accompanying increase in the amount of overburden and other minerals disturbed.
- 2. Mining of deposits farther below the surface with an increasing problem with water transfer.
- 3. An increased threat of invasion by substitutes.
- 4. A continuation of the trend towards greater environmental concerns.
- 5. More interest in developing markets for silica and other potential co-products.

In any outlook, the highly dynamic nature of the kaolin market requires a maximum effort on the part of the industry, not only to seek additional outlets, but also to secure existing ones. Higher energy and transportation costs, as well as an increase in the volume of materials handled per ton of kaolin, will require a significant advance in technology if the kaolin industry is to remain viable.

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#### 2 REGIONAL PERSPECTIVE

#### 2.1 ORIGIN

As recently as a decade ago, the kaolin of the Irwinton District was thought to be exclusively within the Tuscaloosa Formation (Fig. 1.2). Considerable fossil evidence, however, has led to the widely accepted theory that some of the kaolin is of Eocene Age. Analysis of pollen in lignitic clays has provided the most conclusive evidence that the kaolin deposits represent different geologic events.

Murray (Clay, TAPPI) has noted that the world's leading source of kaolin, the Georgia-South Carolina deposits, are also among the least understood. Although there is general agreement that the kaolin originated from the erosion of the crystalline structures in the Piedmont Upland, a variety of theories have been advanced to explain the actual processes responsible for the various kaolin formations.

In addition to the many questions surrounding the origin of the mineral, geologists are seeking answers to such questions as: (1) Why is there such an unusually low iron content in the local deposits? (2) What factors are responsible for the variations in the Tertiary and Cretaceous kaolin? and (3) Why is there such great variation in the grain size of the clays? (Patterson and Buie, 1974).

#### 2.2 GEOLOGIC OCCURRENCE

Kaolin in the Georgia-South Carolina area occurs as sedimentary deposits along the Fall Line, which is the border between the Piedmont Province and the Coastal Plain as defined by Thornbury (1964). The study area is located within the Irwinton District, the leading source area of commercial kaolin in the United States (Fig. 1.2).

Geologists have succeeded in interpreting many of the complex geological factors involved in the formation of the kaolin deposits; however, several perplexing problems still remain. The solutions to the unsolved problems may provide keys to exploration for other deposits.

Georgia kaolin deposits are irregular lens-shaped bodies occurring in thick sand units. They may be as much as 60 feet (20 meters) thick and extend laterally from a few tens of feet up to about a mile. The deposits vary in composition from very sandy clay to essentially pure clay. The principal impurity is sand-sized quartz. Other impurities that occur in minor quantities include muscovite, biotite, smectite (montmorillonite), ilmenite, anatase, rutile, leucoxene and goethite (Patterson, 1977). The presence of even small percentages of impurities cause discoloration of the kaolin or in the case of smectite increases the viscosity of clay-water mixtures that renders it unusable for paper coatings.

In the early 1960s, all the kaolin deposits were thought to occur in the Tuscaloosa Formation of the Late Cretaceous Age (about 65 million years ago). Differences in particle sizes and stratigraphic positions led some geologists to believe that all of the deposits may not be the same age. Buie and Fountain (1968) were the first to find paleontological (fossil) evidence for a younger age for some of the deposits. Subsequent findings by other workers have confirmed a Middle or Late Eocene age for some of them. These younger deposits are located in the Claiborne or Jackson groups (about 45 million years old). Correlations between age and physical properties, including presence of impurities have been made, therefore the age determinations are of more than academic interest.

The two major questions that remain to be solved regarding the geology of the kaolin deposits are summarized as follows:

- 1. Under what conditions did such an extensive area of high purity kaolin form? Specifically, were the clays formed in place or were they deposited as clays?
- 2. Why is there such an exceptionally low iron content in the shallow deposits? Nearly all sedimentary clay deposits contain sufficient iron to cause discoloration.

The Cretaceous and Tertiary formations in which the clay deposits occur are poorly lithified and require no blasting during the excavation process. The overburden and ore materials are easily handled by conventional earthmoving equipment used in the construction industry, which facilitates the mining and reclamation process to a great degree. The soil-like nature of the overburden allows easy grading and contouring, and permits rapid establishment of vegetation. In comparison with other surface mining commodities, these favorable geological factors in the kaolin industry make the mining and reclamation process much less problematic.

#### 2.3 STRUCTURE AND PROPERTIES OF KAOLIN

Technically, kaolin encompasses "any of a group of clay minerals," including kaolinite, nacrite, dickite, and anauxite. The theoretical structural formula is  $(OH)_8Si_4$   $Al_4O_{10}$ , and the theoretical composition is 46%  $SiO_2$ , 40%  $Al_{2O_3}$ , and 14%  $H_{2O}$  (Patterson and Buie, 1974). Details of the structures of clay minerals were not well known until the general use of X-ray diffraction techniques were developed. Interpretation of these data have shown that the perfection of Georgia kaolin ranges from poorly to very well ordered forms. Grim was an early pioneer in developing techniques for describing the various clay minerals (1968) and in identifying their uses (1962).

Kaolinite normally possesses small amounts of impurities such as oxides of titanium and iron, quartz, mica, and organic matter (Mitchell, 1955). As a result its physical constants can only be approximated. Table 2.1 notes typical or representative constants for Georgia kaolin. High brightness and low abrasive characteristics are among the properties that make kaolin so desirable for paper coatings and fillings (Patterson and Murray, 1975).

Table 2.1. Georgia Kaolins:
Representative Physical Constants

Specific Gravity	2.62
- ·	
Hardness (Mohs' scale)	1.5-2
Index of Refraction	1.57
Fusion Temperature, °C	1850
Valley Abrasion Number	4-10
Dry G.E. Brightness (at 457 nm,%)	75-91

Source: Murray, 1977, TAPPI.

Kaolin may be classified as either soft or hard, though the terms are used only on a comparative basis. Soft kaolin is Cretaceous and commonly contains numerous books of vermicular crystals, and, generally, is whiter and purer than hard clay. Hard clay, often referred to as flint kaolin, is of more recent origin than the soft variety (Patterson, 1977).

#### 2.4 CLIMATE

The Georgia Kaolin Belt lies within the humid subtropical climatic zone as defined by Trewartha (1968). The climate supports the growth of a wide variety of crops on the reclaimed mined lands. Prolonged periods of climatic extremes are rare, as the region receives a blend of maritime and continental influences. Warm, moist tropical air from the south modifies the impact of the northwesterly winds that prevail during the winter and early spring months. The southern portion of the Appalachian Mountains serves as a barrier to fast-moving cold air masses. Temperatures of 20°F or lower are relatively rare, occurring on the average fewer than six days during any winter. The climate of the Kaolin Belt of Central Georgia may be described as having temperatures and precipitation that are truly equable (Table 2.2). A growing season that averages almost 250 days with only slight variation from year to year gives further evidence of the area's mild and productive climate.

With a distance of about 200 miles from both the Atlantic Ocean and the Gulf of Mexico, the Georgia Belt is well protected from potential hurricanes. Thunderstorms, however, are common in the area occurring on approximately 40% of the days during the summer from June through August. Property damage from such storms is rare. However, flash floods occasionally dump some of the 30 million tons of waste materials generated annually into local streams. Although these wastes are not chemically active, temporary sediment damage to aquatic life can result.

Snow is sporadic in the area with accumulations of one inch or more having occurred only six times during a 25-year period ending in 1973. Heavy rains, snow, and freezing temperatures are but minor hindrances to kaolin mining, processing, and reclamation operations, with slippage of trucks and other mining machinery and the accumulation of globs of clay on anything that

ventures onto a mine site, the primary inconveniences. Freezes also limit certain crops that might otherwise be profitable ones for reclaiming the surface mined lands.

Table 2.2. Climatic Summary for Macon Georgia

Month	Mean Temp. (°F)	Mean Precip. (in.)
January	48	3.7
February	50	4.4
March	56	5.2
April	66 .	3.6
May	74	3.6
June	80	3.9
July	81	4.5
August	81	3.6
September	76	3.1
October	66	2.3
November	55	2.4
December	48	4.3
Year	65	44.6

#### 2.5 PHYSIOGRAPHIC SETTING

Georgia's major kaolin deposits lie within the Fall Line Zone, which forms a transition between the hard crystalline rocks of the Piedmont Plateau or Upland and the younger sedimentary and partially consolidated structures of the Coastal Plain Province. Although the breadth of the Fall Line Zone generally averages only 5-10 miles, the range is considerably greater in the kaolin-bearing areas of Central Georgia (Thornbury, 1964). The zone reaches its maximum width of 35 miles in Wilkinson and Baldwin Counties and ranges from about 12-15 miles in Washington and Hancock Counties.

The northern half of the Fall Line Zone consists largely of long gentle slopes, rolling hills, and relatively flat ridges. Although geologically similar to the adjacent Piedmont Plateau structure, a covering of loose grey and brownish soils have given rise to the term Sand Hills in reference to the section. The southern half of the zone is dominated by the Red Hills characterized by a highly dissected landscape with a preponderance of broad valley floors with narrow, winding, flat-topped ridges.

Along its southern margins, the Fall Line Zone is made up of gently rolling hills and broad rounded summits with extensive areas of relatively flat terrain. Here significant dissection is limited to the valleys of the larger streams and rivers. These features are typical of the Coastal Plain Province.

Surface conditions in the vicinity of Georgia Kaolin's AICC operations have gently rolling hills with broad slopes and numerous creeks, such as those in Buffalo and Deepstep, with extensive swamps and bottom land (Fig. 2.1). Elevations range from more than 400 feet above sea level to less than 250 feet msl in several streambeds. But, generally the terrain is suitable for most row crops and pasture lands.

#### 2.6 HYDROLOGY

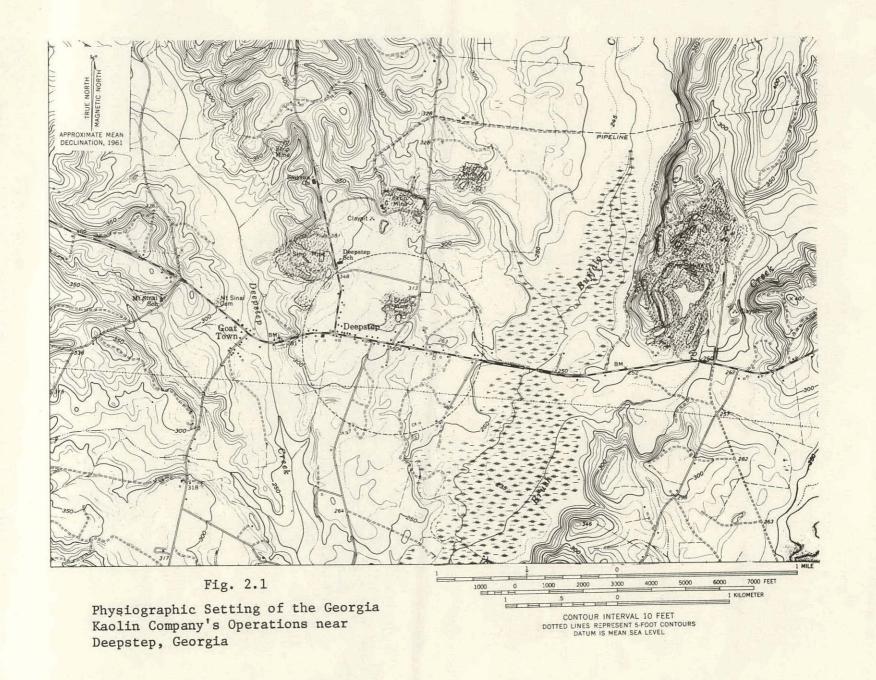
Excellent sources of both surface and groundwater occur throughout the Fall Line Zone. Most of the AICC mining division area drains into the Oconee River, which, along with the nearby Omulgee and Ohoopee Rivers, form the primary tributaries of the Altamaha River. Except for occasionally large concentrations of suspended sediments, surface water is generally of high quality having low mineral content, generally soft in nature and low in color. Even so, only a few kaolin producers utilize surface waters in their operations. Local groundwater, including artesian sources, are generally more accessible, more reliable, and of higher quality than water from surface streams. Furthermore, surface water systems have traditionally received large quantities of untreated sewage and industrial pollutants. The streams also contain processing water, often of high acidity, and clay tailings, but current reclamation practices coordinated by the Goergia Water Quality Control Board have greatly reduced the contaminants from mining and industrial activities.

Underlying the Fall Line Hills are extensive sand and gravel formations that provide artesian aquifers that produce in excess of 1500 gal/min from some wells. Much of the artesian supply originates from a local ground-water stratum that becomes confined between clay beds in its down-slope migration. With greater volume, more dependable flow, and lower mineral content, the artesian wells are more desirable than drilled or dug wells in supplying water for kaolin mining and reclamation uses.

The kaolin industry is not only favored by an abundant supply of artesian water but also a terrain generally suitable for the storage, treatment, and disposal of industrial wastes. A sparse regional population and limited competition for water resources have contributed to the well-being of the kaolin industry. At present, the major water-related problem centers upon the effective utilization and disposal of water trapped beneath commercial kaolin beds. Water supplies offer little or no restriction to the reclamation of the surfaced mined areas (Buie, 1972).

#### 2.7 SOILS

The Sand Hills Soil Province dominates the central Georgia Kaolin Belt (Thornbury, 1964). With a variation in topography and parent material, soil particles range in texture from sands to clay and vary widely over relatively



small areas. Considerable leaching of nutrients and the loss of humus have resulted from the intense mechanical and chemical weathering processes associated with the region's warm and humid climate. Climatic conditions are also largely responsible for the high soil acidity (low pH), a condition resulting from the low ability of clay minerals to absorb cations. Commercial kaolin deposits generally lie beneath 1-20 feet of soil, sands, and clays (Perkins and Troth, 1971). The Kershaw Series, which is the dominant soil type in the Sand Hills, supports only a sparse forest cover with an occasional farm breaking a rather monotonous wooded landscape. Soils of the adjacent Red Hills and Coastal Plain are considerably higher in fertility and are among the most intensively cultivated and most productive soils in the state. They help support the revegetation of the surface mined lands disturbed by kaolin mining.

#### 2.8 NATURAL VEGETATION

Except for the more severely eroded slopes, virtually all of the Fall Line Zone was once densely forested. More than 70% of the region is currently forested. Long-leaf pines once predominated on the ridges and better drained slopes, with such deciduous tree species as oak, hickory, birch, and maple being the most numerous in low lying and poorly drained areas. Although considerable acreage of hardwoods still exists in the region, reforestation efforts have formed the faster growing slash pines that replace the natural long-leaf pines in areas of flat terrain. Short-leaf and loblolly pines generally occupy the more fertile portions of the Fall Line Zone. However, in the vicinity of kaolin operations, much reclaimed land has been upgraded to row crops and pasture, which provide an esthetically appealing change from a forest-covered terrain.

#### 2.9 LAND USE AND THE REGIONAL ECONOMY

Washington County, which encompasses several kaolin mining and processing facilities, has a diversified economic base with kaolin production providing the single leading source of income. Mining is followed by agricultural products, forest resources, and various light manufacturing concerns. Washington County followed the trend of other Oconee-areal counties in experiencing a recent decrease in population. The county declined by 7.5% to 17,480 during the last census period from 1960-1970. Sandersville, which lays claim to the title of the nation's Kaolin Capital, has a population of about 6000 and the adjacent center of Tennille has approximately 2000 inhabitants. No other town in Washington County has as many as 500 people. Deepstep, located in the heart of the kaolin mining and processing center, has two stores and some 100 inhabitants (Washington County Chamber of Commerce, 1975).

The Oconee area consists of seven counties in central Georgia that contain two of the state's leading kaolin producers -- Washington and Wilkinson Counties. The area has a past history of net emigration, low per capita income, and limited economic opportunity. Currently, the Oconee Area Planning and Development Commission in collaboration with other agencies is seeking to expand the economic base of the region.

Farming remains an important activity in Washington County, although the number of farm families, acreage in crops, and various other indices of farm activity have either declined significantly or have shown little change in recent years according to the 1974 Census of Agriculture. The major crops produced are cotton, corn, soybeans, and peanuts. The grazing of cattle comprises another important activity with considerable potential for further development. More than 71% of the county remains in forest, indicating a relatively low level of intensive agricultural development in pasture and row crops. The kaolin mined lands tend to support a higher percentage of such development as well as areas for recreation. I

Based upon observations and examination of approved Application for Surface Mining Permits (see Appendix E).

#### 3 THE MINING PROCESS

#### 3.1 EXPLORATION

The first step in kaolin prospecting or exploration is to determine candidate sites where the mineral might be found. The process of selecting these areas includes an evaluation of the topography, slopes, and elevation by using geologic maps and aerial photographs (Patterson and Buie, 1974). Once a deposit is located and measured, a series of patterned exploratory drillings reveals more details about the quality and quantity of the kaolin deposits. Today's sophisticated exploratory techniques are in sharp contrast to earlier discoveries in which the candidate areas were primarily dependent upon a more superficial observation of outcrops in streambeds and along road cuts (Patterson and Murray, 1975).

Portable drilling rigs are employed in the exploratory drilling operations. In the initial testing, castings from drill holes are removed to a mud pit. If evidence of kaolin is present, a core sampling procedure follows. In the first stage of exploration, the drill holes are made every 12-15 acres, although procedures vary from company to company. The holes are normally drilled to a depth of about 200 feet. Deposits that evaded detection by this method would not meet current economic requirements. Should the company decide to retain the property, more detailed drilling tests are conducted. A split-spacing method having 400-ft, followed by 200-ft, centers is utilized in carrying out further evaluations. Drilling tests are begun near the center of the deposit and advance toward the periphery. Prior to stripping, holes are drilled at approximately 100-ft intervals and maps are compiled that designate the location of stripping cuts and overburden locations. Irregularities in adjacent drill sections may require additional spot drilling.

Large-scale, detailed maps that range from the first stages of exploration to the completion of reclamation are employed in all phases of the mining process. These area maps are used to locate and identify each drill hole and to plot the results and distribution of laboratory evaluations of the various samples. Before removal of the overburden, maps are compiled that depict its thickness as well as the size and location of the kaolin deposits. Another mapping technique used in exploration is the use of contours to designate the size and quality of the kaolin deposits. Later, the mining plan and schedule are based upon information contained on mine maps, which consist of 50-ft centers with each vertical foot of kaolin analyzed separately. Such detailed evaluation is necessary because of the wide variation that exists in the thickness and quality of kaolin over relatively small areas.

Comprehensive planning as mandated by the Georgia Surface Mining Act dictates that a detailed map of each property be compiled before the commencement of mining. Howard (1976) notes that "... a mined land use map illustrates current use of a production site by the mining operator and clearly depicts

land use during and following mining activities. It reflects like a mirror a clear, sharp, concise image of mining and reclamation activities in a given area."

Reclamation maps are also useful in planning overburden removal and kaolin mining. As proper waste disposal and contouring are necessary to reduce the time and costs of meeting the reclamation standards, the maps have to be considered a fundamental tool in planning the mining process.

#### 3.2 EVALUATION OF DEPOSITS

Cores obtained from exploratory drillings are also treated systematically. Once a bed of kaolin is located, the drill bits are replaced by ten-foot hollow core barrels. This procedure is repeated for obtaining and analyzing additional cores. Clay technicians inspect the cross-section for such physical aspects as color, texture, and impurity content and record the information in drill logs (Kennedy, 1976). Before the core samples are removed to the Yara Laboratory for further analysis, each sample is identified by date, location, and depth.

In the laboratory, 2-ft sections from test drillings are subjected to tests for purity, uniformity, and other selected physical properties. Georgia kaolin for paper coating, its primary use, must meet a rigid set of specifications. Among the tests are:

- 1. Brightness. Based on a standard reading of 100 for freshly fumed magnesium oxide and at a constant wavelength. Measurements are made on degritted crude clays and on the various coating clays. A minimum brightness of 85.5% is required for No. 2 coating clay with a minimum of 87% for finer No. 1 coating.
- 2. Particle Size. Determined by measuring settling properties of clay particles. The percentage of particles of less than two micrometers in diameter is also noted. Viscosity, brightness, and other important physical characteristics are related to particle size. Blends of various deposits might be required to meet filler and coating requirements and to maximize the value of the finished product.
- 3. Percent Grit (Screen Residue). Crude clay is chemically treated and later washed through a standard-sized screen. Although the quality of kaolin under analysis is a factor, a maximum of 10-15% grit is the approximate upper level of grit content. A higher grit content increases the cost of beneficiation and lowers the percentage of kaolin recovered.
- 4. Viscosity. Fractionated kaolins are dispersed in an aqueous slurry. The viscosity influences coat weight, smoothness, and the rate of application of paper coatings. Even, fast-flowing coatings are desired. Both low- and high-shear viscosity are measured according to established standards.
- 5. Leachability. A measure of the maximum brightness that can be obtained for the various coating fractions using standard procedures. From an analysis of leachability, levels of treatment, if any, required to meet brightness specifications are determined (Patterson and Murray, 1975).

