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Costs and Effects of Environmental Protection Controls Regulating U.S. Phosphate Rock Mining

By Ronald F. Balazik

UNITED STATES DEPARTMENT OF THE INTERIOR
James G. Watt, Secretary

BUREAU OF MINES
Robert C. Horton, Director

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COSTS AND EFFECTS OF ENVIRONMENTAL PROTECTION CONTROLS REGULATING U.S. PHOSPHATE ROCK MINING

By Ronald F. Balazik [1]

ABSTRACT

This Bureau of Mines study identifies and examines the costs of Federal, State, and local environmental protection controls on domestic phosphate rock mining. The costs include the expenditures needed to comply with government regulations and the effects that these expenditures and regulations have on supply. The study analyzes costs of environmental impact assessments, air and water quality standards, reclamation laws, potential solid waste controls, and local government restrictions. In addition, an industry survey and the Bureau's Minerals Availability System (MAS) are used to evaluate land management policies that restrict access to phosphate resources. Conclusions drawn from these analyses confirm that (1) domestic phosphate mining has incurred substantial control costs and may be subject to significant new regulatory costs in the next several years, (2) certain environmental controls can discourage mining investment, (3) environmental policies governing land-use controls affect the disposition of sizable phosphate resources, and are key determinants in the development of those resources on the Federal domain, and (4) environmental costs could diminish the competitiveness of domestic producers.

[1]Minerals specialist, Division of Minerals Policy and Analysis, Bureau of Mines, Washington, DC.

INTRODUCTION

Phosphate rock[2] mining[3] is one of the few U.S. mineral industries that satisfies virtually all domestic demand and supplies a large export market as well. In fact, the United States is the world's leading producer of phosphate, an irreplaceable plant nutrient in agriculture. Regardless of its significance, however, phosphate mining has some adverse environmental impacts if not properly conducted. Public issues and concern regarding these impacts are detailed in chapter 1.

In response to concerns about environmental degradation, Federal, State, and local authorities have imposed regulatory controls[4] on domestic phosphate mining. These controls primarily set water quality standards, limit airborne emissions, and prescribe mine reclamation practices. Other controls restrict access to phosphate deposits and require impact assessments of proposed mining. The scope and cost of each existing and potential control in the phosphate mining industry is examined in chapters 2 and 3. These controls, however, entail many costs in addition to those borne by the industry and encompassed by this report.

The costs identified in this report indicate that environmental protection controls have several immediate effects on domestic phosphate mining. The effects are as follows: (1) increase capital and operating expenses, (2) limit access to potentially important mineral resources, and (3) can discourage investment by introducing financial uncertainty and risk. Each of these effects and their consequences are analyzed in chapter 4. Conclusions drawn from the information presented herein are given at the end of this report.

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[2]Phosphate rock is the commercial term for naturally occurring phosphate compounds usually found in the apatite minerals group, generally expressed as $Ca_{10}(PO_4, CO_3)_6 (F, OH)_{2-3}$.

[3]This report covers mining operations from deposit excavation through ore beneficiation, and also includes mine reclamation activities. The processing of beneficiated ore at fertilizer plants and for other consumers is beyond the scope of this report.

[4]For this study, environmental protection controls are defined as "government policies and regulations designed to preserve the natural features of a landscape, including atmospheric, vegetation, and wildlife characteristics."

CHAPTER 1.--DOMESTIC PHOSPHATE ROCK MINING: STATUS, ENVIRONMENTAL IMPACTS, AND REGULATORY ISSUES

This chapter presents a brief description of domestic phosphate rock mining that highlights mining operations and public issues relevant to environmental regulation of the industry. The description is designed to serve as a background for the discussion and analysis in the chapters that follow.

INDUSTRY STATUS

The United States is the world's leading producer of phosphate rock. Moreover, phosphate rock mining is one of the few U.S. mineral industries that meets virtually all domestic demand for its product and is a major exporter as well. In 1981, the industry produced approximately 54 million tons[5] of marketable phosphate rock valued at $1.4 billion (31). Exports (primarily to Canada and Europe) totaled 11 million tons, while imports amounted to less than 14,000 tons (30). Imports accounted for less than 1 percent of domestic consumption in 1981, and averaged less than 3 percent of consumption throughout the 1970's.

Most of the phosphate rock mined in the United States is used to produce phosphate fertilizers. These fertilizers provide phosphorus, which is essential to plant growth. Phosphate rock is virtually the only source of phosphorus used as a plant nutrient; there is no practical substitute on a commercial scale. Phosphate rock is also used in animal feed supplements, food additives, detergent compounds, insecticides, and other chemical products.

Twenty-six mining companies, with a total employment of about 10,000 personnel, accounted for all U.S. phosphate rock production in 1981 (30). Thirteen companies in North Carolina and Florida produced 87 percent of the total output (30). The remainder was produced in Tennessee (2 percent) and in Idaho, Alabama, Montana, and Utah (11 percent) (30). Nearly all of the phosphate rock mine properties in the Eastern States are privately owned, whereas most of the properties in the West are on public lands or are held by both government and private concerns.

As might be expected, the geographic pattern of phosphate rock production in the United States reflects the distribution of known deposits. Table 1 shows the location of phosphate rock reserves by State. Note that over two-thirds of the total reserves and reserve base are accounted for by only two States, Florida and North Carolina.

Phosphate rock mining costs vary considerably throughout the country. Ore grade and depth, deposit impurities, plant age, and cost of equipment are some of the key variables affecting costs (31). The costs per ton of P_2O_5 product calculated[6] in 1981 with the Bureau of Mines Minerals Availability System (MAS) are Florida and North Carolina, $10.73-$36.14; Tennessee, $15.91-$22.41; and Western States, $27.79-$41.31.

Phosphate rock prices vary considerably, depending on factors such as mine location, product grade, and whether the rock is destined for domestic or foreign markets (31). Average phosphate rock prices for various producing areas are shown in table 2.

[5]Except where noted, "ton" in this report refers to metric ton (2,205 pounds).

[6]These calculations assume certain conditions, including a 15-percent return on investment, operation at full capacity, and a market available for all production.

TABLE 1. - U.S. phosphate rock reserves, million tons (29)

State	Reserves[1]	Reserve base[2]
Florida	546	2,590
North Carolina	405	1,290
Tennessee	21	29
Idaho	56	235
Utah	224	831
Wyoming	-	690
Montana	-	3
Total[3]	1,250	5,660

[1]As shown in the MAS. These reserves cost less than $30 per ton to mine. Costs include capital, operating expenses, taxes, royalties (if applicable), and miscellaneous costs; a 15-percent rate of return on investment is also included. Costs and re-reserves are current as of January 1981.

[2]The "reserve base," a concept developed jointly by the Bureau of Mines and the Geological Survey, comprises those parts of the resource that have a reasonable potential for becoming commercial and profitable to mine within planning horizons beyond those that assume proven technology and current economics. The reserve base includes reserves, marginal reserves, and some materials that are currently uneconomic.

[3]Data do not add to totals shown because of independent rounding.

TABLE 2. - U.S. phosphate rock prices in 1981, dollars per ton, f.o.b. mine (30)

Source	Destination	
	Domestic	Export
Florida and North Carolina	27.80	37.26
Western States	19.91	40.88
Tennessee	13.24	-

Studies by the Bureau of Mines indicate that the domestic supply of phosphate should be adequate through the remainder of this century (29). As in every mining industry, however, new deposits of phosphate rock must be developed if producers are to compensate for the depletion of existing mines. (Subsequent sections of this report show how the development of new deposits are affected by certain environmental protection policies.) The eventual depletion of phosphate mines that are currently operating could be partly offset by planned operations in Florida and North Carolina. In Tennessee, however, phosphate reserves may be exhausted by the year 2000. Reserves in the Western States are large, but significant amounts are located on Federal lands and environmentally sensitive areas where mining is likely to be contested. Phosphate rock resources on the Eastern Outer Continental Shelf could prove to be another source of production. Nevertheless, mining such resources may be costly and could require special environmental protection controls.

In addition to the need for new resource development, the domestic phosphate rock industry must face more aggressive production and marketing by foreign competitors, especially producers in North Africa and the Middle East (18). Moreover, the proliferation of environmental protection regulations has not encouraged new mine development. Foreign producers not subject to such regulations and the ensuing costs have a competitive advantage. In view of such costs and declining ore grade accompanied by growing foreign competition, it is possible that the United States may no longer be a major phosphate rock exporter by the end of this century (31).

RELEVANT MINING OPERATIONS

Phosphate rock mining operations in the United States are outlined below, with an emphasis on those activities which have the greatest environmental impacts. As illustrated by the schematic diagram in figure 1, the major phosphate rock mining operations are categorized for discussion here as "excavation," "beneficiation," and "final preparation."

Excavation

Except for some underground mining in Montana, phosphate rock is surface mined in the United States. Regional variations in excavation procedures occur due to a number of factors, principally geologic structure, deposit hardness, and ore depth. These geographic variations are as follows:

Florida (57).--At a typical Florida mine, a dragline digs a series of parallel cuts several hundred to several thousand feet long and 200 to 300 feet wide. The overburden is cast into the previously mined cut and the underlying ore is exposed. The ore is then mined and transferred to a slurry pit located above ground within reach of the dragline. In the slurry pit, large water guns deliver 10,000 to 12,000 gallons of water per minute at a pressure of about 200 pounds per square inch to break down the friable ore into a slurry for pumping to the central washing unit in the mill area. Each dragline usually has its own associated pumping system. The ore is not completely recovered due to the irregularity of the contacts with the overburden or underlying bedrock and irregularity of the ore itself. Upper and lower contact losses can be significant. It is estimated that 85 to 95 percent of the ore is recovered from the cut.

Shallow total mining depths of less than 60 feet and favorable

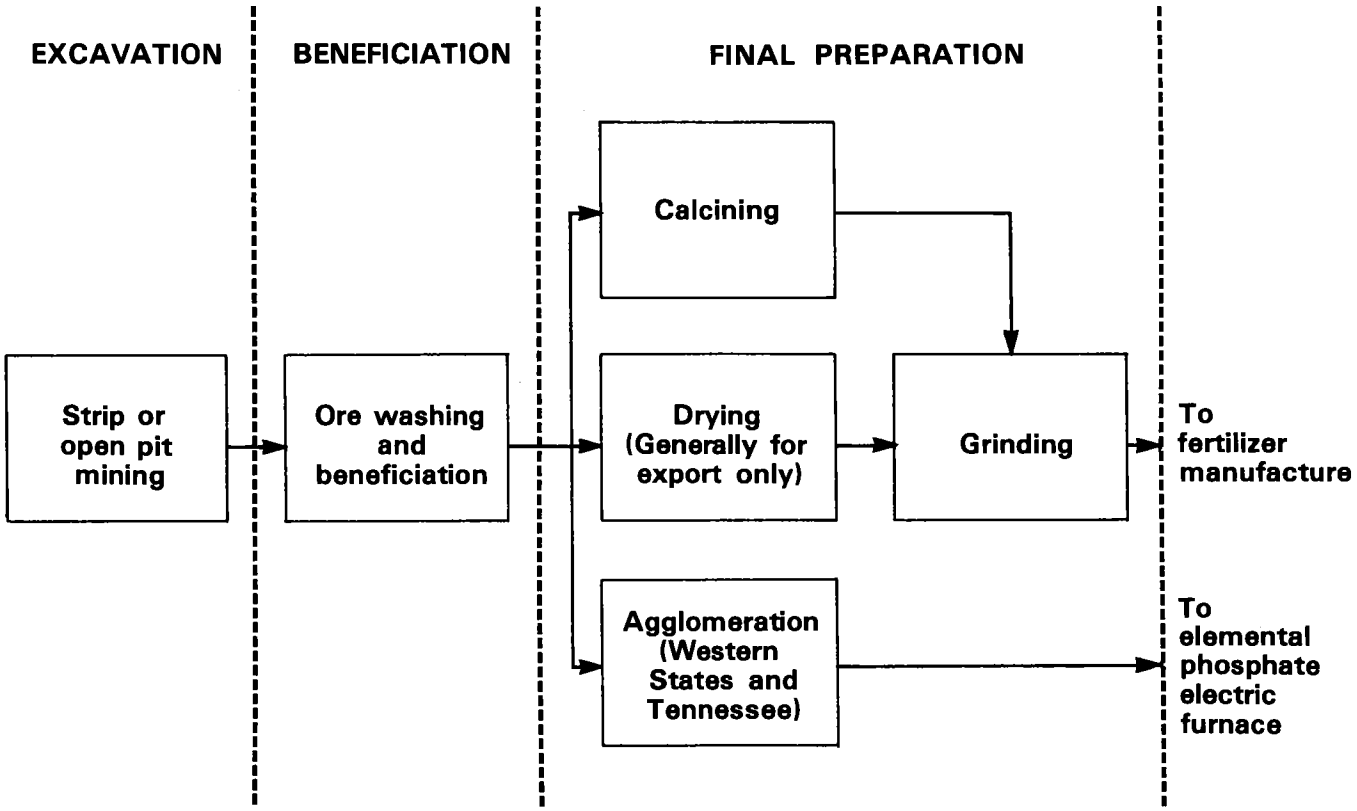

FIGURE 1. - Generalized diagram of U.S. phosphate rock mining operations. (Based on various Bureau of Mines reports and on reference 46.)

overburden-to-ore thickness ratios (in the range of 1:1) have made dragline use for both stripping and ore extraction the standard method of mining. In more recent years, total depths have increased, and overburden-to-matrix ratios have become less favorable, placing more demand on total digging capacity and greater reach to allow sidecast spoiling of the overburden without encroachment on the ore. Some projected operations have average mining depths of 75 feet with maximum depths up to 110 feet.

The strip mining practices just described have affected large areas of land.[7] However, all phosphate mine operators are required to have reclamation programs. More than 70,000 acres of the mined land have been reclaimed to data (13). The reclaimed lands are now being used for pastures, farms, citrus groves, residential and commercial development, pine forests, recreational areas, and wildlife refuges.

North Carolina (31).--The mining procedure is similar to that in Florida. A 30-inch hydraulic dredge removes the upper 40 feet of overburden. A 72-cubic-yard dragline and 45-cubic-yard draglines are used to strip the remaining overburden and mine 40 feet of ore. A small dragline moves the ore to the sluice pit.

Tennessee (31).--Ore in Tennessee is strip mined with 2- or 3-cubic-yard draglines. Blasting is not necessary to remove overburden or ore. Ore is trucked or shipped by rail to beneficiation plants. Loose clay overburden averages 8 feet in thickness but may be 20 feet. Ore thickness averages 6 feet but may be up to 25 feet. Ore is not mined if the ratio of overburden-to-ore exceeds 3:1.

[7]In Florida alone, over 220,000 acres of land have been surface mined for phosphate rock (6, 13).

Western States (31).--Most of the mines in southeastern Idaho use conventional scrapers and bulldozers to remove overburden and mine the ore. However, power shovels are used in some locations to mine ore and remove overburden. In Montana, the ore is broken in the stopes and and removed through chutes into several adits. In Utah, the phosphate rock is quarried after an overlying limestone cap is drilled, blasted, and removed. Unlike most Eastern mines, ore mined in the Western States is transported by trucks or rail to beneficiation plants. Also, because of the drier climate in the West, more dust is generated by Western mining and hauling operations (46).

Beneficiation

Beneficiation is the term applied to the processes utilized to upgrade the phosphate rock ore and remove impurities. As with excavation procedures, beneficiation processes vary regionally, as shown below:

Florida and North Carolina (31,46).--Beneficiation of Florida and North Carolina ores varies from plant to plant, according to differences in grade and the size of different ore fractions. In both States, an ore slurry ranging from 20 to 50 percent solids is first sent through a series of screens using "hammer mills" and "log washers," which enable phosphate-bearing materials to be separated from waste sand and clay.

A typical Florida beneficiation unit involves a preliminary wet screening to separate a fraction called pebble, which is smaller than one-quarter inch and larger than 14 mesh, from the balance of the ore. In some cases, pebble product is then sent to a rock dryer. In North Carolina, the ore does not contain pebble. In Florida and North Carolina beneficiation processes, the ore fraction smaller than 14 mesh is slurried and

treated by one- or two-stage "flotation," which utilizes chemical reagents in conjunction with aeration to selectively separate suspended particles. The special environmental problems associated with the disposal and storage of solid and liquid wastes generated by the flotation-beneficiation process is discussed below, immediately following the remaining State summaries.

Tennessee (46).--A representative Tennessee beneficiation plant uses a log washer to slurry the ore and break up large agglomerated masses. This operation is followed by size classification using hydrocyclones. The product-size fraction is then sent to nodulizing kilns where it is prepared for use in electric arc furnaces to produce elemental phosphorus.