Decisions relating to the possible development of a mine site are made upon an analysis of field data, laboratory testing, and company needs. Generally, it is economically feasible to mine kaolin deposits with overburden to clay ratios of from 6:1 to 8:1, depending upon the nature of the overburden, and the size and quality of the ore deposit. Potential problems in meeting reclamation standards that were established by federal and Georgia laws are also weighted in the evaluation process.

After an evaluation of properties under the company's control and a consideration of future demand, a general, long-range surface mining program is formulated (Kennedy, 1976). Detailed planning is necessary if maximum efficiency is to be attained in the exploration, mining, and reclamation operations of the kaolin industry.

#### 3.3 REMOVAL OF OVERBURDEN

The mining of kaolin includes initial land clearing by dozers; overburden removal by scrapers or draglines; blunging or truck haulings; and pumping to beneficiation plants (Fig. 3.1). In recent years, some of the most dramatic changes in the kaolin industry have taken place in the various aspects of overburden stripping and dumping (Patterson and Buie, 1974). Among factors contributing to these recent changes are: (1) a comprehensive reclamation law that mandates high standards of backfilling, grading, and revegetating, and increasing costs of meeting these requirements, (2) the ever-increasing depths and amounts of overburden that must be removed to expose the kaolin ore, (3) the development by a highly competitive equipment industry of larger

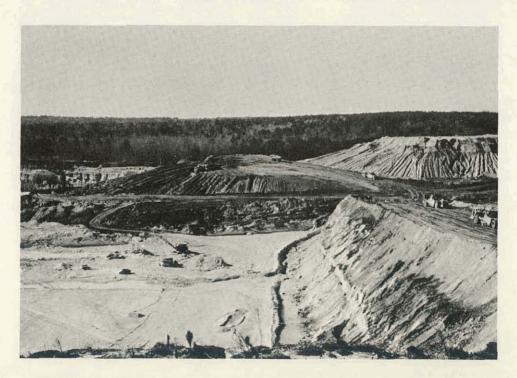


Fig. 3.1. The kaolin mining operation is progressing to the right. The overburden is removed by pan scrapers in the right foreground and placed in mined out area in center background. The kaolin ore and blunger are visible in the left foreground.

and more efficient stripping machinery to remove the overburden, and (4) the necessity of minimizing production costs. The latter is a factor that is becoming of increasing importance in view of the ever-higher labor, energy, and transportation costs and the sharp competition that the kaolin industry is receiving from foreign sources and substitution products.

The three basic steps leading to the mining of kaolin deposits are:

- 1. Surface Clearing and Disposal. Commercial timber is cut and sold and the remaining growth is bulldozed into lower areas where it is eventually covered with overburden.
- 2. Scraper Removal and Contouring. Scrapers remove the excess overburden but most draglines can only operate at depths of from 40-60 feet. Scrapers are required to smooth irregular surfaces and to grade and landscape the area for efficient dragline operations (Fig. 3.2).
- 3. Dragline Removal and Placement. Normally long parallel cuts are made with the overburden stacked in irregular, conical piles adjacent to the cut. Prompt removal of kaolin ore allows for the backfilling of the previously mined cut.

Most mining operations now employ draglines and self-loading rubbertired scrapers (paddle wheel) in stripping operations. Draglines, which range in size to more than 25-cu-yd capacity, are less mobile and require a smoother terrain than scrapers, but they normally permit the more expeditious removal of overburden. On the other hand, scrapers have the capacity to move the overburden greater distances and allow dumping farther away from excavation



Fig. 3.2. Self-loading type pan scrapers are used for both overburden removal and excavation of kaolin ore. The unit depicted here is loading ore.

areas. However, the economic limit of the maximum displacement of overburden is about 1000 feet. Other advantages are that the scraper has more flexibility in backfilling and greater efficiency in reclamation work than is provided by draglines. Other machinery employed or developed for possible uses in stripping and mining operations are front-end loader-truck combinations, bucket-wheel excavators, shovel-truck combinations, and dredging and hydraulic devices (Fig. 3.3).

Decisions relating to the proper choice of mining equipment are weighed on the basis of topography, composition of overburden, rainfall patterns, investment and operating costs, location of stripping operations relative to waste-disposal areas, and reclamation plans.

Georgia Kaolin's American Industrial Clay division contracts for its stripping operations on the basis of volume of overburden removed. Among the primary factors influencing costs are: the nature of the overburden, the depth of overburden removed, and the distance involved in hauling it. Costs tend to increase with larger amounts of moisture and rock content. AICC deposits are stripped by large self-loading pans capable of transporting about 40 tons of overburden in a single load or by dump trucks with capacities of approximately 50 tons (Fig. 3.4). In order to meet one year's demand for crude kaolin, AICC requires the stripping of some 6 million-cu-yd of overburden. The dumping and backfilling of the overburden is carefully planned, as it is generally considered too expensive to move mining wastes more than once. Yet, all topsoil must be stockpiled for use in the reclamation process in compliance with the Georgia Surface Mining Act (Kennedy, 1976).

#### 3.4 MINING OF KAOLIN

The removal of overburden, backfilling, grading, revegetating and the mining of kaolin are interrelated processes. New reclamation rules and regulations, more sophisticated equipment, and innovative practices within the industry have ushered it into a new era. At AICC, mining of crude clay involves the use of a 1-cu-yd dragline to shovel the crude clay ore from the stripped deposit and to deposit it into a blunger where processing begins (Kennedy, 1976).

Soler (1969) describes the *roll-over* method, a mining technique that allows for the stockpiling of ore and expedites the reclamation process (Fig. 3.5). Rather than leaving windrows of overburden in the mined-out areas, which formerly left a devastated landscape, wastes and kaolin ore are now stocked in a predetermined manner. Although the actual practices and dimensions vary somewhat from place to place, the essential stages in the roll-over method are:

- 1. The initial selection of a box cut, approximately 70-90 feet in width adjacent to the edge of the clay deposit and paralleling the direction in which the cross section was determined.
- 2. The dragline is located at one end of the cut and digs the first trench or box cut. The overburden is removed next and placed at least 100 ft away. Then the dragline moves to the front of the pit, mines the clay ore and dumps it between the pit and the first overburden pile.

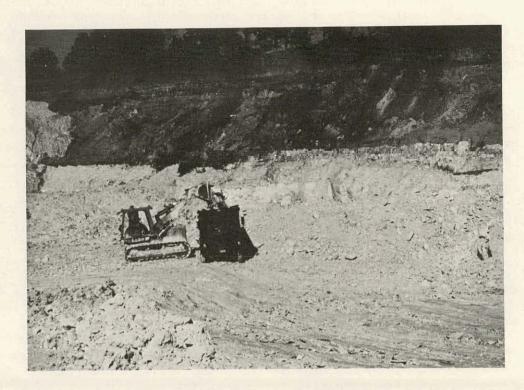


Fig. 3.3. In some small limited area operations track-mounted front-end loaders and trucks are used for mining.



Fig. 3.4. Kaolin ore is transported by pan scrapers to a central area where it is stockpiled while awaiting placement in the blunger by a small dragline.

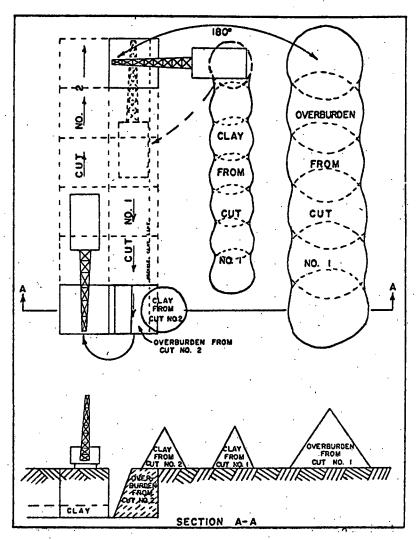


Fig. 3.5. Plan View Showing Mining Sequence Used in Roll-Over Method

- 3. The dragline is moved to a position adjacent to the first trench or box cut where a second cut is dug. The procedure noted in step #2 is repeated until the total cut has been mined.
- 4. The overburden from the second cut is cast into the pit left from the initial cut. Grading of the overburden surface by dragline and bulldozer prepares the overburden surface for the clay to be mined. Completion of the roll-over method leaves only the conical clay piles and the overburden from the first cut.

The use of the roll-over technique is restricted by: (1) the reach of the dragline boom; (2) the composition and slope of the overburden; (3) the overburden to clay ore ratio; and (4) any excessive ground water. The technique has to be modified where a thick layer of overburden dictates the use of traditional dragline mining methods. In such cases, there is a limited space available for the stockpiling of kaolin and a series of irregular waste piles are left that require more extensive reclamation efforts (Soler, 1969).

## 3.5 LAND OWNERSHIP AND MINERAL RIGHTS

Most of the land containing minable kaolin is owned by individuals. Several alternate procedures are followed in securing access to the clay. The company may: (1) negotiate an agreement with the landowner, giving the company an option to purchase the land, (2) set a time limit for mining the clay at a fixed price per ton, or (3) pay the landowner a royalty on the kaolin as it is mined. At AICC, purchases outnumber leases by about 3 to 1. Although mining and reclamation laws must be followed, regardless, ownership gives the company more flexibility in mining the site (owned units may be held in reserve) as well as in the determination of the reclaimed landscape. Except in rare instances, possibly one in a thousand cases, ownership of the surface also carries the rights to all minerals and other resources of the land. Kaolin producers increasingly are having to deal with middle men who are speculators acquiring properties that the company needs for the effective development of a particular deposit.

Prices paid for crude kaolin vary from a few cents to several dollars per ton. Factors determining the value of a deposit are quality, size, proximity to other properties controlled by the company, the ratio of clay to overburden, and the needs of the organization.

# 3.6 PROCESSING OF KAOLIN

The formation of a slurry for transfer of kaolin to various processing facilities represents the completion of the mining process and the first stage in the beneficiation of the mineral. Large portable blungers located at the mining sites screen out large-sized impurities and produce the slurry that is utilized in most phases of processing (Fig. 3.6). A typical blunger has a capacity of 1500 gallons and consists of a set of bottom-driven blades powered by a 250-hp electric motor (Soler, 1969). Inside the blunger, water and small

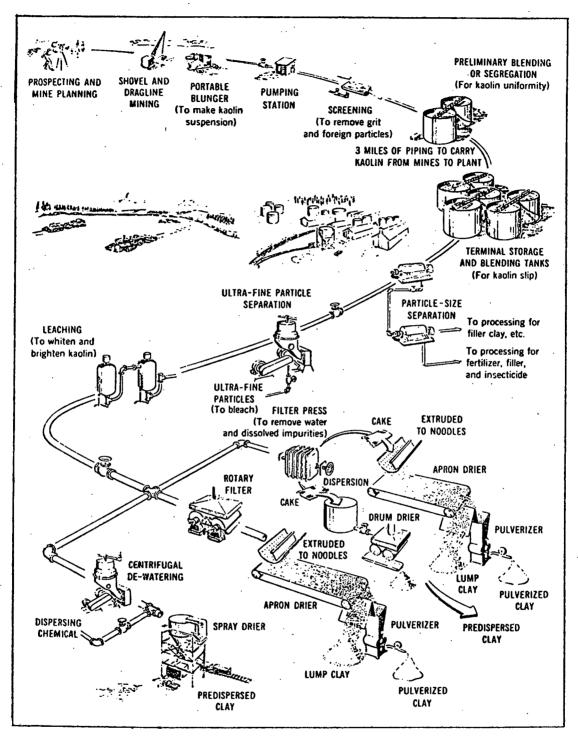


Fig. 3.6. Illustrated Flow Diagram Showing Kaolin Beneficiation Methods (Murray, 1963b)

amounts of a dispersing agent are added to the clay at uniform rates. The mechanical blending of these *ingredients* produces a low-viscosity, clay-water suspension that can be pumped easily via pipeline to a degritting station, a journey of several miles in most instances (Fig. 3.7).

Degritting removes coarse materials, such as sand and mica, from the slurry by the action of gravity in settling tanks called sandboxes (Fig. 3.8). A series of metal flights or rakes continuously drag the bottom of the tanks removing oversized materials that are discharged as wastes into nearby settling Although of simple design, degritting boxes reduce percentages of oversized particles (larger than 44 microns or 0.00173 in.) from as high as 15% to less than 0.5%. The continuous flow of slip from the settling tanks passes through a finely meshed vibrating screen that removes floating matter (Fig. 3.9). Terminal storage tanks are the next stop for the slurry, here quality determination and decisions relating to the use of the kaolin are made (Kennedy, 1976). After preliminary blending or segregation, the slurry is pumped to the mill terminal storage and blending tanks, a trip that may reach 12 miles at  $AICC^2$  (Fig. 3.10). At AICC, blunger output is either pumped directly to terminal tanks, or blended with clay from other mine sites, depending upon composition and consumer demand. The mill terminal tanks there have a capacity of approximately 7000 tons of crude kaolin. Storage is required for meeting a high degree of product uniformity and to insure sufficient reserve for the processing plant, which runs 24 hours a day, seven days a week most of the year (Kennedy, 1976).

Kaolin used as a coating clay requires beneficiation by one of two basic methods — a dry process or a wet process. Although it is simpler and less expensive, the dry process yields a lower quality product than the wet process. Deposits meeting specific requirements as to brightness, purity, and particle—size distributions are located by drilling and testing. Thus, the finished product has properties similar to those of the crude kaolin. The basic stages in the dry process are: (1) crushing (approximately to egg size), (2) drying, (3) mechanical shredding or disintegration, and (4) air flotation for removal of oversized particles and grit (Patterson and Murray, 1975).

A generalized model for the processing of kaolin from the mining stage to the finished products is shown as Fig. 3.6. Although the basic procedures utilized in wet processing have remained relatively unchanged over the past

<sup>&</sup>lt;sup>1</sup>Kaolin particles occur naturally in a forced (non-dispersed) system; however, the particles are easily dispersed, a characteristic that makes it possible to process the mineral to the rigid specification required by consumers. Introduction of a dispersing agent, such as sodium hexametaphosphate or sodium silicate, imparts a preponderance of negative charges to the clay particles resulting in their alignment into decks, consisting of individual plates or units. This procedure significantly reduces the amount of water required for the slurrying and transfer of kaolin. The product is a suspension that is both free-flowing and relatively pourable (Kennedy, 1976).

<sup>2</sup>Freeport Kaolin is now transferring kaolin slurry from the Sandersville area to the company's processing facilities, a distance of some 24 miles.

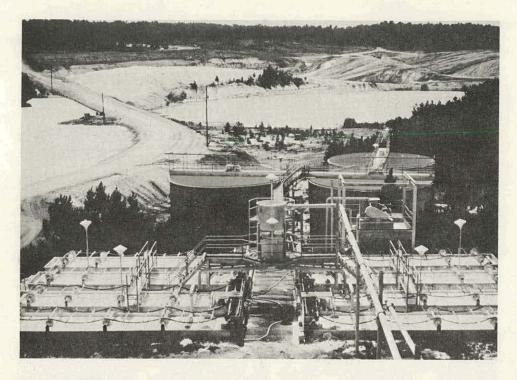


Fig. 3.7. Small degritting stations remove silica sand from the kaolin before final processing at the main plant. The sand disposal area is located in the background.

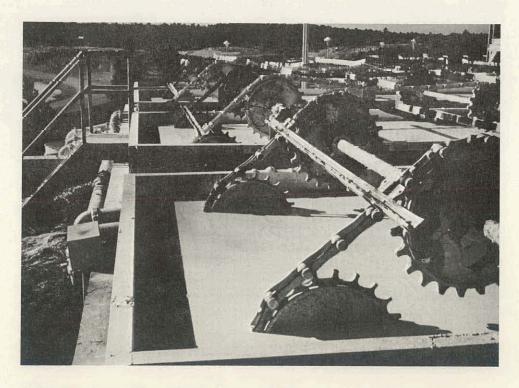


Fig. 3.8. Depicted here are the settling boxes of the degritting station.

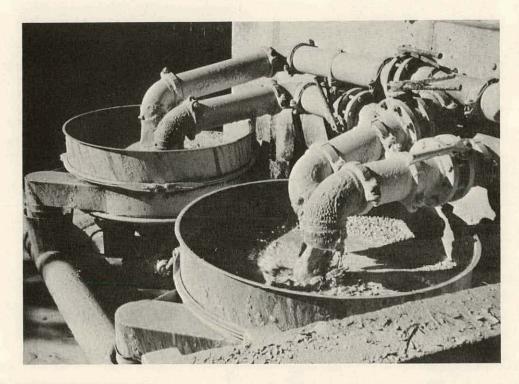


Fig. 3.9. The screens on the settling boxes further refine the kaolin.

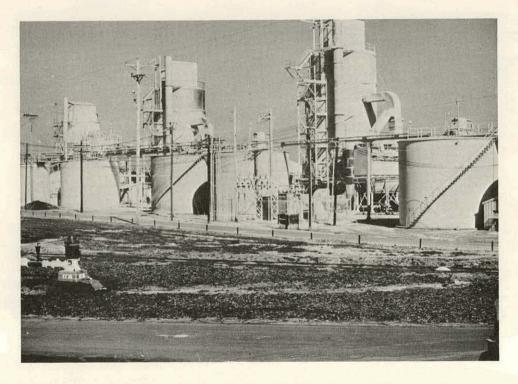


Fig. 3.10. The beneficiation plant provides the final product treatment.

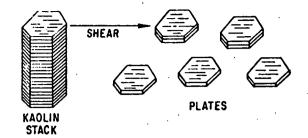


Fig. 3.11. The Mechanical Shearing
Method Used in Reducing
Kaolin Stocks to Individual Plates

several decades, technological advances have resulted in occasional modification to the processing infrastructure.

The mill processing of degritted crude or slip consists of the following steps:

Step 1.

Fractionation. This process is similar to but considerably more complex than the degritting of crude clay. Clay slurry at 35-40% solids is fed contin-

uously to centrifuges producing forces up to 1100 times that of gravity. Most of the centrifuges are cylindrical devices with volumes of 1.5 to 2.5 m<sup>3</sup>. Inside the centrifuge, pipeline slip is introduced at a uniform rate.

The centrifugal force produced by the rapidly rotating device results in the heavier particles being thrown outward against the interior walls where they collect, eventually forming a solid mat. The two products of fractionation, the coarse, high solid reject and the fine coating clay fractions are emitted at rates that together equal the feed rate of the centrifuge. The coarse fraction is diluted and the above process is repeated, producing more high-grade clay.

Step 2.

Delamination of kaolin stacks. The development of this process occurred at about the same time as the demand for filler clay increased. Previously, much of the coarse grade kaolin had either been discarded or utilized in lower quality products. Mechanical shearing and grinding or import are the methods employed in reducing kaolin stocks to individual plates (See Fig. 3.11).

Step 3.

Leaching. Removal of excessive iron, rutile, and anatase is necessary to improve the kaolin to the 85.5-87.0 level of brightness required of coating clay. After acidification, wet sulfuric acid or alum and a reducing agent, such as sodium hydrosulfite, is added. Dewatering by centrifuge or filter removes the soluble sulfate, which is discarded (Kennedy, 1976).

Step 4.

Magnetic Separation. One of the more recent innovations in the kaolin industry, the magnetic separator or filter not only upgrades the quality of the final product, but also extends reserves and reduces the consumption of leaching chemicals. Essentially, the kaolin is pumped in slurry form into a uniform magnetic field where much of the remaining iron and titanium materials are removed from the slurry and periodically flushed. Magnetic separation is often used in combination with chemical leaching, depending upon relative energy and chemical costs, and the quality of product desired (Patterson and Murray, 1975).

Step 5.

Filtration. Before preparation of the final product, kaolin must be dewatered by filtration, which is accomplished with filter presses or rotary-drum filters. The resulting material is a sticky, high solids filter cake, which is fed to the various drying units.