Western States (32, 46).--Individual Western beneficiation plants incorporate a variety of size classification and flotation processes. Thus, there is no "standard" beneficiation procedure for the ores. However, Western beneficiation plants generally include a primary crushing step to reduce the size of the ore to less than one-quarter inch. This size reduction is accomplished in several steps, the last of which is a slurry-grinding process, which uses a wet rod mill to reduce the ore to particles about the size of beach sand. The slurry may be size-classified in hydrocyclones, using centrifugal force to separate product-size material from the tailings (clay and sand particles smaller than about 100 mesh). The ore is then filtered from the slurry and conveyed to further processing. The tailings are discarded.

The large volume of water typically used to slurry and beneficiate phosphate rock has raised concerns about effects on land and water resources in the mining regions. An average of 10,000 gallons of fresh and recycled water is utilized to process each ton of ore produced in the Eastern States, while about 2,000 gallons are used per ton of output at Western mines (18). Although up to 90 percent of this water is eventually reclaimed, the effects of phosphate mining on the depletion of ground water aquifers has been an issue, especially within some areas of Florida.

In addition to its water consumption, the industry must store great quantities of water for years in "slime ponds" to settle out the waterborne solid wastes (principally colloidal clay and suspended phosphate particles) that remain after beneficiation.[8] Although the sand-sized particles settle relatively quickly, much water is entrained in the residual clay solids. Depending on intended postmining use, these wastes generally require several years, or even decades, to dewater and compact to a density that permits reclamation (39).

The slime ponds, also known as settling ponds, cover vast areas. Average pond size is 400 acres, and total pond acreage accounts for 65 percent of phosphate rock mine lands (18). In Florida, phosphate rock miners use more than 50,000 acres for settling ponds and require about 5,000 more acres every year for additional storage (18). In addition to the land impacted by settling ponds, there are reports that accidental spills and leaks pose a risk to surrounding areas. However, there have been no major pond failures in Florida since the State instituted new dam construction and inspection regulations in 1972.

Several million dollars worth of research has been conducted for more than two decades by the phosphate mining industry, government, and academia to develop technology to dewater clay wastes more rapidly and with less environmental impact. This research has had some

[8]Approximately 500 to 1,000 gallons of water is entrained by each ton of colloidal clay. Over 40 million tons of this material is generated each year at Florida mines alone (18).

success. If the present level of research continues, it is likely that solutions to dewatering problems at specific sites will be achieved (39).

Final Preparation

Ore leaving the beneficiation plants usually is agglomerated, calcined, (high-temperature treatment) or ground before shipping and further processing. The particular preparation step undertaken depends on the organic content of the ore and the ultimate product for which it is destined. Since Florida rock is relatively free of organics, it is treated by simply heating to about 250° F to drive off free water. However, phosphate rock mined from other reserves in the Nation (principally in the West) contain hydrocarbons and must be heated to 1,400°-1,600° F. If not removed, the carbon causes foaming when the ore is chemically treated to make phosphoric acid, the starting material for phosphate fertilizer. During agglomeration, the ore is heated to 2,200°-2,600° F. This process not only drives off water, carbon dioxide, and organic matter, but also fuses the ore into larger fractions suitable for feed to the electric arc furnace used in the manufacture of elemental phosphorus. Only the Tennessee ore and some Western ores are agglomerated.

PERTINENT ISSUES

This section describes the public issues that have evolved from the interaction of environmental quality concerns and the apparent environmental effects of phosphate rock mining. These issues have led to the regulatory controls detailed in the following chapter.

Land Disturbance

In some regions, large areas of land in the United States have been disturbed by the mining operations just described.[9] Piles of overburden, open ditches, sand tailings, settling ponds, and excavations are among the features of phosphate rock mining which can mark a landscape. In addition to this esthetic impact, mining can disturb flora and fauna habitat and disrupt natural drainage systems. The extent and persistance of such effects were identified as significant environmental problems in a working paper on U.S. surface mining by the National Academy of Sciences (1).

Although reclamation is now required in all phosphate producing States, the impact of phosphate rock mining on the landscape has created considerable public opposition to the industry, particularly where mines are near scenic and recreation areas or in more populous regions. Planning for new phosphate rock mines is vigorously contested when it is perceived that the proposed mining could impact on primitive scenic and wildlife areas with a delicate ecological balance, i.e., the so-called wetlands in Florida. (See page 23.)

Water Contamination

Properly designed, constructed, and maintained settling ponds will protect the public from surface water and ground water pollution. Nevertheless, the alleged water contamination risk posed by these settling areas has been a recurrent environmental issue in Florida for several years. As noted earlier, no major spills or leaks have occurred since the State introduced new dam construction and maintenance regulations in 1972. In

[9] Over 290,000 acres of land (more than 75 percent in Florida) have been affected by domestic phosphate rock mining. This area accounts for about 5 percent of all lands disturbed by surface mining in the United States (13). Nevertheless, all surface mining has disturbed less than 1 percent of total U.S. territory (13).

1979, however, a working paper for a National Academy of Sciences report designated sedimentation, seepage, and discharge from waste ponds as "potential environmental impacts" (1). Subsequently, the Bureau of Mines identified the management and storage of wastes in settling ponds as the most significant issue facing the Florida phosphate rock industry (39).

Water Consumption

As described earlier, phosphate rock mining and beneficiation consume large volumes of water. Sizable water consumption per se typically is not an environmental protection problem. In North Carolina and central Florida, however, water consumption by phosphate rock mines has been an environmental issue as a result of reports that mining in these regions could deplete aquifers and thereby induce saltwater intrusions in the wells of some coastal areas (18, 37).

Air Pollution

Until recently, air quality issues in the phosphate fertilizer industry focused on the processing plants downstream from mining and ore beneficiation operations. In 1979, however, the Environmental Protection Agency (EPA) proposed Federal air quality standards for certain facilities at phosphate rock mines. The industry questioned the value of such controls on mining, which was already subject to air pollution regulations issued by phosphate-producing States (53). Nevertheless, the EPA promulgated Federal air quality standards for certain phosphate rock mine operations in April 1982. These standards and the State regulations are discussed more fully in the next chapter.

Radiation

Phosphate rock typically contains small amounts of uranium and its decay products. Most of this low-level radioactive material leaves the mine site within the phosphate product, but some residues remain behind in the overburden spoils and in the clay wastes. Thus, people are wary of using land reclaimed after phosphate rock mining because they perceive a potential health hazard (18). Although the health effects of low-level radiation in the reclaimed lands have received considerable study, most investigators agree that more testing is necessary before any risk posed by the radiation can be properly assessed. Certain construction practices can minimize the risk. Nevertheless, a moratorium on home construction in some reclaimed areas of central Florida has been imposed by local government at the recommendation of the EPA (18).

Reclamation

Proper mine reclamation practices can mitigate many of the environmental problems that drive the preceding issues. For example, effective reclamation can eliminate the adverse esthetic impacts of mining and can reduce exposure to low-level radiation on derelict mine lands. To date, the industry has reclaimed approximately 25 percent of all lands in the United States disturbed by phosphate rock mining (13). The reclaimed lands have served a wide variety of purposes, including agriculture, residential and commercial development, recreation, and wildlife refuges. New phosphate mining is not permitted by Federal or State authorities without an approved, bonded (prepaid) reclamation plan.

The effectiveness of reclamation has been a key issue regarding the more controversial impacts of phosphate rock mining. Proposals for mining Florida's wetlands (page 23) and other environmentally sensitive lands have been opposed with claims that the original condition of these areas could never be reestablished. The feasibility of reclaiming the wetland areas, which are rich in phosphate, has been debated for more than a decade.

CHAPTER 2.--ENVIRONMENTAL LAWS AND REGULATIONS

The following survey examines the scope and enforcement of Federal, State, and local environmental protection controls applicable to phosphate rock mining. The controls primarily consist of laws and regulations that set water quality standards, limit airborne emissions, and prescribe mine reclamation practices. Other controls restrict access to mineral deposits and require environmental impact assessments of proposed mining. Additional regulations, which may be issued in the near future, also are covered by this chapter. Specific costs of the controls discussed here are identified in the next chapter.

The Federal and State regulations cited below are closely related. Federal air quality regulations are issued by the EPA but are administered by many of the States as part of State Implementation Plans (SIPS) mandated under the Air Pollution Control Act and its amendments ("Clean Air Act"). Both the EPA and the States enforce water quality standards through the National Pollution Discharge Elimination System (NPDES) established under the Federal Water Pollution Control Act, as amended ("Clean Water Act"). The Federal controls are issued as minimum standards, which can be raised by the States. Florida, North Carolina, Idaho, and Tennessee are used to illustrate State regulations.