Step 6.

Drying. The kaolin filter cake is forced through an extruder into spaghetti-like shapes or noodles that fall onto a metal apron. Drying reduces the moisture content of the clay to about 5%, forming a lump clay that is mechanically transferred to open rail cars for shipment. Lump clay has declined in importance due to problems with unloading (lumps often having to be broken up), and because the customer must disperse the clay before processing (Patterson and Murray, 1975).

The primary filter clay product is spray-dried, predispersed clay. The filter cake produced during the filtration process (Step #3) is again dispersed and mechanically mixed. After screening for impurities, the cake is pumped to one of several spray driers for preparation of the final product -- predispersed clay, a highly refined and versatile grade.

An alternative to totally solid kaolin materials is 70% solids, a product that paper companies and other consumers are demanding in greater quantities. This high-quality product can be easily shipped, transferred, and stored, and can be used by the paper manufacturers with little, if any, additional treatment (Kennedy, 1976).

The preceding steps in the processing of kaolin are highly generalized and are intended only to familiarize planners, etc. with the nature and extent to which the mineral is beneficiated.

### 4 MARKETS

Although the world kaolin industry has experienced several upheavals during the 1970s, Georgia-based operations have continued to dominate the free world market for the mineral. Five factors that contribute to the stability of the state's industry are: (1) a reputation for highly dependable, high quality products; (2) the development and subsequent utilization of technological innovations that improve compatibility; (3) a world-wide distribution system of marketing, and widespread technical assistance; (4) one of the world's largest reserves of high quality and relatively accessible kaolin; and (5) an infrastructure acquired largely during preinflationary periods.

### 4.1 DOMESTIC MARKETS

Kaolin consumption is directly related to the demands of the paper industry. Approximately 70% of Georgia's output of the mineral is utilized for paper coating and filler clays. Refractories utilize about 13%; some 4% goes into pottery, tile, and stoneware; and another 4% is used as filler for rubber, paints, and fertilizer. Although the uses of kaolin are expanding rapidly, the primary economic diversification of kaolin occurs within the paper industry. In 1976, the printing and writing paper segments of the industry grew by 15%, and accounted for virtually all of the entire year's increase in the output of kaolin.

### 4.2 FOREIGN MARKETS

The United States was a net importer of kaolin until 1962. Although exports surpassed imports by only 8000 tons that year, it ushered in a new era for the nation's clay industry. By 1969, about 500,000 tons of the mineral were exported, whereas imports amounted to only 65,000. Foreign sales continues as a major dimension of the U.S. industry, with 1976 exports totaling more than 764,000 tons (Murray, 1977).

Western Europe remains the major market area for exported kaolin, especially with the failure of Great Britian's Cornwall facilities to keep pace with the European demand. Significant quantities of American kaolin are also exported to South America and Japan. In Japanese and other Asiatic markets, transportation costs total as much as 50% of the value of the product. The rapid escalation of labor and service costs, as well as the time and expense required to meet state and federal regulations, further restrict U.S. sales potential abroad. Buie (1972) has noted that increased develop-

As a filler, kaolin occupies the space between the paper fibers. It imparts improved opacity and color and gives the finished paper a smoother surface, with a higher affinity for ink. When used as a coating, kaolin adds the advantages of high gloss, brightness, and low viscosity to a high solid content (Murray, 1977).

ments of foreign kaolin deposits make long-range forecasts for U.S. market potential difficult to estimate.

Most foreign shipments are made in small lots, reflecting a dispersed world market pattern. Many developing nations are anticipated to seek to develop domestic supplies or, at least, to consume those of nearby countries, as their demand for kaolin increases. Speciality, high-quality clays with values approaching \$125 per ton are most promising for long-term export potential. Many U.S. corporations, such as Georgia Kaolin's AICC division, are actively developing foreign supplies and assisting in their distribution. Currently, AICC's market is approximately 70% domestic and 30% foreign (Kennedy, 1976).

### 4.3 TRANSPORTATION

The transfer of clay slurry to the processing facility is the first step in the transportation of kaolin. This is normally accomplished by pipeline. For smaller deposits, however, trucks may be used to transport the clay to a slurry-producing blunger at a primary mine site. As kaolin deposits located in the vicinity of the processing plant are depleted, longer pipelines are required. Recently, Freeport Kaolin began utilizing a 24-mile pipeline between a new mine near Sandersville and its main processing plant at Gordon.

Distribution to the consumers of kaolin is transported, in order of importance, by rail, truck, and water (Cooper, 1972). Kaolin is shipped from the beneficiation plant as bulk, in 50-lb multiwall paper containers, and in slurry form, especially the 70%-solid consistency. Weight of the finished product varies from about 65 lb/cu ft for lump clay to as low as 20 lb/cu ft for very fine pulverized kaolin (Patterson and Murray, 1975).

Domestic rail shipments originate primarily with the seaboard railway system, and the Central of Georgia Railway is utilized for transporting kaolin ore to port facilities at Savannah, Georgia, and Port Royal, South Carolina. It is distributed from these ports to both domestic and foreign markets. Export shipments use bulk ore carriers for lots as large as 15,000 tons in either lump or spray-dried form. Smaller shipments are transported in 25- and 50-kilo capacity bags.

### 4.4 COMPETITION

The primary domestic threat to Georgia kaolins comes from the potential use of several alternate or substitution products. The state of tech-

Problems may occur with both spray-dried and slurry clay during shipment and storage. Lumping and compaction of dry kaolin and pumping problems associated with the slurry form are both relatively minor. The use of 70%-solid slurry is increasing in popularity as it is easier to store and utilize, as well as being in the form required for use by the paper industry (Patterson and Murray, 1975).

nological developments and production costs are the primary factors involved in the competitive products, especially from whiting, synthetic paper, plastics, silicates, alumina hydrate, talc, and ground calcium carbonate. Each of these materials, like kaolin, has its advantages and drawbacks: for example, calcium carbonate is cheaper and has superior color, but the substance is chemically active with acids and because of its high solids content does not flow well. Recently, plastic filler materials have been used in a paper that is 40% lighter than conventional clay-coated paper; present costs, however, are limiting the utilization of this product. Increases in the cost of delivered kaolin by 30-40% relative to alternate products, several of which are still in a high-cost developmental stage, could create a highly competitive marketplace in the near future (Patterson and Murray, 1975).

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# 5.0 ENVIRONMENTAL IMPLICATIONS OF THE INDUSTRY

### 5.1 DISTURBED AREAS

Georgia kaolin is mined from 25 mines by 18 companies in 8 counties (Khemnark, 1970). Of the 40,000 acres of the State's land disturbed by surface mining, five-eighths have been disturbed by the kaolin industry (Read, 1973).

The U.S. Bureau of Mines Information Circular 8335 (1977) cites estimates of commercial kaolin reserves in Georgia as ranging from 100-525 million tons. These reserves represent a supply equal to 28-150 times the present United States annual production. Buie (1972) has estimated that the state has about 80 years of kaolin reserves. Buie assumed that the annual production will increase uniformly to 15,000,000 tons in the United States by the year 2000 and will remain relatively constant during the 21st century. In 1970, an estimated 269,000 acres of land in Georgia contained kaolin deposits suitable for surface mining methods (Khemnark, 1970). In short, it appears that the kaolin industry will be able to meet the demands for the future; no near-future situation bordering on gloom is foreseen for Georgia's kaolin industry.

The kaolin overburden and spoil are very diverse texturally, structurally, and in ability to hold moisture. Three to seven layers of soil, sands, or clays, ranging in thicknesses from 1-20 ft, generally occur above the commercial kaolin deposits. The characteristics of a single overburden stratum tend to be relatively uniform but vary among strata, depending upon their origin.

The properties of the disturbed areas resulting from surface mining of kaolin in Georgia were analyzed in an extensive study of 19 sites (May, 1971). The particle sizes of the overburden indicated a range of from 3-91% sand and 2-77% clay among the strata analyzed. Forty-one percent of the strata contained 60-79% sand. Particle-size analyses of these sites revealed the existence of a wide diversity within short distances and within small differences in depths (Table 5.1).

The spoil bank characteristics are affected by the type of mining operation. Surface mined lands are generally composed of a mixture of all strata above the kaolin together with the low grade clays that are cast aside. Therefore, the chemical characteristics of the spoil banks are based upon the matrix of clay and sand particles of which they are composed and the nature of the various strata in the overburden.

Spoil moisture contents are generally similar to those of unmined areas (Johnson, 1970). This similarity was interpreted as resulting from the homogeneity of spoil mixtures created by uniform surface mining methods. It was found that the moisture-holding capacity of the spoil is largely a function of the percentage of clay and fine silt it contains (May, 1971). May found the greater the amount of clay and fine silt the better the moisture- and water-holding capacity of the spoil banks.

Table 5.1. Range in Particle Size Distribution of Spoil Bank Material (Johnson)

Range % of Total	Percent of Samples		
	0-6"	6-12"	12-24"
	Sand (2.0-0.5 mm)		
> 80	0 .	0	0
60-80	35.3	52.9	41.1
40-60	29.4	17.6	41.1
20-40	23.5	17.6	5.8
< 20	11.7	11.7	11.7
	Silt (0.5~0.002 mm	)	
> 25	17.6	0	0
20-25	17.6	23.5	17.6
15-20	17.6	17.6	17.6
10-15	23.5	23.5	17.6
5-10	23.5	17.6	29.4
< 5	0 .	17.6	17.6
	Clay (< 0.002 mm)		
> 80	0	5.8	5.8
60-80	11.7	7.6	5.8
40-60	35.3	11.7	5.8
20-40	52.9	58.8	82.3
< 20	0	5.8	0

Values for pH ranged from 4.0 to 7.9 but averaged 5.1 in the kaolin spoil material (Table 2, p. 39 of Symposium Proceedings). Most pH values ranged between 5.0 and 5.9 and are similar to unmined lands. Major differences occur with respect to plan nutrients rather than pH (Perkins and Troth, 1971).

# 5.2 POLLUTION CONTROLS

Kaolin is basically an inert mineral. One problem associated with the kaolin industry, however, is fugitive dust (see also Section 5.3) from mining and processing operations. The dust is highly reflective; consequently, stack discharges are readily visible, and the surrounding areas appear to be highly contaminated with particulate matter from the kaolin operations. Virtually all major plants have installed equipment to control dust emissions, but not all equipment has proved effective (Patterson and Murray, 1975). The Georgia Code, Chapter 88-9, Air Quality Control Act, as amended, requires a permit prior to construction of a mining facility (Appendix A).

The Air Quality Control Branch of the Georgia Department of Public Health considers the major air pollution problems facing the kaolin industry as amenable to solution. However, it will be neither an easy nor a cheap

process, but kaolin-mining companies have indicated concurrence with adopted state standards that are needed to provide public health and welfare (Appendix A).

During the processing of crude kaolin, it is necessary to dry the material at least once. Since the new material is handled in a wet form, drying involves passing large volumes of heated air over the kaolin. The fine kaolin particles of relatively light weight are often released to the atmosphere and create large visible clouds that extend for miles downwind if no dust collection equipment is being used.

The two types of dust collectors designed to meet the Georgia code of Air Quality Control are the filter-bag for dry dust and the wet scrubbers (Read, 1973). The bag collectors are part of a vacuum cleaner system in which a fan is used to force the dust into bags. The bags are then shaken so that the dust cake falls into a hopper and is then recycled. Since drying of kaolin is done at high temperatures, it often becomes necessary to use other collectors in addition to the bags. Cyclonic separators or wet scrubbers are used under these conditions. In the scrubber, water is added to the air stream and the dust attaches itself to the fine mist. The resultant clay-water mixture is then drawn off into treatment ponds for settlement before the water is discharged to streams. The collection of fine kaolin dust is expensive, for bag houses cost up to \$500,000 and scrubbers almost as much (Read, 1973).

The control of turbidity in water pumped from pits and discharged from washing is another pollution problem of kaolin mines. Maintaining settling ponds to remove the suspended materials in the discharge from kaolin-washing plants constitutes a significant pollution-control cost of the industry. The settling ponds, properly constructed and located, retain water long enough to permit sediments to settle out before the water is discharged to local streams. A discharge permit is required to operate any system discharging industrial wastes under Georgia Code, Chapter 17-5 (Appendix B).

Ground water problems are also becoming critical in areas where water under artesian pressure is confined underneath a commercial seam of kaolin (Buie, 1972). At some locations, kaolin can be produced only because the artesian pressure has been reduced by pumping large volumes of water from wells. This practice is expected to increase during the next few years, and the industry is evaluating the potential for use of these ground-water supplies for irrigation or municipal waters.

The average kaolin mine uses about 700 million gallons of water per year (Sargent, 1971). Any industry using 100,000 gallons per day must obtain a permit under Georgia Code, Chapter 17-11, Ground Water Use Act of 1972, as amended (Appendix C). Recycling and reuse of water within the mining industry is required more and more as the availability of water declines. This recycling is becoming especially widespread in Georgia, which prohibits the discharge of turbid effluent to a receiving stream. The Erosion and Sedimentation Act of 1972 (Georgia Code, Chapter 5-23A) does not include surface mining but gives counties power to adopt ordinances regulating erosion and sediment deposition (Appendix D).

# 5.3 IMPLICATIONS OF ATMOSPHERIC POLLUTION

Kaolin mining and processing results in two different forms of atmospheric pollution -- fugitive dust and kaolin plant dust. Fugitive dust is produced by activities at the mine site and the movement of heavy trucks over the many miles of dirt access roads used to service mining areas. Other sources of fugitive dust include leakage from processing and the transfer of dried kaolin to rail cars. Georgia laws recognize fugitive dust as an integral component of atmospheric pollution and require companies to identify the sources of such pollution and to take the necessary measure to alleviate the problem (Howard, 1976).

The primary sources of plant-generated particulates are the various grinding and drying procedures. Read (1973) estimates that as much as 80% of the dust generated at the processing plants is due to the drying process and the handling of dry clay. This factor forces the production of 70%-solid clay, as it minimizes plant area pollution and the costs required to regulate emissions. The primary particles are those of extremely fine clay, approximately 90% of which are less than 10 microns in diameter. Control of airborne particles is accomplished largely by the use of two devices; the filter-bag dust cachet and high-energy wet (Venturi) scrubbers. Bag collection involves greater initial costs but is cheaper to operate and allows for the retention and use of most of the kaolin dust. Scrubbers utilize water to form a claywater mixture that must be treated before being discharged to settling ponds (Read, 1973).

Results of a 1971 study in Sandersville, located approximately 10-20 miles east of Washington County's primary kaolin-producing area, indicates a strong relationship between wind direction and atmospheric pollution. During periods when the prevailing winds were blowing from the kaolin area, levels as high as  $491 \text{ mg/m}^3$ , more than three times the allowable limit, were recorded. Winds from areas not significantly affected by kaolin operation carried an average 61 mg (Collom, 1971). Fortunately, recent improvements in pollution control have largely alleviated this problem.

An intensive study covering a period of more than five years examined kaolin workers having continuous exposure to dust. Based upon observation during the study, Collom (1971) concluded: "... The general health of 1130 workers in the industry did not differ significantly from that of the general population in the area of corresponding age and race."

Georgia law has required reclamation of surface mines since 1969 (see also Sec. 6.1), yet AICC's reclamation program was in effect prior to legislative action. The company has now had more than 250 acres of reclaimed land officially released. AICC's reclamation program has been supervised by experts in the field of soil science, forestry, agronomy, and other areas. As a result of the company's performance in meeting reclamation requirements, the Georgia Department of Natural Resources has waivered future bonding for the company (Bloodworth, 1976).

In most instances, mining and the subsequent reclamation procedures have resulted in the upgrading of the developed property as shown in Fig. 5.1, and an excellent example of the use of reclaimed land for recreational purposes is AICC's Lake Franklin complex shown in Fig. 5.2. Most of the kaolin



Fig. 5.1. Planned bathing beaches and fishing areas on Lake Franklin are examples of recreational facilities developed in a region having no natural lakes.



Fig. 5.2. The clubhouse on Lake Franklin for the use of employees and their guests.

mines developed are on forested land that includes a large percentage of scrub or unmanaged woodland. After reclamation, pasture land, farm land, and well-designed lakes dominate the landscape. Other selected projects in addition to those designed for recreation, such as residential and industrial development must be approved by the program manager, Surface Mined Land Reclamation Program, (Appendix E). Onsite testing of soils and various grasses and trees maximize the efficiency of reclaimed acreage. Many individuals are as anxious to have their land developed for the beneficiation of the reclamation process as for the monetary gains from the sale of clay.

If the surface owner is also the mining operator, he may have an economic incentive to reclaim surface productivity to the point where the cost of reclamation is greater than the value of the reclaimed lands. Given the prevailing low land values in Georgia, however, this incentive is not likely to be adequate for intensive reclamation efforts because of the uncertainty in predicting agricultural prices and generally low productivity.

### 6 RECLAMATION

### 6.1 RECLAMATION LAWS

Georgia kaolin has been known since colonial times. The first publication describing the clays appeared in 1908 (Murray, 1977). Today the value of kaolin amounts to several hundred million dollars, and the industry employs about 5000 persons in Georgia. To a large extent this expansion has occurred as a result of technological innovations that have made large-scale surface mining possible. The vast kaolin deposits of Georgia cannot be mined by any other method (Gronow, 1971).

Surface mining and reclamation are currently regulated under Georgia Code, Chapter 43-14, Georgia Surface Mining Act of 1968, as amended (Fig. 6.1). During the General Assembly of 1967, a House resolution created a study committee to analyze the feasibility of a state law that would require mining operations to reclaim their mined-out lands. After several meetings the group submitted the skeleton of the bill, which was modified and passed by the Georgia General Assembly. The Governor signed the Georgia Surface Mining Act in March, 1968. The adopted rules and regulations pursuant to this law constitute the Official Compilation Rules and Regulations of the State of Georgia, Chapter 391-3-3 Amended.

An essential feature of the Georgia Surface Mining Act of 1968 is the requirement that an operator intending to engage in surface mining must obtain a permit in order to operate a surface mine. The application for a permit is made to the Director of the Environmental Protection Division. The permit (Appendix E) is used as a means for providing evidence, which is satisfactory to the Director, of compliance with the provisions, rules and regulations about the proposed operations. The issuance of a permit is contingent upon the permittee's compliance with the approved land use plan. Each permit application must include specified baseline information about the lands and community to be affected. Each permit application must include a mining plan, a reclamation plan, a land use plan, and anticipated reclamation costs. The permit must also include the following elements for each phase of the mining sequence.

- The Mined Land Use Plan has to indicate how the operator is going to reclaim the land to a condition acceptable to the Environmental Protection Division. Each operator is given considerable discretion in the way he wants to reclaim the land. However, the plan must show that the operator will take measures to protect the health and welfare of the people from the adverse effects of surface mining. Some of the measures of reclamation are as follows:
  - (1) Grade all peaks, ridges, and valleys resulting from surface mining and backfill all pits and trenches resulting from the same.

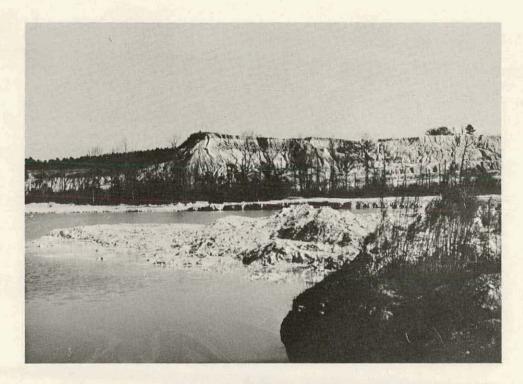


Fig. 6.1. The pre-law mined land consists of irregular spoil piles and interspersed bodies of standing water.

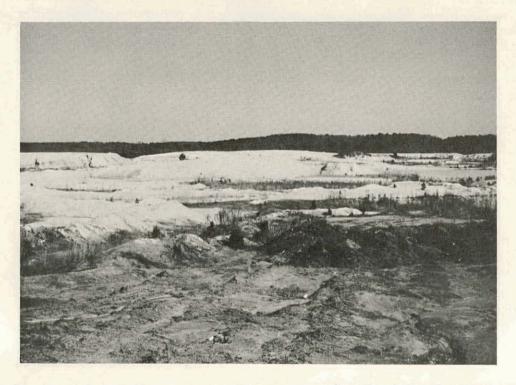


Fig. 6.2. A contrast is prominent between pre-law land in the background and graded reclaimed land in the foreground.

- (2) No natural creeks, streams, rivers, lakes, or other bodies of water are to be altered in course or relocated unless authorized in the operator's approved Mined Land Use Plan.
- (3) No operator on his own initiative shall construct any protective barrier, dam, berm, silt pond, or similar structure as a part of his surface mining operation without the prior approval of the Environmental Protection Division.
- The Land Use Plan is to include, but is not limited to, a description of:

Company and minerals or materials to be mined Mining methods Lands and community to be affected Reclamation objective Schedule of mining and reclamation, including time to accomplish reclamation Affected acreage Natural drainage and water disposal Provisions for erosion and siltation control Protection of contiguous natural resources Topsoil use Overburden (spoil) and refuse placement or use Backfilling Highwall reduction Grading and sloping Lake development Site clean up Revegetation of reclaimed lands Location map of affected lands Land use map (or accurate aerial photographs)

Once the structures, equipment, stockpiles, mining refuse, and all other materials associated with surface mining are removed or disposed of, the affected land will be reclaimed to the condition stated in the mining operator's approved Mined Land Use Plan. All reclaimed lands must have a neat, clean appearance and contain a high quality, permanent vegetative cover, except those specifically exempted by the Environmental Protection Division (Howard, 1976).

The Georgia Surface Mining Act of 1968 requires basically that mining operators reclaim annually as much land as they disturb each year. A surface mine operator may, however, substitute and reclaim an area mined in the past for lands currently being mined, on an acre-for-acre basis. According to the Surface Mining Act, reclamation shall be initiated during the first growing season and must be completed within three years (Fig. 6.2).

It is the intent of the Georgia Surface Mining Act to: (1) assist operators of surface mines; (2) expand the mining economy; and (3) bring

about acceptable land reclamation. The law requires an annual license to operate a surface mine. Upon application the mine operator is furnished with forms on which he furnishes a land use plan for the reclamation of lands affected. When the plan is approved, the mine operator must post a bond. When the proper bond has been posted and the license fee paid, the mining license is issued (Howard, 1976).

The mined land use plan included in the application for a surface mining permit must be consistent with the land use in the mine area. The surface mining permit must include, but is not limited to, a description of: (1) the minerals to be mined; (2) the mining methods; (3) the lands to be disturbed; (4) the reclamation objectives; (5) the mining schedule; (6) the reclamation schedule; (7) the drainage and water disposal plans; (8) the provisions for erosion and siltation control; (9) the topsoil use; (10) the overburden use; (11) the grading and sloping plans; (12) the lake developments; and (13) the revegetation of reclaimed lands (Appendix E).

The operator furnishes as a part of his Mined Land Use Plan an accurate location map of affected lands, and in addition, prepares and submits a detailed Land Use Map. The Land Use Map is to include, but not be limited to, details of anticipated mining advancement and provisions for drainage and erosion control measures.

The mining operator's plan is to incorporate sound engineering and conservation measures to protect the health and welfare of the people of Georgia from adverse effects of surface mining. The operators are required to grade all peaks, ridges, and valleys resulting from surface mining, and to backfill all pits and trenches to minimize any hazardous effects of mining adjacent to any public road. If the original elevation of the area mined is at or below the road elevation, operators are required to grade to the original elevation and plane a strip of land of a reasonable width lying adjacent and parallel to the public road involved.

Whenever a mining site lies contiguous to any state waters, an operator is required to follow sound engineering and conservation measures to provide protective barriers, such as dams, berms, silt ponds, or other similar structures, between the lands to be affected and waters or watersheds involved. All such structures must be approved by the Environmental Protection Division as a part of the operator's Mined Land Use Plan and are to be substantial for the protection of contiguous natural resources of the state. All structures referred to above are to be constructed at a reasonable distance from waters of the state, or that portion of a watershed of the state adversely affected, as determined by the Environmental Protection Division. Before natural creeks, streams, rivers, lakes, or other bodies of water may be altered in course or relocated, the plan for such alteration or relocation must be approved by the Environmental Protection Division as a part of the operator's approved Mined Land Use Plan.

If the mining operator fails to comply, his license may be suspended or revoked. Any industry that violates any provision of the Surface Mine Act is guilty of a misdemeanor. Each day of noncompliance after notification is considered a separate offense.

The Georgia Surface Mining Act is one of the most comprehensive the United States (Gronow, 1971). After the law was implemented in January of 1969, several significant problems arose. One problem centered around the backfilling and reclamation of previously mined land. The original law indicated that if a 50-acre mine was developed and the overburden was used to backfill and reclaim a 50-acre area previously mined, the total area affected was 100 acres. Thus, it was interpreted that 100 acres had to be reclaimed. The conflict was resolved in 1971 when the Act was amended to exclude the backfilling of land previously surface mined (Gronow, 1971).

Another problem centers around the fact that the Act requires an operator to reclaim the same number of acres that he disturbs in any given year. In the case of a new surface mining operation, the operator may be constantly behind in his reclamation requirements. Despite these and other problems, experience is proving the law is working to require reclamation procedures that improve the quality of the disturbed environment (Gronow, 1971).

### 6.2 RECLAMATION PLANS

According to Khemnark (1970), five factors largely determine the quality of surface mine reclamation in the kaolin operation. They are: (1) the properties of the overburden; (2) the climate of the disturbed area; (3) the mining methods and reclamation costs; (4) the legal requirements; and (5) the intensity of the subsequent agricultural practices. Of these five factors, only two are natural. The other three can be influenced by man's activities, his social objectives, and technical and economic conditions.

Information about the properties of the overburden necessary for reclamation planning and for determining research needs and priorities has been studied extensively (May, 1971). Overburden above operable layers of kaolin is stratified in relatively uniform layers of sands, sandy loams, sandy clays, and clays with depths to operable clay ranging from 10-50 feet. Textural classes range from sand to clay. Particle-size distribution ranges from 3-91% sand and 2-77% clay. Color is quite variable but reds, yellows, and browns are predominant. Calcareous strata are grayish to white, but mottles could occur in any strata below the surface. Indurated material is limited to scattered manganese and iron concretions. Some marine fossils, soft calcareous rock, and soft partially lignified woody plants also occur.

The pH of the overburden ranges from 4.0-7.9 or from extremely acid to moderately alkaline (May, 1971). High pH values are not associated with the highest levels of calcium, manganese, sodium, or potassium. Extractable calcium ranges from a trace to 3660 ppm; magnesium follows the same pattern as calcium, ranging from a trace to 640 ppm. Sodium although not an essential plant nutrient is abundant in many of the strata, concentrations ranging from a trace to 390 ppm. Potassium is extremely low in nearly all strata, ranging from a trace to 250 ppm, and available phosphorus ranges from 1 to

160 ppm. Levels of extractable iron, manganese, and zinc are extremely variable. Iron ranges from a trace to 25 ppm, manganese is extremely low, and zinc is relatively low ranging from 0.4 to 8.4 ppm. Copper is found only in trace amounts.

The spoil material is an unsorted, diverse mixture of strata, including non-merchantable kaolin and viscous clays. Characteristics of the spoil bank are also determined by the type of mining operation. Banks are a mixture of all strata in the overburden. There is a wide variation in particle-size distribution and elements, both vertically and laterally and at all depths. Generally the surface of the spoil contains a much higher percentage of clay than the undisturbed sites. The infiltration capacity and erodability of spoil material are related to length and steepness of the slope, the sand-clay ratio, the diversity of the sand-clay structures, and extent of crusting and compaction in the surface layer. The moisture-holding capacity of spoil is extremely variable for a single mining area.

The general concentrations of elements within the spoil are similar to those within the combined strata of the overburden. The high concentration of K evident in some strata has been diluted. Sodium and magnesium are lower in the spoils than in most strata of overburden. Calcium levels of pH were generally low except in the presence of fuller's earth or calcareous spoil. No element is found in amounts to be considered toxic for plant growth; rather, much of the overburden was deficient in some of the nutrients considered essential for plant growth. May (1971) concluded that the results of the study may not represent the entire range of characteristics within the kaolin mines, but they provided a basis for preliminary evaluation for revegetation prospects.

The nature of the overburden can be modified by fertilizing and redistributing the topsoil, but reclamation plans are often altered by uncontrollable weather conditions. Heavy rains often fall during the spring followed by extensive droughts during summer and early autumn. Mined lands that have been graded, fertilized and planted are often eroded by sheet wash resulting from torrential rains that occur before the seeds germinate. Sometimes reclamation work has to be repeated in order to obtain a protective ground cover. To date autumn seeding has produced the best results and requires fewest number of reseeding attempts (Fig. 6.3).

The mining methods and reclamation costs are variables that depend upon specific site conditions. The greatest cost items are the removal and placement of overburden, grading, and preparation of the land for revegetation. But the use of the pan scraper for overburden removal enables the kaolin industry to have greater versatility and flexibility in both the mining and reclaiming operations than other extractive industries.

There are many economies of scale enjoyed by larger companies who operate their own earthmoving equipment. On the other hand, some companies contract earthmoving and may have to move the overburden twice in obtaining satisfactory reclamation. Reclamation can, therefore, place a disproportionate cost on the small kaolin operator who has to stockpile topsoil for subsequent use in reclamation.



Fig. 6.3. Unreclaimed pre-law land (background) is easily reclaimed (foreground) for pasture.



Fig. 6.4. Pasture (foreground) and row crops (soybeans in background) were established during the first year of reclamation.

In order to satisfy the legal requirements of reclamation, considerable time, effort, and money must be expended by the kaolin operators to obtain a successful blend of mining efficiencies and reclamation successes. A wide range of reclamation choices are available under the Georgia Surface Mining Act of 1968. The land use classifications after reclamation include the following possibilities: (1) clean tilled row crops; (2) pasture or hay crops; (3) forestry; and (4) special land use projects. The special projects that may be approved by the director include recreation, sanitary landfills, residential, commercial, and industrial developments.

The field work to date suggests that perennial grasses (fescuegrass or bermudagrass) are the most desirable for stabilizing the spoils prior to planting the area to trees or preparing them for other more intensive uses. Both grasses are slow to establish, and hence it becomes more desirable to seed rye or millet as a nurse crop.

Once surface mined lands were considered reclaimed if several hundred pine seedlings were poked into steeply sloping lands. Today the requirements of the Georgia Surface Mining Act, the landowners, and the general public are demanding more intensive revegetation (Bengtson, et al., 1971). Farmers want productive pastures restored or even upgraded to intensify subsequent agricultural practices. In short, the kaolin industry is expected to establish an attractive ground cover whether the primary use is row crops, pasture, forestry, or special use projects (Fig. 6.4).

In order to achieve high quality reclamation of the kaolin mined lands, every reclamation project should begin with an analysis of the spoil for revegetation, including acidity tests, nutritional measurements, seed bed preparation, mulching, and proper seeding. Historically, revegetation has been a one-shot proposition. But those who seek to maintain a long-term attractive landscape and to upgrade subsequent productivity find it necessary also to provide after care (Bengtson, et al., 1971). Similarly, when reclaimed kaolin spoils are heavily grazed or utilized for row crops or hay production, maintenance applications of fertilizer and other nutrients are required to prevent ultimate deterioration in the quality and extent of the revegetation cover.

### 6.3 RECLAMATION PROCEDURES

Under the 1968 Georgia Surface Mining Act, all companies are required to reclaim mined land for a useful purpose. Most kaolin companies actually began land reclamation prior to the 1968 law. The following account written by Darwin Soler (1969), Mine Superintendent of the Freeport Kaolin Company illustrates that company's reclamation procedures used during the years immediately preceding the enactment of the Act.

Freeport Kaolin Co. started a land reclamation and reforestation program in 1965. This program was conducted by the Land Dept. in mined-out areas where the roll-over method of mining had been used.

The first step in the program was to experiment with various types of ground cover to arrive at the simplest and most economical method of reclamation. This work indicated that the native Georgia slash pine gave the best results.

The first restoration trials consisted of planting about 15 acres of land with one-year-old slash pine seedlings without the use of fertilizer. The seedlings were planted in rows about 10 ft apart and about the same distance between seedlings. Of the seedlings so planted, it is estimated that between 60 and 70% had taken root by the spring of the following year.

Eighteen months later, a group of pairs from this planting were chosen on the basis of equal size and appearance. One of each pair was fertilized with about 2 lb lime and mulched; the other of the pair was not fertilized. It was found that those fertilized outgrew the others by better than two to one.

During the fall of 1967, 25 more acres were planted with improved one-year-old slash pine seedlings, which had been recommended by the Georgia State Forestry Commission as being more resistant to disease and as having an improved growth rate. This area was prepared as previously, and no fertilizer was used. Although the general appearance is satisfactory, it is too early to predict the final results.

All seedlings used in the experiments described above were purchased from the State of Georgia Forestry Commission. This is a program which will continue and be expanded, and full cooperation has been received from both the University of Georgia Agricultural Department and the Georgia Forestry Commission.

May (1971) observed that both pines and hardwoods were established on some earlier kaolin spoils, especially those from shallow mining where the original A and B solid horizons constituted an appreciable part of the spoil. Efforts to establish woody plants on kaolin spoils were widespread during the 1950s. Some plantings were failures, except where topsoil comprised a significant part of the spoil. Seedling survival was usually very good during the first year, but growth rates were often poor. Foliage often began to show signs of nutrient deficiency during the first growing season, but mortality was light during the second year and increased during later years.

The selection and use of trees in reclaiming kaolin spoils has depended upon the characteristics of the spoil material and the trees and the ultimate objectives of the land-owners. All kaolin mined lands should be revegetated so as to conform with adjacent land uses, although trees may be planted for a variety of uses. They may produce wood products, provide ground cover for wildlife and protect the strip mined lands from sheet and gully erosion (Fig. 6.5).



Fig. 6.5. Picturesque headlands, combined with planned water bodies such as that depicted here of Lake Franklin, provide for recreation areas.

The better tree species and their suitabilities are summarized below: (May, 1971)

# Group 1 Spoil Sites

These level to rolling sites are predominantly sands and mixtures of coarse and fine-textured material. Colors are variable ranging from white to red, and pH ranges from 4.5-6.0.

Preferred species are loblolly and slash pine, sycamore, and European black alder. Nitrogen and phosphorus are essential for seedling growth. Complete fertilizers, i.e., 10-10-10 pellets of nitrogen, phosphorus, and potassium, respectively, stimulate height growth during the first growing season. The equivalent of one ounce of elemental nitrogen per seedling is about optimum.

# Group 2 Spoil Sites

These level to rolling sites are predominantly mixtures of fuller's earth or of a highly calcareous nature. Colors generally vary from olive to olive brown or olive gray. Values for pH range from 6.0-7.8. Sycamore, European black alder, and bicolor lespedeza have given better survival and

growth than other species tried. Nitrogen is essential for sycamore. Low rates of N may stimulate early growth of the other two species; but they are N-fixing. Pine survival and growth has not been as good on these sites as on Group 1 sites. Fertilization of these sites stimulates the invasion of native grasses and lespedeza; and crowds out planted seedlings.

# Group 3 Spoil Sites

These level flats consist primarily of kaolin clay and have a relatively high water table. Color is white and pH ranges from about 4.0-5.7. Loblolly and Virginia pine, sycamore, sawtooth oak, and white oak have given good survival and growth of these sites.

Cottonwood and willow have become established naturally in some poorly drained areas adjacent to ponds and flats.

### General

Plantings made during the late 1960s were confined primarily to areas with a herbaceous cover. These plantings have been limited to graded sites that can be machine planted. Earlier plantings on steep slopes were severely damaged by erosion. Hardwood and conifer seedlings show signs of nutrient deficiencies after the second or third growing season. One or more supplemental fertilizations will be needed before nutrient recycling begins to affect tree vigor.



Fig. 6.6. Grasses are frequently used to reestablish vegetative cover. This area was mined only two years ago.

During the last decade the Soil Conservation Service has cooperated with the kaolin mining industry to assist in selecting grasses and legumes that survive and grow well in the kaolin mine spoil banks of Georgia (Fig. 6.6). Results show that survival and growth of most plants on unmulched and unfertilized areas are often unsatisfactory. On the other hand, good results are secured under mulched conditions and growth approaches normality when both fertilizer and mulch are applied (Haynsworth, 1971).

A summary of the performance of several plants and Haynsworth's comments are as follows:

Autumnolive was planted using seed. This was a failure with only one plant in the two sites surviving after two years. Autumnolive plants were also set out. Very little growth occurred in the first year. In the second year, growth ranged from good to very good. These plants have grown to over 6 feet tall and are producing food for wildlife. The ability of this plant to fix atmospheric nitrogen favors its success. Autumnolive is not expected to control erosion of the spoil banks in the early years. It is being considered for its additional possibilities as a wildlife food plant to be grown in association with other plants which would be depended upon for early erosion control.

Common Bermuda grass came up to a good stand and spread rapidly the first year. It gave the quickest surface protection of any of the plants. It continued to spread and to provide land cover during the second year but provides very little now. It produced seed in both years.

Kobe lespedeza came up to a thick stand in the fertilized areas and made very good growth. It made a heavy seed crop that resulted in excellent volunteer stands in succeeding years. The leaves and stems of dead plants are providing a good cover of litter. Kobe lespedeza shows outstanding promise for quick establishment and cover on this site. It is also useful as a wildlife food plant.

Sericea lespedeza came up well and has shown good vigor in the fertilized area. It produced seed and some volunteering has been observed. Sericea is one of the best prospects for use. This planting further verified the usefulness of Sericea lespedeza in critical area plantings. It is a standard plant for this use in the southeast.

Virgata lespedeza becomes well established with fair vigor in the fertilized area. It grew moderately well in the first year. Its growth has been better in the succeeding years and the leaf residue from this perennial plant is providing ground cover and mulch. It is judged to have very good prospects for use in stabilizing mine spoil banks. This plant is gaining acceptance for roadbank stabilization. Virgata lespedeza is now considered to be an acceptable alternate to Sericea lespedeza.

Weeping lovegrass was quick to germinate and grew vigorously. Lovegrass seed was transported by runoff water and germinated in many of the plots where it was not planted. Excellent growth and cover resulted everywhere it lodged in fertilized plots. Weeping lovegrass, planted without seedbed preparation but with mulch and fertilizer, is one of the best prospects for cover and erosion control on mine spoil banks. This further verifies the usefulness of weeping lovegrass in critical area erosion control. It is a standard plant for this purpose in the southeast.

Bristly locust was easier to establish from seed than from plants. The seedling plants showed good initial vigor. They grew to about 5 feet in height where fertilized, while those that were not fertilized did not grow over 6 inches. The nursery grown plants grew well in the fertilized area and grew poorly where not fertilized. The seedling plants attained about as much size in the first year as the nursery grown plants. All plants in the fertilized area produced seed. They spread by rhizomes as much as 3 feet in the first year and now reach out 30 feet. It has excellent prospects for use on mine spoil banks.

Pangburn switchgrass came up to a good stand. The plants had good vigor the first year. On the fertilized area they continued in fair vigor and have slowly spread by tillers. Seed has been produced and a few volunteers have been observed. Pangburn switchgrass may have value on these sites. Further observations are needed.

Pensacola and Wilmington bahia grass came up to good stands. They exhibited fair to good vigor in the first year but have been mediocre since. They are rather slow to cover and the highly erodible nature of the mine spoil banks may limit their value as initial covering plants.

Thunberg lespedeza and bicolor lespedeza were grown from seed and have produced plants of good vigor. These plants are providing food and cover for wildlife.

In addition to grading and revegetating, another step in designing reclamation procedures includes a wastewater handling facility design. Georgia Code, Chapter 43-16, requires such compliance for dealing with hazardous solid wastes in reclamation (Appendix E). Solids need treatment in Georgia's kaolin mining industry, regardless of whether they originate from the clays and silts or air pollution controls. Certain chemicals coagulate clay particles. Table 6.1 below lists the principal waste treatment chemicals and their uses.

Table 6.1 Principal Chemicals and Their Use for Treatment of Suspended Matter

Chemical	Use		
Alum	Coagulant (lowers pH)		
Sulfuric Acid	Coagulant (lowers pH)		
Polymers	Coagulant		
Lime	Coagulant (raises pH)		
Caustic	To raise pH		
Soda Ash	To raise pH		

Coagulated solids are removed by settling ponds. The details of land availability and design plans for the settling pond site require the concurrence not only of the Georgia Surface Mining Board but also that of the Georgia Water Quality Control Board, which examines water quality of the

mine waste handling facilities (Appendix G). Biological monitoring is also needed, since wastewater discharges affect aquatic life of downstream areas.