ENVIRONMENTAL IMPACT ASSESSMENTS

Federal

The National Environmental Policy Act of 1969 (NEPA) requires all Federal Agencies to prepare assessments of their proposed actions that would affect the quality of the human environment. These assessments, known as Environmental Impact Statements (EIS), must detail the environmental impact of the proposed action, indicate adverse environmental effects, identify alternatives, and indicate any resources that would be foregone. The EIS must also consider the relationship between short-term uses and long-term productivity.

The process of providing an EIS is often long, costly, and complicated due to several court decisions and strict procedural provisions under NEPA (24). If an EIS indicates that a proposed action will have an adverse impact, the action can be revised, but a new EIS may be required. This procedure can take several years.

EIS's have been prepared by the EPA, the U.S. Department of the Interior, and the U.S. Army Corps of Engineers for several proposed phosphate rock mine projects throughout the United States (e.g., California, Florida, Idaho, and North Carolina). These EIS's were prerequisites for Federal decisions regarding mineral leasing, mining on Federal lands, and issuance of water pollution control permits. The EIS's were required under NEPA guidelines and/or provisions of the Federal Water Pollution Control Act.

State

In addition to NEPA, many States have laws that require State or local agencies to file reports that evaluate the environmental impact of their proposed actions that may significantly affect the environment (24). Some States can forego this requirement if a Federal impact statement is prepared (24). However, the environmental assessment process clearly is more costly and complicated if both State and Federal evaluations are required.

Florida, the State with most phosphate rock production, requires a Development of Regional Impact (DRI) report on all proposed mining projects that will exceed 100 acres or consume more than 3,000,000 gallons of water per day (10). The DRI program, administered by the Department of Veteran and Community Affairs under the Florida Environmental Land and Water Management Act of 1972, calls for a broad spectrum of information that details the proposed mining project and its effect on the environment and on the economy of impacted counties. The mine developer

must prepare the DRI report and submit it to the Regional Planning Councils involved for a public hearing and ruling.

AIR QUALITY STANDARDS

Federal

Federal air quality controls that can apply to phosphate rock mining are issued by the EPA under the Clean Air Act for National Ambient Air Quality Standards (NAAQS), Prevention of Significant Deterioration (PSD), "nonattainment" requirements, and New Source Performance Standards (NSPS). Mines operating since 1970 can be required to satisfy NAAQS by the application of continuous emission reduction technology (18). PSD regulations require that calculations for air quality include fugitive dust from surface mining operations (18). In regions that are below minimum air quality standards ("nonattainment areas"), special permits and the "lowest achievable emission rate" are stipulated for new and modified emission sources, including mines. State agencies administer all of these Federal controls as minimum standards after their regulatory implementation plans are approved by the EPA.

Air pollution regulations specifically for phosphate rock mining recently have been promulgated (40 CFR 60) by the EPA under NSPS provisions of the Clean Air Act. These regulations, issued in April 1982, set air emission standards for certain ore beneficiation and drying facilities such as crushing, screening, and grinding plants (39). The standards implement section 307 (b) (1) of the Clean Air Act and apply to mine facilities constructed, modified, or reconstructed after September 29, 1979, and which have production rates greater than 4 short tons (2,000 pounds) per hour. Both atmospheric opacity and particulate emissions are controlled by the standards. Fugitive dust and other airborne particulates arising from stripping and excavation operations are exempt. The specific emission limits are as follows (49):

Standards will limit emissions of particulate matter to 0.03 kilogram per ton of rock feed from phosphate rock dryers, 0.120 kilogram per ton from phosphate rock calciners processing unbeneficiated rock or blends of beneficiated and unbeneficiated rock, 0.055 kilogram per ton from phosphate rock grinders. Opacity levels from grinders and ground rock storage and handling systems are limited to zero percent. Opacity levels from dryers and calciners are limited to no more than 10 percent.

State

Several States with phosphate rock mining have imposed air quality standards that are more stringent than the Federal controls. A sample of key State regulations is presented below.

Florida.--Applicable regulations in the State are extensive and detailed. These controls, in effect since 1975, cover operations not regulated by Federal NSPS and include the following specifications:

- The maximum permissible emissions from calcining or other thermal phosphate rock processing operations and auxiliary equipment except phosphate rock drying and defluorinating is 0.05 pound of fluoride per short ton of phosphorus pentoxide (P_2O_5) feed.
- The maximum permissible emissions from defluorinating phosphate rock by thermal processing and auxiliary equipment is 0.37 pound of fluoride per short ton of P_2O_5 feed.
- Regulations affecting fugitive particulates require the use of reasonable precautions that prevent emissions.
- Operations must be curtailed or postponed when the State declares than an air pollution emergency exists.

North Carolina.--Key air quality controls stipulate that--

- All mines must register with the State.
- Emissions from existing facilities may not exceed 40 percent opacity for more than 5 minutes per hour or more than 20 minutes per day.
- Emissions from new facilities may not exceed 20 percent opacity under the same time constraints for existing facilities.
- Mining facilities must cease operations when an air pollution emergency is declared by the State.

Idaho.--Relevant air quality standards apply to industry in general. Visible emission standards apply to both existing and new sources. Existing sources may not exceed 40 percent opacity for more than 3 minutes per hour. Regulations base standards for particulate emissions on process weight rate.

Tennessee.--Air quality regulations applicable to phosphate rock mining include the following:

- Fugitive dust standards apply to materials handling, transportation, and storage, and require reasonable precautions to prevent particulate matter from becoming airborne. Among these precautions are use of water or chemicals to control dust from land cleaning or material stockpiles, and installation and use of hoods, fans, and fabric filters to enclose and vent the areas where dusty materials are handled.
- Visible emissions from any air contamination source cannot exceed 20 percent opacity for more than 5 minutes in any 1 hour or more than 20 minutes in any 24-hour period.
- Particulate emission standards for process emission sources constructed before August 9, 1969, may be determined by diffusion equations or process weight rates. The allowable emissions levels or particulate matter for new process emission sources is based on a table of process weight rates.
- New or modified plants building in a nonattainment area may be required to apply the best available particulate emission control technology.

WATER QUALITY STANDARDS

Federal

The EPA has promulgated water quality control regulations specifically for phosphate rock mining (40 CFR 436). These regulations, authorized under the Clean Water Act, were issued for existing phosphate rock mines in July 1977, and for new phosphate rock mines in March 1978 (43-44). The term "new mine" was defined by the EPA to mean any mining facility for which construction began after the regulations were publicly proposed (June 10, 1976).

The EPA regulations place effluent limitations on total suspended solids (TSS) and on pH levels. These limitations, which are the same for both existing and new mines, are shown below.

Effluent characteristic	Maximum for any 1 day	Average of daily values for 30 consecutive days shall not exceed--
Total suspended solids (mg/l).	60	30
pH.....	6.0-9.0	9.0

The limitations required the application of best practical technology (BPT) rather than best available techology (BAT) for compliance.

In addition to the effluent standards described, the Clean Water Act also authorizes Federal control over the discharge of dredge and fill material into "navigable waters" of the United States. Under Section 404 of the act, the Corps of Engineers has the authority to issue or to withhold permits for such discharges, including those from phosphate rock mining. The jurisdiction of the Corps for this permitting was considerably expanded in 1975 when the District Court of the District of Columbia interpreted navigable waters to mean all waters, including wetlands such as swamp and marsh (10).

Final regulations for the Corps Section 404 program were published in the Federal Register in July 1977. As detailed in the next chapter, mine permitting under these regulations can be lengthy and complicated.

State (18)

While most States merely incorporate Federal guidelines and standards, several States have issued additional water quality standards that directly affect phosphate rock mining facilities. Some of these extra standards are listed below.

Florida.--Water standards include the following provisions:

- Discharges are prohibited from from altering the pH of receiving water by more than 1.0 pH unit.
- Permits are required for draining wells.
- Secondary treatment or equally effective treatment and control is the minimum acceptable abatement action for all significant sources of water pollution.
- Effluent limits may be established for settleable solids in addition to Federal guidelines when the projected average solids concentration exceeds 5.0 milligrams per liter. The limitations will lie within the range of 0.1 to 5.0 milligrams per liter.
- Permits must be obtained for the excavation of more than 100 cubic yards of materials when such material is excavated adjacent to or discharged into most water areas.

Idaho.--Standards for water pollution include the following:

- No discharges may increase the turbidity of receiving waters beyond specified limits.
- Wastewaters discharged to lakes or impoundments must not exceed the properties permitted for the receiving water.
- Pollutants from subsurface waste disposal facilities must not enter adjacent waters.
- Wastes must be stored so as to prevent the material from being carried into adjacent waters.

Tennessee.--Regulations include both water quality standards and effluent limitation standards.

- Water quality standards include the following:

  No substances may be added that will increase the hardness or mineral content of receiving waters to such an extent as to appreciably impair the usefulness of the receiving waters.