The general procedures involved in the design and operation of waste-water handling facilities for the Georgia surface mining industry are summarized in Table 6.2. Each company is urged to confer freely and frequently with state and federal officials to ensure compliance with applicable laws and to protect the water quality of Georgia streams.

Table 6.2. Design and Operation of Waste Facilities

### Operation Design • Determine governmental requirements Monitor treatment facility Monitor receiving streams Reduce wasteload by in-house Inspect and maintain mechanical improvements · Define wastewaters to be treated and physical facility components • Perform treatability tests · Rehabilitate facility land area after use • Select treatment process • Prepare design details Receive governmental approvals

### 6.4 RECLAMATION COSTS

Although reclamation costs are originally borne by the kaolin mining companies and later passed on to the consumer, the actual costs vary considerably from one area to another, depending upon site conditions. Areas of thicker involve higher costs than those having thinner overburden. Grading constitutes the greatest cost item, and the mining methods adopted by individual companies are the main determinants of this cost.

Stripping for kaolin mining is often done on a contract basis, as at AICC, at set costs per cubic yard of overburden removed. These costs vary from cut to cut, depending upon depth and composition of overburden and hauling distance. The actual stripping is carried out using pan scrapers capable of self-loading and transporting overburden into the mining, stockpiling, and reclamation cycle.

According to state law, all topsoil removed must be stockpiled to be spread back over the surface of mined-out areas. The placement of over-burden and topsoil is no longer determined by the dragline boom length. Rather, backfilling of previously mined areas is done with low-cost reclamation in mind.

The restoration costs of the strip mined land in the Georgia kaolin mines are as much as \$800 per acre, but the average cost in 1973 was about \$300 (Patterson and Buie, 1974). By 1976, the typical reclamation costs had increased to about \$680 (Appendix E), and in many areas more than \$1000 per acre has been spent in complying with the Georgia Surface Mining Act (Gronow, 1971). Kaolin companies generally feel that quality reclamation

promotes community relations and aids in pollution control and reuse of the land for further productivity. Quality reclamation projects have resulted in the release of bonds.

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# 7 RECLAMATION PLANNING

Reclamation planning can take many different directions, depending upon the mine location, topsoil, overburden, drainage, and topography. Reclamation planning not only depends upon selected socioeconomic factors and the intrinsic suitability of the area, but also involves a consideration of the owners expected returns on his investments and the public's interest in the disturbed environment as reflected by the enactment of various laws (Appendixes A-G). Fortunately, technology is readily available for reclaiming kaolin mined areas for row crops, pasture, forests, sanitary fills, recreation, building sites, and other uses (Ward and Husted, 1976).

Enough research and practical field experience have been conducted to indicate that reclamation of kaolin mined lands can be accomplished satisfactorily (Fig. 7.1). This is not meant to imply that it can always be done easily. On the contrary, it may be difficult, contingent upon the environmental effects of mining on surface productivity, surface and ground water quantity and quality, air quality, erosion and sedimentation, and solid waste disposal treatment. However, if technically sound reclamation planning is followed with as much enthusiasm and vigor as the mining operation itself, reclamation will then result in surface productivity and water conditions that meet public acceptability. In addition, legal requirements of the Georgia Surface Mining Act of 1968 will have been met and, at the same time, the best interests of society will also have been served (Cary, 1971).

In developing reclamation plans for the Georgia kaolin mines, one needs to determine first what future land productivity is to be accomplished and what level of productivity is expected of the reclaimed lands. Thus, management plans involve not only the mining and processing operations but also the subsequent reshaping, reclaiming, and reestablishment of vegetation along with the appropriate means of controlling erosion, solid waste disposal, and ground- and surface-water supplies.

# 7.1 OBJECTIVES OF RECLAMATION PLANS

A principal objective of reclamation plans is to chart a course for the protection of soil, water, land, and air qualities of the region to the maximum extent possible during the mining and processing operations. Another important objective is to improve the aesthetic values of the landscape and to return the mined area to interim productiveness as quickly as possible. And a third is to prevent offsite damages to ground water zones, to streams, to the air, and to adjacent lands.

The first decision that must be made in developing reclamation plans is to determine the purpose for which the land is to be used after mining is completed. Until this decision is made all others lack clarity and definition. The use for which land will be reclaimed is an integral part of the Application for Surface Mining Permit, which is a part or the legal requirements (Appendix E).

The land use decision in the reclamation plan should not only meet the legal requirements of the Surface Mined Land Reclamation Program under the

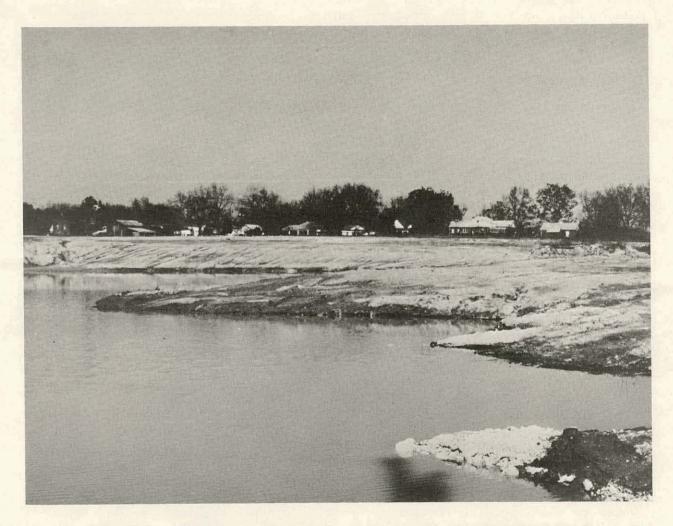


Fig. 7.1. This recently mined area is used as a watering pond for cattle. The Village of Deepstep is in the background.

Environmental Protection Division of the State of Georgia, but should also serve the best interest of future users, operators, and owners of the land. Furthermore, there should be a firm commitment to the decision to the extent that the vegetative treatment of the land will ensure its reclamation to a level that will make its planned use possible. The application for a surface mining permit and plan requires a statement that clearly indicates planned future use of the land. This statement represents a firm commitment to mine and reclaim the land in a practical and feasible manner (Appendix E).

A mining operation involves both an interim and a long-range aspect. Both aspects need to be considered in the permit application and in the development of a reclamation plan. The interim land-use plan can be implemented immediately upon the cessation of activities in parts of the mining site. This action provides an immediate short-term productive use of the resources. The interim aspects deal with such items as: (1) grading and shaping; (2) surface water controls; (3) fertility problems; (4) types or kinds of vegetation to be established; and (5) methods of seeding and establishment.

Successful revegetation also requires the full consideration of the intrinsic fertility of the mined area. Generally soil materials on surface mined areas require heavy initial applications of fertilizer to provide a protective ground cover as rapidly as possible. Not only are the soil materials often low in fertility, but they are also often highly erodible (Appendix D). This makes it all the more imperative that a ground cover be established as rapidly as possible. Additional maintenance applications of fertilizer are sometimes needed to ensure a high survival rate and the fullest possible establishment of a vegetative cover. Another approach is to use a grasslegume combination of species that are adapted to nutrient-deficient, surface mined sites and yet will, with adequate fertilization, produce a protective ground cover during a minimum time span.

Therefore, the guiding factors in selecting the interim land uses to be used are: (1) adaptability to soil-site conditions; (2) rapidity of producing effective cover; (3) ability to persist over a long time span with a minimum of maintenance; and (4) compatibility with local land use needs.

Consideration of these factors in the planning process can contribute significantly to the development of an interim reclamation plan and a more successful reclamation job in the long-term land use plan. If the kaolin mining industry is responding to high reclamation standards, it is imperative then that the public understand the differences between interim and long-term land uses of the areas disturbed by kaolin mining.

Mining operations vary widely in size with some operations involving hundreds of contiguous acres, whereas others affect only small and scattered areas. But irrespective of site size of the kaolin operation or the mining procedure used, a long-range plan is indispensable to a high quality land use reclamation plan. But, an area that is reclaimed for a given land use should be large enough to make it practical to use and manage the area efficiently for a planned unit. Areas that are small and fragmented are difficult to put into economic and efficient operations; but even though a mine site may be relatively small in one year, the area disturbed over several years can be significant.

In the reclamation planning process consideration also needs to be given to the possibility that a site may be reopened and remined at a later date. Where this possibility exists, the short-term reclamation plan should provide for a suitable ground cover that will provide the protection needed until the long-range plan can be effectuated.

When the mining operation has been terminated, a permanent vegetative cover can be established. The plan for a temporary cover should be recognized as such and the long-range land use plan and its application should still remain the primary objective.

The physiographic features of the disturbed area after reclamation must also be considered in reclamation planning. These will affect in a large measure the ease or the difficulty of reshaping the land and of establishing and maintaining an effective vegetative cover, as well as the associated costs. The steeper the slope, the more difficult the problem of stabilizing the area with a ground cover. Generally the more gentle grades present fewer and less complex stabilization and erosion problems. The probability of having to reseed the area is greatly reduced with less relief, and future maintenance problems are either diminished or eliminated.

Long-range planning on the management and the backfilling of overburden material can greatly reduce the amount of grading and shaping that must ultimately take place. Removal and replacement of topsoil over the newly graded areas can substantially increase the opportunities for successful establishment of vegetation. Prior to backfilling all acid-forming materials, refuse, and spoil should be separated from nonacid material and spread along the bottom of the pit.

Considering the different types of spoil material being moved, the wide variety of equipment that is used to move overburden or spoil, and the many possible long-range classifications, it becomes quite evident that a variety of land-use results are obtainable. No one land-use program can be suited to all kaolin operators, but often the mining operation leaves the surface with better spoil material than the undisturbed weathered soils that existed prior to surface mining. In other cases, peaks and ridges are left and these must be graded in such a way that a rolling topography results. An extremely important land use phase of reclamation planning is the possible effect of mining and reclamation on the natural drainage of an area. Adverse effects can be minimized by the proper evaluation of overall drainage patterns and the possible influence of changes in topography resulting from mining.

In order to successfully achieve long-range reclamation goals, a great deal of time, effort, and money must be expended. The bottom line is to successfully blend the choice of operating equipment with the selected method of overburden removal, and optimum land uses of the disturbed areas at a cost that can be supported by the kaolin industry as well as the general public.

Reclamation of kaolin mined lands is not simply a process of removing kaolin and filling in the cut with material from the next one for the two reasons following: (1) kaolin is not uniform, but varies both within the seam and between seams; and (2) the use of large surface mining equipment creates losses caused by contamination of kaolin with impurities. As a consequence, clay recoveries vary from only 40-70% (Soler, 1969).

Most kaolin mines add noise, dust, and odors to local communities and the industry has these problems to overcome in its relationships with them. Removal of the overburden to expose the kaolin produces dust. The trucks that haul the kaolin from the mining area to processing and storage are another source of dust, particularly within the mining property itself.

Dust within the mine site is not only an inconvenience to miners but may also present health problems. Dust can be a nuisance, as well as an irritant, to residents downwind of the mining operations. Particulate matter may also reduce the growth and survival of some plant species. Observations are that the industry is striving to be an asset to local communities and to reduce liabilities to their physical environment. With proper attention to site factors and good reclamation plans, a kaolin mine can function in its given capacity and be accepted as an important asset to local communities too.

Another major effect associated with kaolin mining is the impact on the level and movement of ground water in and around the mining areas. The specific changes that occur differ considerably by location, but during the mining process the water table in the unmined areas nearby generally is lowered, and when mining ceases it is raised until an equilibrium is reached from recharging mine lakes (Fig. 7.2).

Surface water flows may be affected in several ways. Because the spoil piles are likely to be more porous and permeable than the surrounding unmined areas, infiltration of precipitation into aquifers and subsequent discharges into surface streams may increase. However, if a hardpan forms on the surface of the spoil piles, runoff will increase, resulting in more variable stream flows.

It has been the experience of the American Industrial Clay Company that stripping and mining operations have little or no effect on the ground water regime. Any pumping conducted for dewatering purposes would probably be ineffectual regionally because of relatively high recharge rates.

The quality of both surface water and ground water may be impaired as a result of kaolin mining operations. The freshly exposed overburden, with little or no vegetative cover, is highly susceptible to erosion. The erosion of these spoil piles leads to increased chemical and sediment loads in streams located downslope from the mining area.

Physical changes in the landscape associated with the mining operation can also have adverse effects on water quality. Mining may alter existing drainage patterns, setting the stage for the creation of new gullies. It may alter existing channels, reduce local aquatic habitats, and, at least temporarily, increase siltation. If the mining operation is adjacent to or crosses a streambed, the necessary stream diversions and channeling associated with the mining may destroy the aquatic habitats of the affected area and are likely to increase stream velocity, causing some downstream erosion of stream banks. And if, during mining, a number of aquifers are intercepted, there may be some mixing of ground-water layers, resulting in a degradation of ground water of high quality by that of low quality.



Fig. 7.2. Small ponds, adjacent to the grasslands, are often included in the reclamation plans. They provide water for livestock and are usually stocked with fish.

Very little work has been done in the State of Georgia to evaluate impoundment management in kaolin mining areas. Biologists have examined some kaolin pits and reported that the pH is near neutral, although others have been reported to be acidic with a pH as low as 4.5 (Fig. 7.3). Impoundments are generally deep and quite sterile, but bass-bluegill stocking would probably be successful for recreational activities without commercial fees. Commercial catfish production is a possibility if grading methods can be developed to facilitate accessibility. In those areas, it would seem that a sport fishery based on channel catfish could be established (Fox, 1971).

### 7.2 A REPRESENTATIVE RECLAMATION PLAN

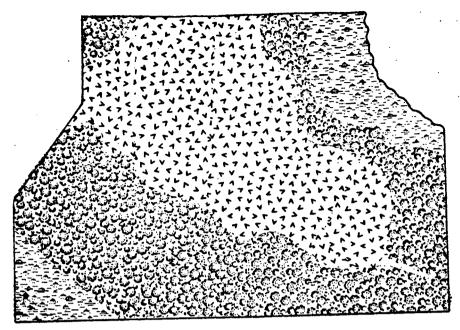
The following generalized model, used during the kaolin mining and reclamation process, is typical of what occurs in the kaolin mines of central Georgia. Figures 7.3-7.6 show the four stages of the model in sketch form.

Stage 1 Premining Landscape. The landscape of the Georgia Kaolin district is characterized by long stretches of forest broken only by an occasional farm; however, the area has not been farmed on a large scale in recent decades. Abandoned farm land is often reclaimed by scrub woodland and brush. The leased lands, such as the Smith property, must be mined and reclaimed as a single unit (Fig. 7.3).

Stage 2 Exploration and Evaluation. Once a company has acquired rights to a property, a series of drilling patterns are established to determine the location and quality of the kaolin deposits (Fig. 7.4). Areas circled were deemed unsuitable for mining. A sample drill hole, ZB 217-N3100, has been included. The exploration and evaluation processes only have a minimally disruptive effect upon the land and do not require reclamation if the decision reached is not to mine clay.

Stage 3 The Mining Process. Once the decision to mine kaolin on the Smith property is reached, maps indicating the extent of the clay deposits and surface contours are analyzed to determine the mining strategy (Fig. 7.5). The sections on the mine map are established on the basis of minable clay and the requirements of the company. Since leased properties must be developed and reclaimed within a specified period, the clay must be mined continuously even if lower efficiency is obtained. Company owned lands may be developed as needed, according to clay quality and plant specifications. Maps employed by the company are extremely detailed and are evaluated periodically.

Stage 4 The Reclaimed Landscape. It is quite possible that the Smith property will be back "in operation" in less than two years following initiation of the mining process. Although areas reclaimed and seeded with pine will not be producing commercial timber for a decade or so, the reclaimed pasture and cropland may already be in use (Fig. 7.6). In most cases, both the economic and aesthetic qualities are superior to those of the premined land.



Smith Property



Swamp and other lowlands Overgrown and farm land
Forest

Fig. 7.3. Premining Landscape

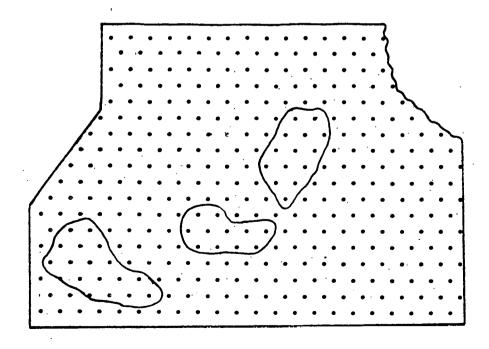


Fig. 7.4. Exploration and Evaluation

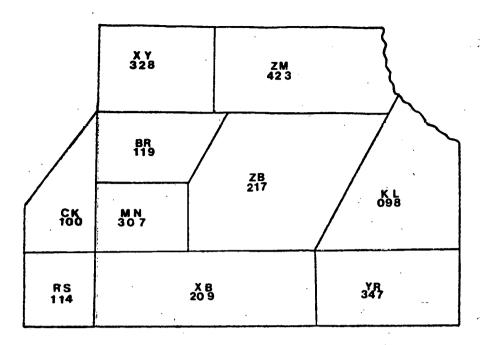


Fig. 7.5. The Mining Process

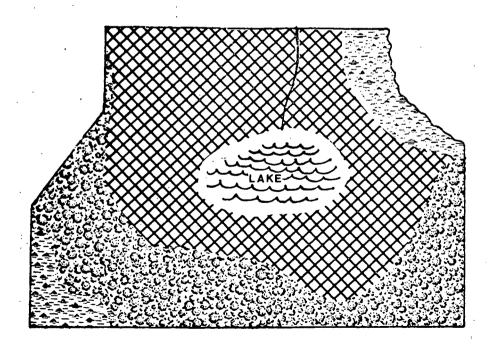


Fig. 7.6. The Reclaimed Landscape

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### 8 OBSERVATIONS FOR PLANNERS

Kaolin mining in Georgia is an extractive process. But, through effective preplanning in advance of mining, the actual mining and reclamation planning is designed to meet the requirements of the Georgia Surface Mining Act of 1968. Preplanning involves techniques for topsoiling, grading, backfilling, erosion control, and water management practices along with revegetation and land use plans. The integrated mining and reclamation planning is mandated in the application for a surface mining permit (Appendix E).

The effective reuse of the Georgia kaolin mined lands is visibly evident by the diversity of landscapes in pastures, row crops, and lakes that exist on the reclaimed kaolin mined lands. Although the existing markets are limited for housing, commercial, and industrial developments in the rural areas of middle Georgia, the capabilities exist for more intensive land uses in the future. By providing more information to public planning agencies, the kaolin companies could realize potential benefits from these future developments.

With more foresight by planners and a better interaction between kaolin producers and local planners, a joint land use/reclamation plan can be formulated that would anticipate the long-term land use needs of the disturbed lands. The reclamation projects are of high quality and often have higher economic and aesthetic qualities than those of the premined lands.

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### **APPENDIXES**

- A: Air Quality Control
- B: Water Quality Control
- C: Regulation of Ground Water Use
- D: Control of Erosion and Sedimentation
- E: Sample Application for Surface Mining Permit .
- F: Solid Waste Management
- G: Water Supply Quality Control

(Reprint permission for Appendixes A-D and F and G was granted by the Georgia Bureau of Industry and Trade. The material is reprinted from Alumina from Kaolin Environmental Considerations, prepared for the Bureau by the Georgia Institute of Technology, pp. 12-36, [April 1976].)

The application for a permit to operate a surface mine is made to the Director of the Environmental Protection Division of the State of Georgia. Appendix E presents a sample application.

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### APPENDIX A

### AIR QUALITY CONTROL\*

### LEGAL REFERENCES:

For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 88-9. AIR QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-1 Amended.

### PERMITS:

Granting of a permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS.

- Construction Permit: A permit is required prior to construction or modification of any facility which may result in air pollution.
- Temporary Operating Permit: Contains a compliance schedule specifying steps to be followed to achieve final compliance with the Act, rules and regulations.
- Operating Permit: Permit application is required within 30 days after commencement of operations.
   Permit is issued if final compliance with the Act, rules and regulations is achieved.
- The permit will specify the conditions under which the facility must be operated so as to comply with the Act, rules and regulations.
- Consulting the Air Protection Branch, prior to permit application, is recommended.