  Total dissolved solids may never exceed 500 milligrams per liter.

  No turbidity or color can be added in amounts that cannot be reduced to acceptable concentrations by conventional water treatment processes.

- Effluent limitation requirements include the following:

  Where practical and economically feasible, a "closed cycle" water reuse system with no discharge will be incorporated into the permit.

  Wastewater discharges to a water course that has no flow for significant periods at the point of discharge are discouraged.

  Instantaneous maximum concentration may be imposed when toxic or harmful parameters are present in such significant amounts as to represent a threat to the receiving waters or when the discharge is irregular.

  Permits may prohibit the discharge of unusually high concentrations of contaminants during short periods of time.

LAND USE AND LAND MANAGEMENT LAWS

Federal

Concerns about environmental quality in recent years have led to an increase in Federal laws and policies that prohibit mining on much of the public domain. Studies by both the Department of the Interior and the Office of Technology Assessment agree that mining already has been prohibited or severely restricted on at least 40 to 50 percent of Federal lands (21). Such prohibitions can place significant restraints on the development of new phosphate resources (50).

More than 20 Federal agencies in a dozen departments control nearly 800 million acres of land (one-third of the country), including extensive areas known to be highly mineralized (23). Many of these areas (particularly in several Western States, Alaska, and the Osceola National Forest of Florida) contain rich deposits of phosphate rock. As deposits are depleted on private lands in the Eastern States, future domestic phosphate production may depend on the development of such public land resources (50).

Most of the authority to control public land mining resides in the U.S. Forest Service and in certain Department of the Interior agencies, particularly the Bureau of Land Management (BLM). Forest Service and BLM controls are authorized primarily by the Forest and Rangeland Renewable Resources Planning Act of 1974 and the Federal Land Policy and Management Act of 1976, which are described below. These laws have given both agencies considerable discretionary authority to permit or forbid mining on the public domain (24).

Prohibitions against mining on Federal lands for purposes of environmental protection are based principally on three types of authority legislated by Congress in the past two decades: (1) The authority to withdraw an area from the purview of other Federal land use laws in order to preserve its environmental character, (2) the authority to manage the public domain and determine the best use for every part of it, and (3) the authority to reserve selected areas for certain uses such as national parks and wildlife refuges. One or more of these authorities are contained in each of the following pertinent Federal land laws enacted since 1964 (23, 42).

Classification and Multiple Use Act of 1964 (43 U.S.C. 1411-1418)

Description: Authorizes the Secretary of the Interior to classify lands under exclusive management of the Bureau of Land Management, and to specify dominant uses and preclude others as inconsistent. Authorizes but does not require classification or proposed classification to segregate land from mining locations and mineral leasing. This Act expired in 1971.

Wilderness Act (1964)
(16 U.S.C. 1131-1136)

Description: Provides for Federally owned "wilderness areas" to be designated by Acts of Congress. Wilderness areas remain open under the mining and mineral leasing laws until the end of 1983 but will be closed (to new entries, permits, and leases) thereafter. In addition to areas proposed by the Congress, the Secretary of the Interior is instructed to examine every roadless area in national park and national wildlife refuge systems (not Bureau of Land Management lands) consisting of more than 5,000 contiguous acres for possible inclusion; the Secretary of Agriculture is to likewise examine the so-called "primitive areas".

Forest and Rangeland Renewable Resources Planning Act of 1974
(16 U.S.C. 1600-1614, as amended)

Description: Directs the Secretary of Agriculture to recommend a renewable resource program including land and resource management plans for the National Forest system, and to implement the plans. Under this Act the Forest Service can reject exploration and mining permits if the agency believes that these activities conflict with other land uses, including natural resource preservation for recreation, scenic areas, etc.

Federal Land Policy Management Act of 1976 (43 U.S.C. 1701-1782)

Description: Provides a basic charter for the Bureau of Land Management; declares national policy for land-use planning, use, and disposal ("national interest," multiple use, fair market value), including land withdrawals, which are defined as:

...withholding an area of Federal land from settlement, sale, location, or entry, under some or all of the general land laws, for the purpose of limiting activities under those laws in order to maintain other public values in the area or reserving the area for a particular public purpose or program..."

Through the act, Congress reserved for itself the authority to create, modify and terminate withdrawals or reservations for national parks, national forests, the Wilderness system, certain defense withdrawals, Wild and Scenic Rivers, National Trails, National Recreation Areas, and National Seashores. It also reserved the authority to modify and revoke withdrawals from National Monuments and the National Wildlife Refuge System. The Act also grants the Secretary of the Interior broad withdrawal authority including explicit authorization to withdraw land from operation of the 1972 Mining law.

The Act mandates tha BLM lands must be managed in a manner which protects the environment. Moreover, if an area is of "critical environmental concern" its environmental value must be protected.

Mining Activity Within National Park System Areas (1976)
(16 U.S.C. 1901-1912)

Description: Makes mining activities in national parks subject to such regulations as the Secretary of the Interior finds necessary or desirable for the preservation and management of those areas. Withdraws all park system units then open from further operation of the mining laws.

In addition to these laws, Executive Order No. 10355 (17 FR 4831; May 26, 1952) delegates to the Secretary of the Interior the authority to withdraw land, whether implied or specifically authorized by statute (42).

State and Local Government

Many State agencies and local Government entities, principally counties and municipalities, enforce land use controls that can restrict mining activities. These controls often serve a variety of purposes (zoning, noise abatement,

planning, etc.) that include environmental protection objectives. Florida, the major phosphate producing State, provides an excellent example of the types of land use controls a mine operator can encounter below the Federal level. In fact, this State probably has the widest spectrum of land-use planning controls in the country (12). Nevertheless, land use regulations analogous to some of these controls can be found in other phosphate rock producing States, albeit restrictions appear to be minimal at the county and local levels in most Western mining regions.

In Florida, counties and municipalities issue most land use plans and regulations, although the State retains a few controls. The Florida State Comprehensive Planning Act of 1972 established a State comprehensive planning process. Under the act, mining plans and operations must be coordinated with land planning at all levels of government (18). The Florida Environmental Land and Water Management Act of 1972 also established a State program to protect environmental, historical, and natural areas of regional or statewide significance. In addition, it established the DRI program discussed previously (18).

In several Florida counties, zoning ordinances and land development guidelines balance mining with other land uses, including parks, wildlife refuges, etc. According to a Polk County zoning ordinance, phosphate rock mining is classified as "a special planned unit development" permitted only if a mine plan is submitted directly to the County Board of Commissioners (18). The county also requires an impact assessment as a prerequisite for any land use ruling on proposed mine development or for a zoning variance regarding mine activities that would disturb more than 50 acres of land. the rezoning process places most of the responsibility for data generation on the mine developer.

MINE RECLAMATION REGULATIONS

Federal

The only Federal environmental law enacted to regulate mine reclamation (the Surface Mining Control and Reclamation Act of 1977) is limited to coal mining operations. On Federal land, however, reclamation is required after mining any mineral, including phosphate rock. This reclamation is controlled to some degree by the BLM through its mineral leasing authority. Before granting a mineral lease, the BLM must approve the proposed mining plan, including intended reclamation practices (18). The Bureau can stipulate what reclamation procedures will be followed to minimize environmental damage.

New Federal controls for non-coal mine reclamation have been considered in recent years. The EPA proposed in 1978 that certain portions of the act be applied to phosphate rock mine reclamation (36). Subsequently, a study required by the Surface Mining Control and Reclamation Act reported that sections of the act were suitable for regulating most phosphate rock mining (7). Thus far, however, no additional reclamation laws have been enacted by Congress.

State

State and local laws account for virtually all of the environmental regulations governing reclamation practices in phosphate rock mining. These laws have similar reclamation objectives, but, as seen below, the States differ in the scope and specificity of their regulations. Florida alone has a radiation control standard. Other differences between the States include different time periods allowed for reclamation and minor variations due to topographic diversity.

Florida (7, 59).--As the largest U.S. producer of phosphate rock, Florida has the most imposing and specific reclamation laws in the country. Chapter 16c-16 of the Florida Administrative Code and Chapters 211, Florida Statutes, constitute the State's mine reclamation law. Under Florida law, all phosphate rock mines active after July 1, 1975, must be reclaimed soon after operations cease. Reclamation of mines closed prior to that date is supported in part by a State severence tax on phosphate rock. Also, an ad valorem tax credit is given to firms that reclaim any phosphate rock mine.

Florida law mandates a specific reclamation schedule. Reclamation under an approved program must begin within 18 months after mining ends; for settling ponds, the waiting period cannot exceed 10 years. All reclamation programs must be completed within 4 years of their initiation. A progress report must be submitted each year for every reclamation program that is underway.

A mine reclamation plan must be submitted to the Florida Department of Natural Resources for approval at least 6 months prior to the date that restoration is scheduled to begin. The reclamation program must meet certain minimum Federal and State standards regarding water quality, soil stabilization, health and safety, and other natural resources. Some of the standards are as follows (7).

- Grading or slopes.--Peaks, ridges, and hills must be blended; slopes no steeper than four units horizontal to one unit vertical (4h:1v); grade to avoid collection of stagnant water; create lake bank side slopes no steeper than 4h:1v; subaqueous slopes no steeper than 4h:1v to a depth of 6 feet; no permanent water body less than 3 acres; lake minimum depth of 6 feet.

- Revegetation of reclaimed area.--Eighty percent of reclaimed area must be revegetated except for permanent roads; bare areas no greater than 1/4 acre should use indigenous species.

- Site cleanup.--All visible debris, litter, junk, worn-out or unusable equipment, footings, poles, piling, and cables should be removed; rocks or boulders must be distinctly visible or buried at least 4 feet deep.

- Structures.--All temporary mining sheds shall be removed.

- Solid waste.--Inform State of quality, source, and future disposition.

- Flooding.--Endeavor to eliminate floods caused by "silting or damming of stream channels, slumping or debris slides, uncontrolled erosion, or intentional spoiling or diking."

- Chemical ponds.--Water discharged must meet effluent standards.

- Lakes.--Lakes must not contribute to soil erosion, stream pollution or jeopardize health, safety, or property; must be able to support fish and other wildlife and allow recreation; must be free of toxic or harmful substances or those that create a nuisance from color, odor, or other conditions.

In addition to State law, five central Florida counties with phosphate rock mining (De Soto, Hardee, Hillsborough, Manatee, and Polk) issue and enforce their own reclamation ordinances. Many of these county laws predate State reclamation standards and some are more stringent. For example, bonding to guarantee reclamation is required by each of the counties, but not by the State.

North Carolina (7, 18, 20).--The North Carolina Mining Act of 1971, as amended, requires that a State mining permit include an approved reclamation plan that addresses the following:

- Proposed action to protect adjacent surface resources.
- Specifications for surface gradient restoration suitable for future proposed use and method of implementation.
- Manner and type of revegetation.
- "The type of vegetative cover and method of its establishment shall be specified, and in every case shall conform to accepted and recommended agronomic and reforestation restoration practices."

All mined land must be reclaimed with 2 years after completion or termination of mining in any given segment of the permitted area. A report is due within 30 days of mine closure, or within 30 days of the permit's anniversary. Reclamation bonds must be posted by the mining company with the State's Department of Natural and Economic Resources.

Tennessee (7, 18, 34).--The Tennessee Surface Mining Law, implemented by the Department of Conservation, governs reclamation in the State. The law requires that a reclamation plan accompany mine permit applications. This plan must include a description of postmining land use and a guarantee to perform the following:

- Regrade to approximately original contours.
- Eliminate all highwalls, spoil piles, and water-collecting depressions using only stockpiled overburden.
- Control water drainage and silt control and soil erosion pollution of streams and other waters.
- Revegetate with appropriate grasses and/or trees.

All reclamation for each acre must be completed within 1 year after mining ends on that acre. Additionally, to assure reclamation, a bond or cash deposit of at least $600 per acre must be given to the State before mining begins. The State holds this amount until vegetation has been successfully reestablished.

Idaho (11, 18).--The Idaho Surface Mining Act regulates mine reclamation activities in the State. The law requires reclamation when exploration or surface mining disturb 2 or more acres of land. Under the law, mine operators must fill a reclamation plan prior to mining in order to specify what will be done to comply with State requirements. The Department of Land is the State reclamation enforcement agency.

The State requires that the following reclamation actions be performed:

- Level ridges and overburden piles.
- Control erosion of overburden piles.
- Control water runoff that result in stream or lake siltation.
- Prevent erosion in abandoned roads.
- Plug exploration holes.
- Revegetate mine areas, overburden piles, and abandoned roads.
- Control tailings ponds.

POTENTIAL ENVIRONMENTAL CONTROLS

In addition to the regulations described, the phosphate rock mining industry faces the possibility of significant new environmental protection controls in the near future. In particular, Federal environmental standards for solid wastes and radiation emissions could be applied to the industry. These standards, along with some analogous State controls, are discussed below.

Solid Waste Regulations

The Resource Conservation and Recovery Act of 1976 (RCRA) could become one of the most complex and far-reaching regulatory controls on surface mining, and has serious implications for the phosphate rock industry (18). When RCRA was enacted, mine wastes were included (Section 1004) among the harmful industrial solid waste materials that the law was intended to regulate. Consequently, in May 1980, the EPA proposed RCRA regulations (40 CFR 260) governing the handling and disposal of certain mining wastes, including those generated at phosphate rock mines. Soon afterward, however, Congress passed the Solid Waste Disposal Act Amendments of 1980, which temporarily prohibited EPA from regulating "solid waste for the extraction, beneficiation, and processing of ores and minerals, including phosphate rock..." The amendments specify that this exemption from RCRA is to remain in effect until 6 months after an environmental impact study of mining wastes is completed in October 1983. As required by the amendments, phosphate rock is one of the minerals on which the study will focus its attention. Thus, the study is likely to influence what solid waste regulations, if any, will be applied to phosphate rock mining.

The States can develop and enforce the waste management programs authorized by RCRA if the programs are approved by the EPA. At present, most States generally exclude mining from solid waste regulation laws (18). However, fugitive emissions and effluents from mining wastes are subject to States air and water pollution controls.

Radiation Standards

In addition to existing radiation limits,[10] there is a distinct possibility that the Federal government may promulgate new radiation regulations intended to control exposure to the radioactive materials generally found in phosphate rock ores. It is conceivable that such regulations would be issued under the Resource Conservation and Recovery Act cited above. Under Section 3001 of the act, the EPA classified phosphate rock mine wastes as hazardous due to radioactive content in 1978.

During the 1970's, following the identification of potential health problems associated with home construction on uranium mill tailings in Colorado, the EPA began investigating the effects of uranium known to be present in the waste products of phosphate rock mines (9). The Agency initiated several studies to quantify the magnitude of radiation in reclaimed mine areas in Florida. Interim reports concluded that under worst case conditions there was a calculated health risk associated with home construction in these areas (9). However, this conclusion was based on extrapolation of health effects recorded at higher exposure levels and assumed that only zero risk was acceptable (9). Most investigators agree that additional study is needed before firm conclusions can be drawn regarding the potential hazard posed by radioactive emissions in phosphate mine wastes. Nevertheless, some EPA studies have recommended that regulatory controls (restricted access, and specific reclamation practices) be placed on certain mined areas to reduce exposure of the general

[10] Worker Health and Safety standards enforced by the Mining Safety and Health Administration and the Occupational Safety and Health Administration (U.S. Department of Labor) already limit employee exposure to radiation at phosphate rock mines.

public to radioactive emissions (48). As a result of EPA findings, Hillsborough County in Florida has imposed a moratorium on building in reclaimed phosphate rock mine lands (18). In other States, such as North Carolina, broad radiation emission control laws conceivably could be applied to phosphate rock mines, although they were not specifically enacted for that purpose (17).

Future Federal regulation of radioactive emissions at phosphate rock mines may be contingent on the results of the environmental impact study of mining wastes ordered by the Solid Waste Disposal Act Amendments noted above. The EPA has indicated that radioactivity in phosphate rock mine wastes will be one subject of the study (15). At this point, however, so little is known about mine radiation control technology and the long-term effects of low-level radiation that it would be premature to speculate about what specific regulations could be issued.

ADDITIONAL LOCAL GOVERNMENT CONTROLS

Various county, regional, and municipal agencies enforce environmental laws and land use regulations that can affect phosphate rock mining. County and local governments can issue zoning and building codes which mine operators must satisfy. In addition, mining companies in some areas must accommodate local pollution, health, and drinking water ordinances (9). Florida has very stringent county and local controls on phosphate rock mining. However, such controls apparently are minimal or absent in many Western producing areas.

County governments administer most of the land-use regulations on mining in Florida (17). Five counties in the State have issued excavation or earth-moving ordinances to control phosphate rock mining (10). These ordinances all require a zoning variance based on the production of a conceptual master plan, a permitting procedure that allows ongoing monitoring, and annual detailed plans and reviews of the operation. The annual reviews require information on mining methodology, reclamation progress, and compliance with numerous environmental considerations including the following (10).