<sup>\*(</sup>Reprint permission granted by the Georgia Bureau of Industry and Trade.)

EMISSION STANDARDS:

Specific emission standards exist for:

Smoke

Incinerators

Fuel-burning equipment

Particulate emission from manufacturing processes

Fluoride

Sulfur Dioxide Nitric acid plants Sulfuric acid plants

Nitrogen oxides Conical burners Fugitive dust

Cupola furnaces for metallurgical melting Particulate emissions from kaolin and fuller earth processes

Particulate emissions from cotton gins

 Monitoring: Monitoring and reporting of emissions by industry may be required by EPD if conditions warrant.

AMBIENT AIR STANDARDS:

Industries must also meet air standards relating to the concentration of pollutants in the air immediately surrounding the plant. Concentration standards exist for:

Sulfur dioxide
Particulate matter
Carbon monoxide
Total oxidants
Non-Methane hydrocarbons
Nitrogen dioxide

OPEN
BURNING:

Prohibited. Exceptions allowed by State.

FEDERAL STANDARDS:

The Federal Environmental Protection Agency's (EPA) air standards are met when the industry complies with Georgia's air standards. It is suggested that consultation with the State agency occur if there are specific questions.

INSPECTIONS
AND INVESTIGATIONS:

EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting and investigating conditions relating to air pollution and obtaining samples of emissions.

### APPENDIX B

### WATER QUALITY CONTROL \*

LEGAL REFERENCES: For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 17-5. GEORGIA WATER QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATIONS RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-6.
- The granting of a discharge permit depends on the industry's demonstrable capability to meed specific standards found in the RULES AND REGULATIONS.
- A discharge permit is required to operate any system for the disposal of sewage, industrial wastes, or other wastes into the water.
- The application of such discharge permit should include:

Complete engineering reports
Schedule of progress
Plans
Specifications
Maps
Measurements
Quantitative and qualitative determinations
Records
All other information as the Environmental
Protection Division may require

Georgia is authorized to issue the NPDES permit.

<sup>\*(</sup>Reprint permission granted by the Georgia Bureau of Industry and Trade.)

## APPROVAL FOR CONSTRUCTION:

- Any industry that desires to erect, modify, or alter a sewerage system must obtain approval of any plans, specifications and related materials for such system prior to commencement of construction.
- Engineering reports which are submitted must be prepared by a professional engineer competent in the treatment of water pollutants and must contain:

Information regarding the existing sewerage system, if applicable.

Characteristics of existing pollutants and existing or proposed treatment of such pollutants.

Demonstration of the need for the proposed sewerage system.

Evaluation of alternatives to define the most cost effective method for meeting established effluent limitations, water quality goals.

Results to be expected from treatment process.

Sufficient maps, charts, tables, calculations, basis of design data and graphs to make the report readily understandable.

An operation and maintenance program description.

Such other pertinent engineering information as the Environmental Protection Division (EPD) may require.

Plans and specifications submitted to the EPD for a sewerage system shall include the following:

Map showing area to be served by the sewerage system.

Profiles of proposed sewers.

Construction details of manholes and other special sewer structures.

General and detail plans for the treatment facility.

Complete design data for the treatment facility plans, to be submitted in duplicate on forms specified by the Division. Specifications for the construction of the sewerage system.

Such other plans and specifications as the Division may require.

 General map plans submitted to the EPD for a sewerage system shall include the following:

Map plan that shows the entire area to be served.

All existing and proposed streets in the area to be served; surface elevators at all street intersections, etc.

Clear designation on the plan by suitable symbols of all sewer appurtenances, including but not limited to, manholes, siphons, and pumps.

Such other information as the EPD may require.

Sewer plans and profiles submitted to EPD for a sewerage system shall include the following:

Sewers and force mains, drawn at a scale that shows the profile for all manholes, siphons, railroad crossings, street or stream crossings, elevations of stream beds, normal stream water levels, and sizes and grades of sewers which show surface elevations and sewer invert elevations.

Detailed drawings of all sewer appurtenances, including but not limited to, manholes, inspection chambers, siphons, lift stations, and any special structures to accompany the sewer plans. Detail drawings shall be to a scale suitable to clearly show the design details.

Plans for treatment facilities submitted to the EPD shall include the following:

General plan that clearly identifies the exact location of the facilities, areas reserved for future expansion, access roads to various units, etc.

Detail plans which show longitudinal and traverse sections sufficient to explain the construction of each treatment unit.

Flow measuring devices at appropriate points in the plan. Sampling and recording devices may be required by the EPD when deemed necessary.

Such other information as EPD may require.

### CONSULTATION:

- It is highly recommended that the industry applying for a discharge permit or seeking approval for the proposed erection, modification or alteration of a sewerage system consult with the Environmental Protection Division in order to work out a system which will enable it to comply with the specific environmental standards. In any event, the EPD may request a conference with the industry before it submits any application for a permit, or a proposal for construction.
- The EPD has the obligation to supply the industry with technical and scientific information as may be helpful in reducing or eliminating the polluting effects of the discharge. Yet the responsibility for development and application of means of preventing pollution rests with the company causing the pollution.

### GENERAL CRITERIA FOR ALL WATERS:

All waters shall be free from:

Materials which will settle to form sludge deposits that become putrescent, unsightly or otherwise objectionable.

Oil, scum and floating debris in amounts sufficient to be unsightly or to interfere with legitimate uses.

Material which produces turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses.

Toxic, corrosive, acidic and caustic substances discharged in amounts, concentrations or combinations which are harmful to humans, animals or aquatic life.

 Applicable State and Federal requirements and regulations for the discharge of radioactive substances shall be met at all times.  No man-made physical or other alteration of stream beds that may violate established water quality standards, or reduce the waste assimilative capacity of the streams, will be permitted without the expressed approval of the Environmental Protection Division.

WATER USE CLASSIFICA-TIONS: • The Environmental Protection Division has established water use classifications as follows:

Drinking water supplies
Fishing, propagation of fish, shellfish, game
and other aquatic life
Recreation
Agricultural
Industrial
Navigation
Wild river
Scenic river
Urban stream

 There are different standards applicable to each specific water usage which deal with the following areas of regulation:

Amount of bacteria that may be discharged into the water

Dissolved oxygen level of the water

pH range of the water

Temperature level of the water

Presence of toxic waste and other deleterious materials

Presence of floating solids, settleable solids, sludge deposits or any taste, odor, or color producing substances

Presence of sewage, industrial or other wastes

Any other areas that are specifically dealt with in the RULES AND REGULATIONS

INSPECTIONS
AND INVESTIGATIONS:

The Environmental Protection Division (EPD) has the power to enter at reasonable times any private or public property for the purpose of inspecting and investigating conditions relating to water pollution.

MONITORING,
RECORDING
AND REPORTING REQUIREMENTS:

Where a person discharges pollutants into the water authorized by the permit, EPD may require the person to:

Establish and maintain records

Make reports

Install, use and maintain monitoring equipment of methods including, where appropriate, biological monitoring methods

Sample such discharge, in accordance with such methods, at such localities, at such intervals, and in such manner as the EPD shall prescribe

Provide such other information as the EPD may reasonably require

LOCAL WATER
QUALITY
CONTROL:

The corporate authorities of the cities and towns in Georgia have the power to prohibit the throwing or depositing of any substance in navigable waterways within their jurisdictions which they consider dangerous to navigation or injurious to vessels or to property along such navigable waters. (See GEORGIA CODE, CHAPTER 80-1).

### APPENDIX C

### REGULATION OF GROUND WATER USE \*

### LEGAL REFERENCES:

For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 17-11. GROUND WATER USE ACT OF 1972, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-2.

### PERMIT:

- Any industry, unless exempted by law, must obtain permit to withdraw, obtain, or utilize ground water in excess of 100,000 gallons per day for any purpose.
- Permit requirements differ according to whether the ground water will be put to either a consumptive or nonconsumptive use.
- During the early planning stages for a proposed ground water withdrawal, and in any case prior to the start of well construction, the intended user should request a conference with the Environmental Protection Division (EPD).
- Representatives of the EPD will determine the acceptability of proposed wells, the aquifers to be utilized, the well spacing and well depth, and the amount and intended ground water use.
- After considering all the factors, the EPD may issue a letter of concurrence setting forth such terms and conditions as it considers necessary.
- Such a letter is not mandatory, but the user proceeds at his own risk if he fails to obtain it.

<sup>\*(</sup>Reprint permission granted by the Georgia Bureau of Industry and Trade.)

- After completing construction of the well or wells, but before water use begins, the intended user must apply for a ground water use permit on forms furnished by the Division.
- The application for a permit should at least include:

Owner identification data
Aquifer(s) utilized
Amount and purpose of ground water use
Detailed well construction data including
drillers' logs
Well location(s) (latitude and longitude and
location map)

 The Environmental Protection Division will consider the following factors when it decides whether the permit should be granted:

Number of persons using the aquifer and the object, extent and necessity of their respective withdrawals or uses.

Nature and size of the aquifer.

Physical and chemical nature of any impairment of the aquifer.

Probable severity and duration of such impairment under foreseeable conditions.

Injury to public health, safety or welfare which results if such impairment were not prevented or abated.

Businesses or activities to which the various uses are related.

Importance and necessity of the uses claimed by permit applicants.

Extent of any injury caused to other water uses (including public use).

Diversion from or reduction of flows in other water courses of aquifers.

Any other relevant factors, such as, but not limited to, the best geologic and hydrologic information available of the aquifer or ground water system of the area.  Duration of Permit: Permits are normally issued for ten years, but a longer period may be authorized by the EPD to provide for reasonable amortization of the applicant's water withdrawal and water using facilities.

### CONSUMPTIVE-USE PERMIT:

Some of the conditions that may be imposed along with the granting of a consumptive-use permit include:

Total permitted well depth in feet.

Aquifer(s) or ground water system to be utilized.

Maximum pumping rate.

Pumping level (elevations below which water may not be pumped).

Amount of ground water to be withdrawn or used.

Well spacing to minimize well interference.

Time of withdrawal.

Require observations or monitoring well(s) be installed for monitoring ground water levels and water quality.

### NONCONSUMPTIVE-USE PERMIT:

- None of the above conditions may be imposed on the user once a nonconsumptive-use permit is granted.
- Nonconsumptive use means the use of water withdrawn from the ground water system or aquifer in such a manner that it is returned to the ground water system or aquifer from which it was withdrawn without substantial diminution in quantity or substantial impairment in quality at or near the point from which it was withdrawn.
- In determining whether a use of ground water is nonconsumptive the Environmental Protection Division considers (based on the best geologic and hydrologic information available) whether any material injury to other water users of the area by reason of the reductions of water pressure in the aquifer or system has not been adequately compensated by the permit applicant who caused or substantially contributed to this injury.

 Granting of a nonconsumptive-use permit does not imply consent to inject any waste or pollutant material into the ground water system.

## GROUND WATER USE REPORT:

 Once a permit is granted, the user must file semiannually with the Environmental Protection Division a certified statement (ground water use report) on forms furnished by the Division which states:

Quantities of water withdrawn and/or injected Sources of water Nature of the use Static and pumping water level in selected wells

 A specific conductance analysis of raw water is required annually.

## DEWATERING WELLS:

 A permit will not be required for the withdrawal of ground water in excess of 100,000 gallons per day if:

> It involves dewatering the subsurface rock to a depth of not more than 30 feet, or to a greater depth if approved by the EPD, and

Is for the purpose of construction of trenches for sewer or water pipes, or excavation for foundations, or utility construction, and

Is for a period of not more than 60 days, unless an extension of time is approved by the EPD.

SALT WATER EN-CROACHMENT OR DETERIORATION OF WATER: To protect against salt water encroachment or the deterioration of the water quality of the ground water, the Environmental Protection Division may require various control measures, a list of which can be found in the RULES AND REGULATIONS.

INSPECTIONS AND INVESTI-GATIONS

EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to the use of ground water.

OTHER LAWS:

Industries should be aware that there might be municipal or county ordinances which relate to the regulation of ground water use.

### APPENDIX D

### CONTROL OF EROSION AND SEDIMENTATION \*

The EROSION AND SEDIMENTATION ACT OF 1975 (GEORGIA CODE, CHAPTER 5-23)\* allows counties and municipalities to regulate soil erosion and sediment deposition onto lands and into water of the State. The State already has this authority under its Water Quality laws and is attempting to share this responsibility with local governments.

The Act has given the governing authority of each county and municipality until April 24, 1977 to adopt a comprehensive ordinance which sets up procedures that regulate land-disturbing activities. These activities are defined as those which may cause soil erosion from water or wind and the movement of sediments into water or onto lands of the State. They include but are not limited to clearing, dredging, grading, excavating, and the transporting and filling of lands other than federal lands.

This comprehensive ordinance must at least contain these requirements:

- Stripping of vegetation, regrading and other development activities shall be conducted in such a manner so as to minimize erosion.
- · Cut-fill operations must be kept to a minimum.
- Development plans must conform to topography and soil type so as to create the lowest practical erosion potential.
- Whenever feasible, natural vegetation shall be retained, protected and supplemented.
- The disturbed areas and the duration of exposure to erosive elements shall be kept to a practicable minimum.
- · Disturbed soil shall be stabilized as quickly as practicable.
- Temporary vegetation or mulching shall be employed to protect exposed critical areas during development.
- Permanent vegetation and structural erosion control measures must be installed as soon as practicable.
- To the extent necessary, sediment in run-off water must be trapped by the use of debris basins, sediment basins, silt traps, or similar measures until the disturbed area is subilized.

<sup>\*(</sup>Reprint permission granted by the Georgia Bureau of Industry and Trade.)

- Adequate provisions must be provided to minimize damage from surface water to the cut face of excavations or the sloping surfaces of fills.
- · Cuts and fills may not endanger adjoining property.
- Fills may not encroach upon natural water courses or constructed channels in a manner so as to adversely affect other property owners.
- Grading equipment must cross flowing streams by the means of bridges or culverts except when such methods are not feasible and provided, in any case, that such crossings are kept to a minimum.

Land-disturbing activities governed by comprehensive ordinances do not include:

- Surface mining (as defined in the GEORGIA SURFACE MINING ACT OF 1968), (GEORGIA CODE, CHAPTER 43-14).
- · Granite quarrying and land clearing for such quarrying.
- Minor land-disturbing activities such as home gardens, individual home landscaping and other related activities which result in minor soil erosion.
- Construction of single-family residences when such are constructed by or under contract with the owner for his own occupancy.
- Agricultural practices which involve such activities as harvesting, planting of pasture land, livestock and poultry mangement practices.
- Any project carried out under the technical supervision of the Soil Conservation Service of the U. S. Department of Agriculture.
- Activities which involve a land change of five acres or less or the movement of not more than 500 cubic yards of land. This exemption does not apply to any land-disturbing activity within 200 feet of the bank of any major stream or river which drains at least a land area of 100 square miles.
- Construction of maintenance projects undertaken or financed in whole or in part by:

Georgia Department of Transportation Georgia Highway Authority Gerogia Tollway Authority Any county or municipality Activity for which bids have been let or a construction contract signed prior to effective date of local ordinance or local government board regulation, provided that the activity is completed within 12 months or such effective date.

If the county or municipality does not enact this comprehensive ordinance by April 24, 1977, the Department of Natural Resources, in cooperation with the State Soil and Water Conservation Committee, will adopt rules and regulations which control land-disturbing activities. The rules and regulations will contain the same requirements that must be in the comprehensive ordinance.

By April 24, 1977, any industry that engages in land-disturbing activities will have to obtain a permit from either the county or municipality (if an approved ordinance is in effect), or from the Environmental Protection Division of the Department of Natural Resources. The industry applying for a permit must submit erosion and sediment control plans and supportive data which indicate that the land-disturbing activity will be carried out so s to meet the minimum requirements contained in the ordinance or rules and regulations. The permit will be issued only when the applicant's plan has been reviewed by the Soil and Water Conservation District and does in fact show that these requirements can be met. Specific conditions may be imposed with a permit.

Until April 24, 1977, enforcement of the minimum requirements for the prevention of soil erosion and sedimentation will be by counties and municipalities. After this date, the Department of Natural Resources will have enforcement procedures for its own rules and regulations but only for those counties and municipalities which do not have ordinances in effect.

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## APPENDIX E

## SAMPLE APPLICATION FOR SURFACE MINING PERMIT\*

DATE September 25, 1976	APPLICATION NO.
TO: Surface Mined Land Reclamation Program	
Environmental Protection Division	•
Department of Natural Resources	
	•
Dear Sir:	
It is our intent to engage in surface mi Application is hereby made to engage in surface Mining Act of 1968 as amended. Please issue t	ining when permitted and as shown herein. ce mining as required by the Ceorgia Surface the necessary permit to cover our operation.
•	
It is our intention to affect 58 is located in Walton Big Jack Creek	acres under our permit. Our mine County(s) and is identified as the pit(s).
Dig back creek	
A description of the area to be affected	d is as follows:
1. Name of Property Owner:	•
	Land Lot Number: 15-14
2. Overburden: 0-25' 26'-50' XX	Rocky Creek
3. Product(s) to be mined:	
4. xx We will reclaim lands where our open	ration will be located.
<ol> <li>We request approval to reclaim previous those being mined under this Permit.</li> </ol>	iously mined land, substituting same for
We specifically grant, as mining operator Resources, Environmental Protection Division of entry and travel upon our lands or operation necessary field inspections.  We certify that all information contained	or their authorized representatives the right
the best of our knowledge.	
	Yours truly,
Affix corporate Scal here.	Signature
(Liberty)	Described
(Liberty Mining Co. )	President Title
	11(16
Inc	Liberty Mining Company, Inc.
I hereby certify that no official	Company
Corporate Seal has been adopted	- •
by this company.	205 First Street
•	Address
ŧ	
	Monroe Georgia 31520
	City State Zip Code
	012/741 2214
*Permit application is made to:	912/744-3346 Telephone Number
Director, Environmental Protection	to to future transcer
Division, State of Georgia.	