- Dam construction and settling ponds.
- Easements of adjacent owners.
- Soil vibrations and noise.
- Flood plain restrictions.
- Monitoring requirements for water and air, groundwater, rainfall, sewage effluent, radiation, etc.
- Reclamation standards with respect to slopes, lake depths, time limitations, etc.

To enforce these restrictions, several counties require evidence of financial responsibility or require bonds (up to $2,000 per acre) to be posed on lands to be mined. County officials in Florida also review and rule on the DRI reports for major mine projects, which were previously cited (9).

CHAPTER 3.--THE COST OF ENVIRONMENTAL PROTECTION CONTROLS

This chapter identifies the costs associated with each of the categories of regulations examined in chapter 2. These costs include the restraints imposed by regulations as well as the expenditures necessary to achieve compliance. (Refer to the preceding chapter for a description of specific regulations related to the costs discussed below.)

ENVIRONMENTAL ASSESSMENT COSTS

Preparation of Federal EIS's on phosphate rock mining cost both time and money. The companies that proposed the mine projects covered by the EIS's cited in Chapter 2 had to develop much data and conduct many analyses, and in most cases were required to reimburse the Federal agencies involved. Two companies in Florida reported that the EIS's on their projects cost them about $2 million each and required at least 3 years to complete (27-28). In North Carolina, another company paid nearly $700,000 and needed almost 2 years to finish its EIS (51, 56). These expenses are confirmed by collateral information from Federal agencies which prepared regional EIS's on the phosphate mining in Florida and Idaho; each of these two studies required $2 to $3 million and more than 3 years to complete (2, 25).[11] Although these latter two EIS's were funded principally by the responsible agencies, the companies involved had to provide analytical support and could not plan or schedule mine development with any certainty while the studies were underway.

In addition to providing EIS support to Federal agencies, phosphate mining companies must prepare studies of their projects for environmental impact assessments required by State and local authorities. For example, the DRI reports required in Florida and noted earlier can take several years to prepare and were estimated to cost an average of more than $250,000 in a 1978 study (57). Several phosphate mine operators claim that this cost now easily exceeds $1 million (10). As with most EIS's, the DRI costs are borne principally by the operator.

AIR QUALITY CONTROLS COSTS

Prior to the recent Federal air quality regulations reviewed in the preceding chapter, domestic phosphate rock mines were operating under air pollution controls either initiated by the State or mandated by State-implemented programs of the Clean Air Act. The annualized installation and operating costs of these preexisting controls was calculated by the EPA to be about $0.35 per ton of phosphate rock at new Eastern U.S. mines and approximately $0.87 per ton at new Western mines (49). It is estimated that the additional Federal performance standards would increase control costs by $0.02-$0.07 and $0.08-$0.28 at Eastern and Western mines, respectively (49).[12] EPA computations indicate that compliance with the new standards would increase mine production costs less than 0.2 percent (46).

The EPA also has stated that the cost of removing air pollutants under the Federal standards for phosphate mining is much less than analogous costs in other domestic industries (45). In a public review of the standards, however, the phosphate industry claimed that some of the new regulations and implementing technology are neither feasible nor economic (8, 45). The industry did not contest the assertion that the air standards account for only a small portion of total production costs and are minor compared with other control expenditures.

[11] It should be noted, however, that these studies examined more projects than are encompassed by most EIS's on phosphate mining.

[12] The greater costs for the latter mines reflect their smaller capacity as well as the higher percentage of fines and lower moisture in Western phosphate rock ores (49).

WATER QUALITY CONTROL COSTS

As described in chapter 2, Federal water quality standards were issued for phosphate rock mines in 1977 and 1978. The estimated cost of meeting such standards when they were promulgated is shown in table 3. The lower costs shown for Western mining is attributable to more favorable mineral characteristics, process practices, and climatic conditions (3).

Some caveats apply to table 3: The costs shown represent the expenses of a hypothetical mine that had no preexisting effluent controls and would require BAT to meet the Federal standards. Most phosphate mines, however, already had installed pollution abatement controls and were operating under State regulations at or near compliance with the Federal standards prior to their promulgation (3).[13] Moreover, the EPA allowed the industry to achieve compliance by using BPT rather than the more costly BAT.[14] Thus, EPA calculations indicate that the cost of meeting the Federal standards was a fraction of the costs shown in table 3, and accounted for less than 8 percent of total mining and beneficiation costs (3).

Despite the foregoing qualifications, table 3 is useful because it provides some basis for estimating the cost of complying with water quality regulations that meet existing Federal standards. These costs may be conservative for most phosphate mines in view of the more strict State regulations cited in chapter 2.

The section 404 dredge and fill permit described in chapter 2 has been a prerequisite for phosphate mine projects in at least two States (Florida and North Carolina). The permitting process in each State took more than 3 years to complete; moreover, one of the section 404 permits required an EIS that cost a phosphate mining company more than $600,000 to prepare (56). The impact of section 404 permitting on industrial activities, including mining, currently is being evaluated by the Office of Technology Assessment for Congressional review of the Clean Water Act in 1983 (41). Mine permitting costs under section 404 of the act and other environmental laws is discussed in more detail in the last section of this chapter.

In Florida, a State program that parallels the section 404 permitting procedure requires two additional dredge and fill permits in order to mine "wetland" areas (9). It has been estimated that strict enforcement of the water pollution regulations regarding these permits would

[13] A study by the National Academy of Sciences (19) reported that the cost of meeting State wastewater regulations in Florida (for slimes and tailings disposal) totaled $0.13 and $0.14 per ton of product at existing and new mines, respectively.

[14] The Agency originally proposed BAT controls before the final standards were issued, and still retains the option to issue requirements for such controls (14).

TABLE 3. - Cost of complying with water quality standards for domestic phosphate rock mines in 1977 (18)

Mine location	Investment	Annual	Per ton of product	Total industry cost
Eastern States.....	$17,213,500	$3,182,000	$1.59	$67,322,000
Western States.....	2,487,500	541,300	1.07	5,529,000

Notes: Typical mine capacity used in estimating cost was 2 million tons per year for Eastern mines and 500,000 tons per year for Western mines.

Cost estimates assume an annual recovery of capital at 10 percent interest and depreciation of pond construction cost over 20 years, process equipment over 10 years, and handling equipment over 5 years.

prevent the mining of up to 40 percent of phosphate resources in central Florida (10). A further discussion of the costs involved in the regulation of these wetland resources begins in the next section.

COST OF LAND-USE RESTRICTIONS

As described earlier, a combination of environmental protection policies and land-use laws, particularly at the Federal level, can significantly reduce the amount of land where mining is permissible. The costs imparted by such restrictions can have the following results: First, the restrictions decrease the amount of mineral resources available for development; second, delays and uncertainties regarding the application of restrictions can deter mine investment and increase project expenditures.

In order to clarify the cost of land-use restrictions on phosphate mining, two case studies of potentially significant resource areas (Florida's wetlands and certain Western Federal lands) under government land-management controls are examined here.

Florida Wetlands

Certain parts of Florida known as wetlands provide an excellent example of phosphate rock resource areas where mining activities are very restricted and, in some cases, entirely prohibited by State environmental protection agencies. These wetlands are low, water-saturated areas (such as swamp and marsh) that serve as wildlife habitats and protect water quality. Florida contains over 20 percent of all U.S. wetlands, which are gradually being eliminated (at a rate of about 50 square miles per year) by encroaching development, especially urbanization, highway construction, and agriculture (39). Consequently, there is strong opposition to mining phosphate rock in these areas of the State (57).

The Florida Department of Environmental Regulation and the Southwest Florida Water Management District control access to phosphate resources in wetland areas through their dredge and fill permitting authority (9). Currently, such permits are granted only for wetland areas previously modified by agriculture or other land-use activities. This policy applies to all wetland areas, including those on tracts already purchased by mining companies. Wetland reclamation techniques proposed by the industry presently are viewed as unproved by the State (22).

An attempt was made in this study to identify some of the potential costs of prohibiting phosphate rock mining on wetlands and other environmentally sensitive areas of Florida. These costs, identified in terms of resources relinquished, were determined by (1) surveying all phosphate rock mining companies in Florida to determine their reserves on wetlands, and (2) assessing the phosphate reserves on Florida lands that were designated as environmentally sensitive in the Bureau of Mines Minerals Availability System (MAS). The results of these efforts are described below.

The Survey

In March 1982, all 15 phosphate rock mining companies in Florida were requested to furnish their estimates of recoverable phosphate rock that would be lost if the State prohibited mining within wetland areas on their properties. Every company responded with estimates of their reserve base[15] in wetland areas and in all of the properties they owned. This information revealed that the total reserve base in wetlands owned by the companies amounted to 458 million tons, or approximately 17 percent of all their holdings. The wetlands contained 3 to 55 percent of the reserve base owned by individual companies.