Company Mine Name or Number MINED LAND USE PLAN	D.N.R. Serial No. Assigned						
NAME OF OPERATOR: Liberty Mining Company Inc.	<u></u>						
COUNTY WHERE MINE LOCATED: G.M.D. NO.	LAND LOT NO.						
NAME OF LOCAL MANAGER:							
HOME OFFICE ADDRESS:							
HOME OFFICE TELEPHONE: ORE(S) MINED	Sand and Gravel						
HOME OFFICE SUPERVISOR OVER GA. OPERATION:	TITLE: President						
TYPE BUSINESS: $\overline{X}$ Corporation $\square$ Partnership $\square$ Proprietors	ship Other						
NAME OF CORPORATE OFFICIALS/MEMBERS OF PARTNERSHIP: President- and Secretary-Treasurer-	Vice President-						
CERTIFICATION AND REQUEST FOR APPROVA	\L						
We hereby submit this plan containing our plan of action for reclaiming affected lands described herein and for protecting adjacent watersheds. We request approval of said plan as partial fulfillment of our responsibility in obtaining a Surface Mining Permit. We agree that our local designated company management representative directly responsible for the on-site day to day operation of the surface mine being permitted will be thoroughly acquainted with the contents of our approved plan, furnished a copy of same, delegated the necessary authority to implement provisions thereof, and will fulfill the requirements contained therein. We specifically agree to conduct our operation so as to comply with all provisions of our approved plan. We fully understand that any Permit issued is applicable and limited only to lands described in our plan. We acknowledge that the various provisions of our approved plan will apply to all lands to be affected on properties described herein. We further certify that all details contained in this plan are true and correct to the best of our knowledge.							
COMPANY: Liberty Mining Company Inc.	DATE: 9-25-76						
SIGNATURE:	TITLE: President						
Affix Corporate Scal here.  Instructions: When completing this plan, add additional pages if necessary. Contents of the plan must be cross-referenced to appropriate maps, specifications and engineering drawings. The plan, along with maps, specifications and engineering drawings, must be submitted with the permit application.							
- DO NOT WRITE BELOW THIS LINE -							
ENVIRONMENTAL SPECIALIST'S RECOMMENDAT							
Certification: I hereby certify that I have evaluated this plan following an inspection of lands to be affected and compared reclamation commitments contained herein with approved Land Reclamation Rules. Based on my findings, I recommend said plan be:							
Approved Disapprov	ved						
Affected Acreage and Ronding Data: (1) Under the provisions of this plan, I have determined that acres are to be affected and bonded for \$ per acre.  Total Bond - \$ (2) Recommend bond be waived;  (3) Recommend no additional bond, as sufficient posted.							
By:							
LAND RECLAMATION PROGRAM APPROVAL							
Plan Approved By: Date: Disapproved By:							
Bond Approved By: Pate: Type:	Total \$ Bond Waiver						
Approved for Permitting: By: Permit to EPD D							

1.	NAME AND TITLE OF AUTHORIZED LOCAL "ON-SITE" COMPANY REPRESENTATIVE WHO IS DELEGATED RESPONSIBILITY FOR CONDUCTING SURFACE MINING AND RECLAMATION ACTIVITIES ON A DAY-TO-DAY BASIS SO THAT THE MINE BEING PERMITTED AND DESCRIBED IN OUR PLAN WILL BE OPERATED IN A MANNER SO AS TO COMPLY WITH THE VARIOUS PROVISIONS OF OUR APPROVED MINED LAND USE PLAN.  Mine and Reclamation Superintendent									
2.		DESCRIPTION OF LANDS AND COMMUNITY TO BE AFFECTED BY SURFACE MINING. (check or fill in appropriate space)								
•	a.	(1) Unmined Site Previously Mined S (2) Urban Rural (3) Residential Area Industrial Area	X	<b>(4)</b>	Farmland Pastureland Forest Land Swamp land Marshland Other (specify below)	X				
		Commercial Area	Name & Valid		Isolated Sparsely Populated Heavily Populated	X				
	В.	Name of and Distance to Point	Nearest Indi	cated 10	Name	Distance to Point				
		City or Town	-	Between	, Ga.	3.8 miles				
		Occupied Residence	-			4 mile				
		Paved Public Road	_	Ga. Hwy	. 17	600 feet				
		Unpaved State or County	Road	New Hop	e Road	200 feet				
		Creek, Branch, River, L	ake, etc.	Big Jac	k Creck	300 feet				
			_							
	•	Nearest Adjacent Proper	ty Line		<u></u> .	400 feet				
	ċ.	Average Height or Depth	in Feet of:		•	•				
	٠.	Overburden to be remove deposits to be mined	d from above	10	to 40 feet	·				
	,	Waste disposal areas re spoil placement (spoil ; banks, etc.		not o	ver 25 feet in height	up to \$5 feet				
		Pit/Mine	•			<del></del>				
3.		TNG EQUIPMENT TO BE USED ate space)	AND DESCRIPT	ION OF P	LANNED MINING METHODS.	(check appro-				
	Hydraulic Front-end Loader X Blunger Bulldozer X Wining Wheel X Conventional Trucks Dragline Explosives X Explosives X Blunger Mining Wheel X Conventional Trucks Other (specify below)									
		cribe method of mining, painted (cross-reference			ce schedule for affect at map using map ident					
	Spoi	ng will be carried out i den will be removed from I will be used in consti	ore deposit unction of ero	using pow osion con	er shovel and off road trol facilities and ro	d trucks and pans.				
	in our mining advancement and erosion control map. Balance of spoil will be placed in a temporary waste disposal area for backfilling into mining pit as shown in our mining advancement map, which is attached hereto and made a part of this plan.									

4. LAND OFFERSHIP SEPRENCE TOTAL ACREAGE OF PROPERTY TO BE SPREACE MINED AND ACREAGE OF PORTION OF TRACT TO BE AFFECTED WITH ANTICIPATED DATE OF COMPLETION OF MINING.

		DATA FOR TOTAL PROPERTY			
Name & Address of Landowner by Type Ownership	Company Mine Name or No.	Total Acres of Land in Property	lotal Acres to be Affected When Haning is Composed	Anticipated Date for Completion of Mining on Property	
Fee Simple Title Liberty Mining Co.	Big Jack Creek Pit	171.3	92.1	1988 - but see attached schedule of mining	
Leased Properties	Harris Mine	45.6	34.5	advancement by phases	
TOTAL ACRES		216.9	126.6		

5. PLANNED COMPLIANCE SCHEDULE FOR COMPLETION OF MINING AND RECLAMATION ON ACREAGE BEING PERMITTED FOR MINING SHOWING AFFECTED LANDS BY LAND USE CLASSIFICATION AND RECLAMATION ORDER TIVE

			Planned		RECLAMATION DATA 1/		
	!		Mining Dates -		Reclamation   Planned Rec. Date		Rec. Dates-
	·		Permitted Acres		Objective -	Permitted Acres	
Identification of	[		(Month & Year)			(Month & Year)	
How Permitted Lands		No. 2/	Date to	Date to	Land will be	4	Date to
are to be Affected	Map I.D.#	Acres	Begin	Complete	Roclaimed	Begin	Complete
						PHASE	1
Pit/Mine		23.4	12-76	7-79	Forest lands	11-76	12-79
					with lake on	Ι.,	
Waste Disposal Areas		16.4	12-76	7-79	with lake on	(same al	types
resulting from spoil	Ī I		Ì		all types of	affected	lunde
placement				<del> </del>	all types of	arrected	Tands
00.1.1.1.	!	6.4	12-76	7-79	affected lands	except t	ose
Stockpile .	l	0.4	12-70	1-73	1	-	-
Refuse-Debris Storage		1.0	10-76	7-79	and as shown	specific	below
Keruse-Deorra Scorage		· · · · ·			<del>                                     </del>	and as s	iown in 3/.
Haul Roads		2.4	10-76	6-78	on land use map	11-76	1-88
Hadi Konds			<u> </u>				
Silt/Debris Basins	1	3.6	10-76	6-87		11-76	1-88
	1					]	i
	İ <u></u>		<u> </u>		ļ	ļ	
		i	1	i			
Tailings Ponds		ļ			ļ	<u> </u>	<del> </del>
·	ļ '	.6	10-76	7-79		1	1
Diversions-Waterways	ļ	.6	10-76	1-/3	<del> </del>	<del> </del>	<del> </del>
	1	5	16-76	6-87	1	11-76	1-88
Equipment Storage			10 .0	<del>  • • • • • • • • • • • • • • • • • • •</del>	<del> </del>	<del>                                     </del>	
Office-Shop	i	1.1	12-76	6-87		11-76	1-88
Ollice-Snop	\ <del></del>	<del></del>	<del>                                     </del>	1			1
Plant Site		1.4	12-76	6-87	1	11-76	1-88
t tuile ofte		1	<u> </u>	1	1	1	1
Other (specify below)	1		İ	l	l	<u> </u>	<u> </u>
• •				1			
Silt Fence Barrier	ļ	.4	10-76	7-79	<u> </u>	<u> </u>	<b></b>
	1			L			1

TOTAL ACREAGE TO BE PERMITTED FOR SURFACE MINING UNDER THIS

57.2 = 58 Acres

PLAN (omit fractional acreage by rounding up to next whole acre)

- 1/ Do not complete this portion of item #5 if substitute acres are to be reclaimed.
- 2/ Note: Use care in acreage determination so duplicate bonding will not occur.

-3-

3/ Affected lands are to be reclaimed concurrent with mining and on at least a monthly basis as minerals are removed and lands become available for reclamation.

## SUMMARY OF LANDS TO BE PERMITTED FOR SURFACE MINING BY MINING SEQUENCE

Planned Hining Sequence	Acreage to be Affected and Bonded During Specified Mining Sequence	Planned Date for Permitting	Remarks	
Phase 1	57.2	9-76	See Compliance Schedule on page 3, item #5.	
Phase 2	29.0	4-79	To be submitted as amendment to plan.	
Phase 3	40.4	1-83	To be submitted as amendment to plan.	
TOTAL	126.6	-		

 $\delta_{\bullet}$  SUBSTITUTE SITE DATE (omit if no substitute site involved)

By completing this portion of our plan, we request approval to substitute and reclaim a previously mined site as identified and described below.

Name and Address of Landowner by Type Ownership 1/	Company Mine Nume or No.	Total Acres of Land in Property	Total Acres in Need of Reclamation	Year Mined
Fee Simple Title				
Leased Properties	(OMIT - NOT A	PLICABLE)		
TOTAL ACRES				

7. PLANNED COMPLIANCE SCHEDULE FOR COMPLETION OF RECLAMATION ON SUBSTITUTED SITE BEING RECLAIMED SHOWING AFFECTED LANDS BY LAND USE CLASSIFICATION AND LAND USE OBJECTIVE.

	i			RECLAMATION DATA		
	ł		1	Reclamation Objec-		Rec. Dates
Land Use Classification		No. 2/	Average	tive-Use for Which		i Year)
as to How Substituted	l		Depth or	Land will be Reclaimed	Date to Begin	Date to Complete
Acres Were Affected	Map I.D.#	Acres	l!cight	Reclaimed	ведіп	Complete
Pit/Mine						
			<b></b>	· · · · · · · · · · · · · · · · · · ·		
Waste Disposal Areas	}	(OMIT -	NOT APPLI	CAHLE)	l	ļ
resulting from spoil placement						
Stockpile			·			
Refuse-Debris Storage						
Haul Roads						
Silt/Debris Basins			1	·		
		-				
Tailings Ponds						ļ
Diversions-Waterways						
Equipment Storage			Ì			ļ
Office-Shop						
Plant Site	ļ	<u> </u>				
Other (specify below)			•		ļ	ļ
			]			
	<u> </u>		<del></del>	<u> </u>	<u> </u>	

TOTAL SUBSTITUTED ACRES TO BE RECLAIMED UNDER THIS PLAN (omit fractional acreage by rounding up to next whole acre)

<sup>1/</sup> All required maps to be submitted for substituted acres in addition to acres being permitted.

<sup>2/</sup> Note: Use care in acreage determination so duplicate bonding will not occur.

8. DESCRIBE A PLAN OF ACTION THAT IS BASED ON ACCEPTABLE ENGINEERING AND CONSERVATION PRACTICES FOR CONTAINING THE EFFECTS OF EROSION AND SILTATION TO TYPE LAND SHOWN BELOW. INCLUDE DETAILS FOR ELIMINATION OF ANY UNDESTRABLE EFFECTS TO CONTIGUOUS WATERSHEDS SO THAT THEY BILL ROT BE DECEMBED. A DESCRIPTION (INCLUDING SPECIFICATIONS AND ENGINEERING DRAWINGS) AND PLANNED CONSTRUCTION SEQUENCE OF FACILITIES AND MEASURES TO BE USED (INCLUDING ANITHENANCE AND OPERATIONAL PROCEDURE) IS TO BE INCLUDED, ALL FACILITIES AND MEASURES THAT ARE CROSS-REFERENCED TO MINING ADVANCEMENT, DRAINAGE AND EROSION CONTROL MAP. (use additional pages if required)

#### a. Acres being Permitted:

We specifically guarantee that the siltation and sedimentation of adjacent unpermitted lands and waters will not occur, as we will take satisfactory protective action to prevent environmental damage from all phases of our operation.

Under the provisions of this plan, we will not allow waste waters from our mining pits or surface runoff from affected lands to leave the permitted area without proper treatment. All waters of any type that flow from our permitted site will meet, at all times, all State Water Quality standards, including a pH of 6.5 to 8.5 and a turbidity of less than 50 JTU. Any water discharged or allowed to leave our permitted site will not degrade the water quality of contiguous natural drains or streams or cause siltation of adjacent unpermitted lands.

Under the terms of this plan and at the request of the Environmental Protection Division, we agree to employ the services of a reputable, independent water analysis laboratory on a consulting basis to develop specifications, techniques and facilities to chemically or physically remove suspended or dissolved solids from all waters discharged from our mining operation, including mining effluent or runoff from precipitation, so as not to affect adjacent watersheds. Specifications, procedures and facilities developed by our water laboratory consultant will be submitted to the E.P.D. for approval and will produce water of a quality that will meet State of Georgia and N.P.D.E.S. Water Quality Standards.

We specifically agree that no mining will occur in naturally occurring hollows, drains, draws, etc. Areas of this type where surface runoff is concentrated and flows into natural drainage below our mining site will be left in an undisturbed condition. No trees, debris, stumps, boulders, etc. will be placed in areas of this type so that natural drainage is interrupted or blocked. A strip of land of a reasonable distance and at least 200' in width from the center line of all natural drains will remain unmined.

In event our operation should become inactive or mining ceases, we will immediately take the necessary action as specified in our crosion control plan below to insure that the periphery of lands affected by our operation will be stabilized, thus preventing contiguous, unpermitted lands from being affected due to crosion and siltation. Should it become necessary for our mining operation to become inactive prior to the completion of mining, all crosion control facilities will be placed in a high state of readiness for the intended purpose. We will immediately notify the E.P.D. of our intent to close so that an inspection can be made to determine if additional facilities or measures are needed and we agree to construct these if officially requested to co so.

NOTE: - BALANCE OF PAGE 5, ITEM #8 TO BE TAILORED TO FIT NEEDS
AND REQUIREMENTS OF EACH SITE AND LAND RECLAMATION RULES
391-3-3-.05 (2), "PREPARATION OF A PLAN" and 391-3-3-.08,
"PROTECTION OF PUBLIC INTEREST".

10. CONSTRUCTION AND COMPLIANCE SCHEDULE FOR COMPLETION OF CONSTRUCTION OF HIME DRAINAGE AND NATURE HANDLING FACILITIES AND/OR DEASURES  $\underline{1}/$ 

PERMT	TEO SITE	
Description of Drainage or Water Handling Pacilities and/or Measures	Map I.D.# of Structure	Date for Completion of Facility or Structure (Month and Year)
Silt Pond	1	11-76
Berm	2	11-76
Berm	3	6-79
Silt Pond	. 4	3/83
Berm	5	3/83
Ветт	6	3-83
Brush Barrier with Filter Fabric Fence	7	6-79
		·

# SUBSTITUTED SITE (complete only if substitution involved) Date for Completion of Facility or Structure Map I.D.# of Structure April 1.D.# (Month and Year) (None - not applicable)

<sup>1/</sup> To be installed prior to beginning surface mining operation as part of site preparation activities for mining.

#### 11. RECLAMATION PLANS AND SPECIFICATIONS.

8. Backfilling: All pits under this plan shall be backfilled, including the final cut. Prior to backfilling, all acid-forming materials, refuse, minerals or spoil will be separated from nonacid producing spoil and spread along the bottom of the pit. A clay seal will be placed to a minimum depth of 4' over any exposed acid producing material. Backfilling shall begin at, or beyond, the top of the highwall and be sloped to the toe of the spoil banks at a maximum angle not to exceed the approximate original contour of the land with no depressions to accumulate water. No backfilling will be done when the soil is extremely wet. (continued on page 8A)

b. Bare or Rocky Areas Attributed to Mining:

No bare or rocky areas, houlders, etc.  $\kappa$ -11 exist at this site, as areas of this type will be covered by soils of sufficient quality and depth that will support a permanent vegetative cover.

#### c. Fencing (location and type):

A protective fence will be erected around and/or parallel to any affected land, pits or highwalls that are determined by the E.P.D. to be hazardous to the health and wolfare of the community. The fence will be a five strand barbed wire or a 36" hogkire, topped by two strands of barbed wire mounted on pressure treated wooden or metal posts and properly gated at selected access points. The fence will be constructed in keeping with sound engineering principles and conservation practices. Following written notification by the E.P.D. that a protective fence is necessary, we will construct same no later than 45 days from receipt of notification.

#### d. Grading:

Rough grading will be carried out on a weekly basis and will be kept concurrent with mining. Finish grading of all affected areas, including spoil disposal areas, will be kept concurrent with mining and completed on at least a monthly basis. No more than 5 acres of ungraded affected land is to occur at any time. All affected lands will be graded to the approximate original contour into a rolling topography, being blended in with existing landscape, and will be left in a mowable condition.

#### e. Highwall Reduction and Development:

No highwalls will be left. They will be reduced by backfilling and grading. During mining, access roads will be provided to the top of the highwall at 2,500' intervals for the purpose of forest fire control. A diversion ditch or berm will be constructed parallel and above all highwalls to channel surface waters to natural drainage areas allowing same not to accumulate in our mining pit.

f. Lake Development (location, access into water and development):

No lakes will be developed under this plan unless prior written approval is obtained from the Land Reclamation Program and plans and specifications which incorporate the specifications shown below are submitted for approval. Specifications that we will use for lake development are as follows:

- (1) Water of a quality suitable for the intended purpose.
- (2) Nater having an average minimum depth of at least 4' except water occurring immediately adjacent to banks of the lake (4').

(continued on page 8A)

#### a. Backfilling: (continued from page 8)

The upper 12 inches of soil on backfilled areas will be of a quality that will properly support a permanent vegetative cover. The upper 12" of soil will be left in a friable condition to create a faverable seed bed. All fines or mining refuse that may exist contiguous to ained out pits will be backfilled into the pit to properly dispose of material of this type. No mining refuse, gob, stockpiles of any type, saprock or fines or low grade ores or mineral solids will remain on the surface of rehabilitated land.

- f. Lake Development: (continued)
- (3) Entire perimeter of lake banks will be graded and sloped so as to provide safe access on all sides of the lake.
- (4) A 3:1 grade will be provided on all above water lake banks extending slope into lake and ending at a point where waters of the lake have attained a 7' depth, at which point the slopes of the lake bank may be perpendicular.
- (5) All above water projections of land and/or spoil occurring will be reduced in height by grading or hydraulically so that same will be covered with a minimum of 4' of water when the lake is filled to its normal water level. However, properly constructed islands may be built into the lake providing they meet other specifications regarding grading, slopes, revegetation, etc. Nater of the lake is to be free of all underwater hazards, including poles, pilings, spoil, abandoned mining equipment, boulders, etc. Prior to developing a lake from a mining pit, any toxic overburden, spoil, ores or mineral solids occurring in lake area will be covered with a minimum of 4' of compacted clay.
- (6) All above water portions of lakes developed are to be revegetated with an approved, permanent vegetative cover as specified in item 11 p. of this plan.
- (7) All structures, such as emergency spillways, overflow pipes, dams, levees, etc. are to be developed in keeping with good conservation practices and engineering techniques.
- (8) No abandoned or worn out equipment of any type will be placed in mining pits that are to be developed into lakes.

Only properly approved lakes will remain on rehabilitated lands.

g. Overburden Placement and Use (include cross-sections or contour map of land form to be developed):

No overburden will be placed downslope as spoil in steep terrain. All overburden and spoil, except that which is suitable for use in constructing protective barriers, berns, waste water handling facilities, roads, dans, etc., will be placed in such a manner so that it will not interfere with natural drainage and will have a very low profile. No land forms will be created from this material over 20 feet in elevation above the average surrounding topography. Our engineering drawing, which is attached and made a part of this plan, shows typical cross-sections and contours of rehabilitated spoil areas. The toe of overburden spoil areas, mining waste or refuse disposal site will not be placed within 200° of any natural drain or waterway, creek, stream, river, lake or other water body. No overburden will be placed downslope on previously unmined lands. Overburden or spoil will not be placed on any previously filled slope but will be placed on lands having an undisturbed base.

Overburden and spoil areas will be developed in such a manner so as to control erosion and siltation, protecting contiguous natural resources. When mining previously (continued on page 9A)

#### h. Pipelines:

All pipelines occurring on affected lands and used by our operation will be maintained and operated in such a manner so that no environmental damage will result from the use of pipelines or during periods when the operation is closed for repair or clean-up work. Sturries containing ores or chemicals contained in pipelines will not be discharged into any natural drain or watershed. All pipelines will be removed from affected lands prior to reclamation and none will exist when rehabilitation work has been completed.

#### i. Professional Technical Assistance:

We will use the services of a registered professional engineer in the preparation of engineering drawings, such as original and final contours, drainage and erosion control facilities and measures, planned mining advancement, roads, (continued on page 9A)

1. Roads and Right-of-Way Development and Rehabilitation:

#### (1) Access Roads -

Access roads will be constructed using good engineering principles and conservation practices and will have a minimum width of 12'. All roads will be provided with satisfactory drainage ditches on either side, will be equipped with proper sized culverts so as not to interfere with natural drainage and will be maintained (continued on page 9A)

#### (2) Equipment or Dragline -

Any equipment right-of-ways that may be needed will be constructed and maintained in keeping with good engineering techniques and conservation practices. Facilities of this type will not interfere with the natural drainage of the area. Slopes of facilities of this type will be developed so as to comply with (continued on page 9A)

k. Standing Water: No pools of standing water or low areas that will allow the accumulation of same will remain unless a properly developed lake is constructed. Affected lands will be graded in such a manner so as to eliminate waters of this type and create site conditions favorable for the growth and development of a permanent vegetative cover.

#### 1. Screening:

#### (1) Berms -

We will leave an undisturbed strip of land from 50 to 100' in width on the downslope side of our mining operation. As our mining cuts are made, the natural undisturbed strip of land that will remain will serve as a herm and screen. This will also prevent runoff and drainage from our mining pit from flowing downhill onto unpermitted lands and waters.

#### g. Overburden Placement and Use: (continued from page 9)

undisturbed areas, overburden and spoil will be placed only on cleared areas that have had all trees and stumps removed. On initial cuts of unmined lands, an undisturbed, unmined area of natural ground at least 50 to 100' in width will be left between our mining site and down hill slopes.

#### i. Professional Technical Assistance: (continued)

silt basins, berms, diversions, highwall reduction, etc. All facilities and measures to be used will conform to minimum design standards and specifications of the Soil Conservation Service serving the county where our mine is located. All engineering drawings, plans and specifications prepared by our engineering staff have been submitted to our local SCS representative for technical review and an official copy of this agency's recommendations and comments are attached hereto and made a part of this plan. We will become a cooperator with the Soil and Water Conservation District serving the area where our surface mine is located.

#### j. Roads and Right-of-Way Development and Rehabilitation: (continued)

#### (1) Access Roads - (continued)

as an all weather road until reclamation is complete so that the road may be traveled by a half-ton vehicle. all roads will be surfaced with nonacid producing material. Details of road development and construction are shown in our engineering drawing, which is attached hereto and made a part of this plan. Access roads will be rehabilitated for the purpose as shown in our compliance schedule.

#### (2) Equipment or Dragline - (continued)

other applicable specifications contained in our plan and will be rehabilitated for a purpose that is compatible with our compliance schedule. Details of equipment and dragline right-of-ways are shown in our engineering drawing which is attached and made a part of this plan.

and trees will be maintained between our mining operation and any state or county maintained public roads that are contiquous. The buffer zone to be left will be a minimum of 200' in width. Should portions of buffer zones be void of sufficient vegetative cover to properly screen our operation from public view from roads involved, we will establish a satisfactory stand of indigenous forest trees so that screening will be continuous.

#### (3) Other -

Not applicable.

m. Slope Specifications: Two methods of developing slopes will be employed. Slopes will be graded so as to blend in with the existing topography and graded to a maximum angle not to exceed the approximate original contour. All slopes, unless meeting other specifications set forth below in this section, will be a minimum of 3:1 (180) or 35%. No slopes steeper than 28% will be mined under this plan without first obtaining prior written approval from the E.P.D. All slopes will be developed in keeping with good conservation and engineering practices, will be filled in layers, properly compacted and constructed so that they will have a sound foundation. Slopes will be left in a mowable condition. All slopes resulting from our operation will be stabilized and of a permanent nature. Satisfactory drainage will be established from runoff and/or seepage from above to prevent saturation of soils, thus preventing slumping or "floating" of slopes. No waters discharged from our operation will be placed on the surface of any slope and discharge points will be riprapped to prevent erosion. The toe of slopes occurring on previously unmined areas will have a base of undisturbed, unmined, natural ground at least 50 to 100' in width as specified in item 2. MINING METHODS, page 2 of this plan. Adequate natural drainage will be maintained so that newly created and graded slopes will not be adversely affected due to erosion. The toe of no slopes will be placed within 200' of any natural drain or waterway, as in areas of this type the undisturbed natural waterway is to remain so that satisfactory drainage will exist. Should gullying from erosion develop on any slopes, same will be immediately repaired so as to provide a properly graded and stabilized slope.

#### n. Site Clean-up:

#### (1) Abandoned or Worn Out Equipment -

None will remain on site, as it will be buried to a depth of at least 4', using spoil for cover or removed from the site.

#### (2) Boulders and Large Rocks -

No rocks or boulders will remain exposed on the surface of rehabilitated lands. They will be removed from the site or buried and covered with a minimum of 4' of soil capable of supporting a permanent vegetative cover. Suitable nonacid producing rock will be used for riprap where needed.

#### (3) Debris (stumps, logs, timber, etc.) -

Debris and refuse, such as trees, stumps, litter, etc., will be removed from the site to an acceptable disposal area or will be buried to a depth of at least 4'. No open burning will occur on affected lands. Debris will not be deposited within any natural drainage system of the area.

#### (4) Foundations and Bases -

All structures of this type, whether concrete, wood or otherwise, will be removed from the site or covered with no less than 4' of soil capable of supporting a permanent vegetative cover.

#### (5) Structures and Buildings -

All will be removed from site except those specifically approved by the E.P.D. in writing to remain. Any structure or building approved to remain on site will be of a design and quality that is compatible with our reclamation objective and its location will be shown on our approved land use map.

#### (6) Stockpiles and Maning Refuse -

All stockpiles and mining refuse, including fines, will be backfilled into mining pits on a continuous basis as lands are rehabilitated. Areas occupied by materials of this type will be topsoiled to a depth to adequately support a permanent vegetative cover. All stockpiles will be provided with properly designed structures, such as berms, diversions, etc., so that runoff from areas of this type can be properly treated prior to discharge. See our engineering drawing, which is attached and made a part of this plan, for design details.

- (7) Ramps No ramps or benches will remain on rehabilitated lands, as they are to be obliterated continuously as part of our simultaneous mining and reclamation program. They will be eliminated by backfilling and grading.
- (8) <u>Water Handling Facilities</u>, <u>Holes</u>, <u>Pits</u>, <u>Silt or Debris Basins</u>, <u>etc.</u> All facilities of this type are to be removed from rehabilitated lands. Only settling ponds and debris basins specifically approved in writing by the E.P.D. are to remain on reclaimed lands. Settling ponds or debris basins not approved by the Division as remaining a part of the overall reclaimed site will be dewatered in a satisfactory manner, graded and rehabilitated in a manner that will conform to the various specifications contained in our approved Mined Land Use Plan. All waste water handling facilities or silt basins will be cleaned out when same have reached 60% of designed capacity.
- (9) Other As affected lands become inactive or mining ceases for a period of 12 months, all affected lands will be properly graded and rehabilitated, completing all specifications contained in this plan.
- o. Topsoil Placement and Use:

Prior to stripping overburden, topsoil and/or the upper 12" of soil occurring in the "A" and "B" soil horizon will be removed and stockpiled. Following the backfilling of affected lands, stockpiled topsoil will be spread uniformly to a depth of no less than 3" over graded, affected lands.

p. Planting Plan (check o	ne):
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(1)	We request approval to file a delayed planting plan for Divisional
<del></del>	approval 180 days prior to seeding or planting. We agree that no
	planting will occur until our planting plan is officially approved in
	writing by the Environmental Protection Division as part of this plan.

X	(2)	Our planti	ng plan	is as	follows:	(Note:	Use	this	Chart	for	balance
		_	-				of N	o. 2	Planti	ing F	'lan)

Species of Vegetative Cover to be Planted	No. Trees or Pounds of Seed Per Acre		Type Fertilizer and Amount Per Acre	Seedbed Preparation for Planting	Type Mulch and Amt. Per Acre
WE I	ILI. FOLLOW	THE RECOMMENDATIONS	OF THE S.C.S. FOR	ESTABLISHING A PERM	NENT
VEGI	TATIVE COVE	R. THESE RECOMMEN	ATIONS ARE CONTAIN	ED IN THE ATTACHED SO	IL
AND	WATER CONSI	RVATION PLAN DATED	MAY 11, 1976.		

#### q. Other Planned Reclamation Activities:

None

#### [continued from page 11]

r. Description of Rehabilitated Lands as Compared to Original Undisturbed Site at Completion of Final Reclamation:

Reclaimed lands are to be restored to a rolling topography, blended in with the existing landscape and returned to the approximate original contour or graded so as to have no slopes steeper than 3:1. Reclaimed lands will be topsoiled, left in a mowable condition and have a permanent vegetative cover established on same. Rehabilitated lands will have a neat, clean appearance and be suitable for use as shown in our compliance schedule. Rehabilitated lands will have all evidence of mining minimized. Long, uninterrupted slopes will not exist, as they will be developed in keeping with sound engineering principles and conservation practices so that proper drainage is restored to reclaimed areas. Natural waterways or drains will remain unaffected by mining.

Our reclaimed site will contain lands which are improved in topography over the original unmined site and will be of an increased value from land utilization viewpoint and are suitable for "multi-purpose" use such as pasture, recreational or forest lands.

12.	ANTICIPATED RECLAMATION COST.	0000	44.50=
	Item	Persitted Site	/ACRE Substitute Site
Back	filling and Grading	\$350.00	None
	erials (seed, fertilizer, lime)	\$165.00	
Site Preparation		\$ 44.00	
Mulc	•	\$ 90.00	·
Seco	ling	\$ 30.00	
Tree	Planting		`.
Othe	er (specify below)		
	TOTAL COST	\$679.00/acre	
B.	PREVIOUS PERMIT DATA.      Rave you previously been permitt      If previous Georgia Surface Miniand permit number.     Liberty Mining Company     Permits #297-70 and 305-72	_	
	<ul> <li>c. Has a Georgiz Surface Mining Perhas a reclamation performance bo</li> <li>d. If permit has been suspended or</li> </ul>	ond posted by you been cancell	ed? X Yes No
	involved and details for this ac Permit #297-70 bond forfeited for approved manner due to business f	ction inability to complete reclam.	•
14.	LIST OTHER PERMITS OR LICENSES YOU IN		LATION TO THIS SURFACE
	Local Zoning Permit - #41789 - Na Nater Quality N.P.D.E.S. Permit - Air Quality Permit - not received	not received	

#### 15. MISCELLANEOUS INFORMATION.

- 2(1) We will immediately report to the Surface Mined Land Reclamation Program, Environmental Protection Division, Macon, Georgia, telephone 912/744-3346, any environmental damages or problems that occur from our operation. In addition, a properly written report will be mailed within one week of the incident to the Division's office at P. O. Box 233, Macon, Georgia 31202, giving a description and details of the event.
- (2) We will erect and maintain, in a permanent and visible location, until reclamation has been satisfactorily completed, a neat sign showing our company name and permit number. The sign will be no smaller than 2' by 2' and have lettering with a minimum size of 4". Our identification sign will have a yellow background with black permit numbers and will be displayed 5' above the surface of the mining site where mounted.
- (3) Under the provisions of this plan, we agree to furnish, at the request of the E.P.D., an updated mining and reclamation progress map or a scale accurate vertical aerial photograph of lands affected under this permit. Said map or photograph is to be of a scale of 1" = 400" and will be made by a reputable qualified independent consulting engineer or surveying company qualified to prepare documents of this type. In event we affect more land than originally anticipated, we will also submit an updated progress map at the time our approved plan is amended.

#### (continued from page 12)

- (4) We agree, prior to mining, to establish boundary markers on lands to be permitted. Said markers are to be either metal or pressure treated wood. Markers will be a minimum of 5' in length, 3' of which will be driven into the ground and the upper 2' will be painted yellow. Markers will have a minimum size of 2" by 2" or equal. Boundary markers will be placed at each property corner and no less than 200' within indivual boundary lines.
- (5) Under the terms of this plan, no deep (underground) mining will occur from landpermitted for mining and reclanation.
- (6) Under the terms of this plan, prior to mining, we agree to submit to the E.P.D. official evidence from the Secretary of State, State of Georgia, that we have appointed an official Georgia Registered Agent to represent our corporation.

#### APPENDIX F

#### SOLID WASTE MANAGEMENT \*

# LEGAL REFERENÇES:

For a detailed legal citation of the information summarized below, sec:

- GEORGIA CODE, CHAPTER 43-16. SOLID WASTE MANAGE-MENT ACT.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-4 Amended. .

#### PERMIT:

It should be emphasized that the granting of a permit depends on the industry's demonstrable capability to meet specific standards found in the RULES AND REGULATIONS. A permit is required for these solid waste activities:

Storage
Collection
Transportation
Utilization
Processing
Disposal
Disposal facility construction
Disposal facility operation

# PROHIBITED ACTS:

Handling of solid waste which:

Creates a nuisance
Contributes to insect and rodent infestation
Contributes to the harboring or feeding of
animals
Impairs the quality of the environment
Creates other hazards to the public health

- Burning of solid waste, except by an approved method.
- · Permitting scavenging at a disposal site.
- Open dumping.
- Hazardous wastes and sludges not handled in accordance with a written, approved procedure.
- Disposal of special wastes without an approved proposal.

<sup>\*(</sup>Reprint permission granted by the Georgia Bureau of Industry and Trade.)

- Site closures without prior 30-day written notice and approved closing procedures.
- Failure to maintain closed sites for a period of one year, with special attention to erosion control and development of adequate vegetative cover.

#### EXEMPTIONS:

- Disposing of solid wastes originating from an individual's own residence onto land or facilities owned by him, when disposal of such does not thereby adversely affect public health.
- Disposing of livestock feeding facility waste from facilities with a total capacity of up to 1,000 cattle or 5,000 swine.
- Livestock feeding facility regardless of total per head capacity, if an approved waste disposal system is provided that can properly dispose of runoff from a "ten year storm."
- Use of poultry or other animal manure for fertilizer.

#### GUIDELINES:

GUIDELINES that can assist industries in complying with the RULES AND REGULATIONS are available from the Solid Waste Management Section. Five GUIDE-LINES are available:

Sanitary landfill or landfill disposal of liquid, semi-solid, and industrial sludge wastes. Hazardous solid wastes.

Control of flies and odors on caged layer poultry farms.

Highly putrescible solid wastes.

Sanitary landfill disposal of solid latex wastes.

# COLLECTION AND TRANSPORTATION:

- Owners or occupants are responsible for the collection and transportation of solid waste accumulated on their property, unless the services of a licensed collector have been engaged.
- Vehicles transporting putrescible waste must be covered, substantially leakproof, durable, and of easily cleanable construction.
- Vehicles must be cleaned frequently and maintained in good repair.
- Vehicles must be loaded covered, and moved in such manner as to prevent littering and spillage.
- Special precautions must be taken regarding these areas of transfer station maintenance:

Scattering
Accumulation
Floor maintenance
Sewage solids
Hazardous wastes
Dust
Pests

#### DISPOSAL:

 Sanitary Landfill Operations. Special precautions must be taken regarding:

Unloading
Spreading and compaction
Daily cover
Intermediate cover
Final cover
Grading and drainage
Continuity of operation
Environmental protection
Hazardous waste
Supervision
Limited access
Litter control
Fire protection

• Landfill Operations. Special precautions must be taken regarding:

Spreading and compaction Cover Grading and drainage Environmental protection Limited access Fire protection

 Other Disposal Operations. Special approval must be obtained.

#### PROCESSING:

 Incineration or pyrolysis. Special precautions must be taken regarding:

Supervision
Residue
Waste water
Air quality
Posted information
Cleanliness and sanitation
Fire control

 Shredding. Special precautions must be taken regarding: Supervision
Shredding
Waste water
Air quality
Posted information
Cleanliness and sanitation
Fire control

 Baling. Special precautions must be taken regarding:

Supervision
Bale size
Waste water
Air quality
Posted information
Cleanliness and sanitation
Fire control

 Reclamation and Recycling. Special precautions must be taken regarding:

Supervision
Storage
Incineration
Posted information
Fire control

 Composting. Special precautions must be taken regarding:

Supervision
Posted information
Residue
Cleanliness and sanitation
Fire control

- Other Processing Operations. Prohibited unless special approval obtained.
- INSPECTIONS
  AND INVESTIGATIONS:

 EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to air pollution.

OTHER LAWS:

The Act in no way limits the power of various public bodies, officials and private citizens to impose additional nonconflicting regulations on solid waste disposal in their own jurisdictions.

TRANSPORTA-TION OF GARBAGE ACROSS STATE & CERTAIN COUNTY BOUND-ARIES: Prohibited, except with permission of authorities in county where garbage will be dumped (See GEORGIA CODE, CHAPTER 23-32, as amended).

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#### APPENDIX G

#### WATER SUPPLY QUALITY CONTROL\*

# LEGAL REFERENCES:

For a detailed legal citation of the information summarized below, see:

- GEORGIA CODE, CHAPTER 88-26. GEORGIA WATER SUPPLY QUALITY CONTROL ACT, as amended.
- OFFICIAL COMPILATION RULES AND REGULATIONS OF THE STATE OF GEORGIA, CHAPTER 391-3-5.

# CERTIFICATE OF APPROVAL:

- A Certificate of Approval is required to operate a public or community water supply system.
- The granting of the Certificate of Approval is based on whether the particular water supply system meets specified requirements and has the capability of providing a sufficient quantity of water meeting standards governing the quality of such water set forth in the RULES AND REGULATIONS.
- Once granted, the Certificate will indicate the operating conditions that must be followed.

CONSTRUCTION
OF THE
WATER SUPPLY
SYSTEM:

Before an industry is permitted to construct its water supply system, it must submit to and have approved by the Environmental Protection Division:

Engineering report prepared by a professional engineer containing a comprehensive description of the feasibility of the proposed project. A list of certain items that must be included in the report can be found in the RULES AND REGULATIONS.

Plans and Specifications prepared by a professional engineer that should include, but are not limited to, areas to be served by the water system, source and the treatment facilities of the system, and plant laboratory equipment necessary to make all analyses for the control of the processes involved.

General Plan Map that indicates the location of various structures, the size and type of the materials of the existing and proposed water mains, and other items enumerated in the RULES AND REGULATIONS.

<sup>\*(</sup>Reprint permission granted by the Georgia Bureau of Industry and Trade.)

# WATER SUPPLY CLASSIFICATIONS:

In some instances varying requirements are set forth in the RULES AND REGULATIONS applying to these three classes:

- Class I. Water supply systems supplying finished water from any surface water sources.
- Class II. Water supply systems supplying finished water from ground water sources to more than 25 housing or mobile units, to schools, to State owned facilities, and to industrial operations employing more than 100 persons.
- Class III. All other water supply systems supplying finished water from ground water sources, including but not limited to, tourist accommodations, food service establishments, and commercial establishments.

# SOURCE OF WATER SUPPLY:

- Industries must collect raw water samples for bacteriological examination before approval can be obtained for a source of water supply.
- Standards for surface and ground water sources are found in the RULES AND REGULATIONS.

# WATER TREATMENT FACILITIES:

#### Specific standards exist for:

Design and operation of surface and ground water treatment plants

Raw water and multi-level intakes

Raw water lines

Chemical feed equipment

Initial mixing

Flocculation

Sedimentation

Filtration

Use of finished water

Chlorination

Fluoridation

WELLS:

Specific standards exist for:

Distance between a well and a septic tank

Protection of pumping equipment and water treatment facilities

Construction of the well and maintenance of construction data

Turbine and submersible pump installation

Well casing

Location of the raw water sampling tap and the blow-off pipe

Rehabilitation of existing wells

Plugging and sealing of drilled holes

Furnishing of samples of raw water for bacteriological examination

Furnishing of the results of physical and chemical analysis of the raw water

SPRINGS:

Specific standards exist for:

Construction and operation of springs

Furnishing of samples of the raw water for bacteriological examination

Furnishing the results of physical and chemical analysis on the untreated water

STORAGE TANKS AND DISTRIBUTION SYSTEM: Specific standards exist for their construction and operation

DISINFECTION:

Specific disinfection standards exist for:

All newly constructed water supply systems

Storage tanks

Water mains

Wells

OPERATION OF THE WATER SUPPLY SYSTEM: Specific standards exist for:

Chlorination of the system

Experienced operator on duty

Maintenance of a chemical and biological laboratory

Performance of bacteriological and chemical tests

Collection of samples for bacteriological tests

WATER SAMPLES: Specific standards exist for:

Number and places where samples must be taken

Shipment of samples

OPERATING RECORDS:

Specific standards exist for the maintenance of operating

records.

DRINKING
WATER
STANDARDS:

Specific standards exist for:

Bacteriological quality

Physical characteristics

Chemical characteristics

Presence of radioactive materials

INSPECTIONS
AND INVESTIGATIONS:

EPD has the power to enter at reasonable times any private or public property for the purpose of inspecting or investigating conditions relating to the furnishing of water to

the public.