[15]See table 1 for definition of "reserve base."

The total wetland tonnage on company lands equates to about 11 years of domestic consumption at 1981 demand levels. With a conservative appraisal of $1 per ton of reserve base, the same assessment given in a 1978 study (6), tonnage would be valued at $458 million. If produced, the value of this tonnage (at average f.o.b. mine prices in 1981) could increase to at least $12 billion. Moreover, the quantity and value of wetland resources discussed here does not include additional amounts of phosphate rock that may be in other wetland areas not on mine company properties, nor do these estimates include phosphate rock that may be in wide buffer zones around wetland areas where mining also may be excluded.

Many factors (such as ore grade and depth) must be considered before it is assumed that the reserves in all wetland areas can be mined economically if access were permitted. In addition, the reserves in the areas discussed here account for less that one-fifth of total Florida phosphate reserves. Nevertheless, the magnitude of reserves relinquished in the wetlands reveals the need to consider the potential for such losses when evaluating the cost of environmental regulations that prohibit mining.

MAS Evaluation

Data from the MAS covering 79 mine properties in Florida were used to further clarify the amount of phosphate rock reserves that may be on environmentally sensitive lands in the States, and thereby could be subject to mining restrictions. For each developed and undeveloped property, the MAS evaluates the sensitivity of the natural environment to mining. This evaluation is given for specific features (vegetation, water, wildlife, etc.), and includes estimates of persistence as well as degree of impact (significant, moderate, etc.).

Ten of fifty-one undeveloped Florida phosphate properties examined in the MAS are designated as lands with a "significant" or "extreme" environmental sensitivity to mining. Although the actual impact of future mining may prove to be more moderate, this current perception of significant or extreme environmental disturbance is important because such perceptions among the general public or regulatory officials could be a major obstacle in obtaining permission to mine deposits on these properties. According to the MAS, the 10 properties contain 557 million tons of phosphate rock.[16] This amount could have a product value of at least $15 billion (based on average 1981 f.o.b. mine prices), and equals 26 percent of the reserves on all the undeveloped mine properties identified by the MAS.[17]

Both the company survey and the MAS exercise support the contention that environmental protection laws prohibiting mining could significantly affect the phosphate rock industry in Florida. comparatively little MAS data on phosphate rock properties outside Florida precluded a similar evaluation of other States at the time of this report. However, it was observed that only a few of these properties were identified in MAS as susceptible to significant environmental damage from mining.

Western Federal Lands

The total amount of phosphate rock resources on the Federal domain, and therefore the quantity subject to national land management controls, is not precisely known. However, similarities in the distribution of phosphate reserves and public lands suggests that such controls should be considered in the development of the reserves in Western States. Table 4 illustrates that, although only a small portion of domestic phosphate production currently is drawn from Federal lands, large phosphate resources are in Western States where there is extensive Federal land ownership.

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[16]Based on a valuation of $1 per ton, this tonnage would be worth $557 million.

[17]Another study concluded that 27 percent of Florida phosphate rock reserves in 1978 were on land judged to be significantly and/or extremely sensitive to mining (57).

TABLE 4. - Federal land ownership in States with significant phosphate rock production and reserves

State	1981 production,[1] million tons	Reserve base,[2] million tons	Percent of State acreage owned by Federal Government[3]
Florida	47.2	2,590	12
North Carolina		1,290	7
Utah	[4]5.6	831	64
Wyoming		690	49
Idaho		235	64
Tennessee	1.6	29	7

[1]Stowasser (30).
[2]MAS data.
[3]BLM (38).
[4]Includes minor output in Alabama and Montana.

Most of the lands of Idaho, Utah, and Wyoming (which contain one-third of the total U.S. reserve base shown in table 1) are managed by Federal land agencies. Approximately 25 percent of the phosphate outcrop areas in Utah are on Federal lands (21). In fact, virtually all known and suspected phosphate rock deposits in the Western States are on or near the Federal domain. Thus, environmental policies that preclude further mining on these lands could seriously limit the development of Western phosphate rock resources. Such limits on mining cannot be ignored if these resources are to be a credible alternative to Eastern production.

In addition to the mineral resources left unexploited when mining is prohibited, companies may encounter delays while negotiating with Federal land agencies for access to deposits. Policies concerned with environmental degradation often lead to lengthy government assessments of resource values and options. The resulting delays reportedly can exceed 2 years, and may extend mine project completion time by more than 40 percent (21). Among the problems cited by industry are "insistence on supplying voluminous data not required by regulation, undue interference in claim development, exceeding authority under the regulations, refusal to approve operation plans because of busy schedules, and staffing turnovers which require new initiatives to speed approvals" (21).

Federal decisions regarding the disposition of phosphate rock leases in the Osceola National Forest in Florida and national forest lands in Idaho have been pending for nearly 15 years. Also, long-proposed phosphate leases in the Los Padres National Forest of California may not be resolved in this decade (50). Such lengthy lead times to open a new mine increase the risk of investors by making them more vulnerable to changes in economic conditions as well as alterations in contractual terms stipulated by the government (26). Since 1972 and 1974, when Environmental Impact Statements were initiated for phosphate mining in the Osceola and Idaho National Forests, mine investment costs (according to changes in the Producer Price Index) have grown by 136 percent and 70 percent, respectively. Presumably, such increased costs eventually would be passed on the consumers in the form of higher prices. How much these higher prices might reduce industry competitveness is uncertain. (A related discussion of delays in mine permitting follows later in this chapter.)

MINE RECLAMATION COSTS

The cost of reclaiming phosphate rock mined land varies considerably, principally as a function of earthmoving (i.e., volume and distance) and revegetation (i.e., seed, saplings and topsoil) requirements (55). Ultimately, these requirements, and the consequent reclamation costs, depend on the type of mined

land involved and the use intended for the reclaimed land. For example, the cost of reclaiming a phosphate rock mine site for pasture can be as little as $600 per acre, but the cost of reclaiming the same area for residential housing can be more than $2,000 per acre.

Table 5 illustrates the minimum reclamation costs reported for various types of phosphate-rock-mined lands in Florida. A 1978 report indicated that such costs translated into incremental costs of about $0.37 per ton of product at existing operations and $0.46 to $0.62 per ton of product at new mines (19). These estimates are corroborated by two other reports (18, 57). Average reclamation costs in 1982 are estimated to be $3,000 to $4,000 per acre (55).

TABLE 5. - Cost of reclaiming various types of phosphate rock mine lands in Florida (59)

Land type	Average cost per acre
Clay settling areas.....	$2,117
Mined-out areas.....	1,022
Hydraulically mined areas..	563
Sand tailings areas.....	1,330
Other areas.....	2,472

Reclamation costs at an Idaho phosphate rock mine are shown in table 6. The mine operator claims that his total reclamation costs are within $50 to $100 of those of other Western phosphate rock mines.

TABLE 6. - Reclamation costs at an Idaho phosphate rock mine (5)

	Cost per acre
Grading and contouring (3:1 slopes).....	[1]$150
Topsoil.....	250
Fertilizer.....	100
Seed.....	100
Total.....	600

[1]Grading some waste dumps at another Idaho mine reportedly cost more than $2,500.

In lieu of a wide range of costs such as those in tables 5 and 6, an average cost of $750 per acre reportedly had been used for reclamation planning in the late 1970's (18).

CURRENT AND POTENTIAL WASTE DISPOSAL COSTS

Solid Wastes

Costs of solid waste disposal at phosphate rock mines are difficult to differentiate from the water pollution control costs discussed earlier because the disposal and water treatment operations are interdependent; e.g., solid wastes such as overburden and sand tailings are used to build settling pond dams where process water is treated by removing other solid wastes. Consequently, very few studies make a clear distinction between solid waste disposal costs and wastewater treatment costs. However, a 1979 study, which identified these costs separately, reported that the cost of solid waste disposal for Florida phosphate mines was $0.13 per ton of product at existing plants and $0.41 per ton at new plants (19). Disposal costs undoubtedly have increased since the report. A study in 1978 revealed that water reclamation and waste disposal costs together accounted for 1 to 2 percent of total capital investment for mining and beneficiation in Florida (57).

Presumably, solid waste disposal costs at phosphate rock mines would escalate if the Resource Conservation and Recovery Act of 1976 were applied to domestic mining. However, published studies of precise costs are not yet available. An EPA study of phosphate mining wastes mandated by recent amendments to the act will include some cost estimates of standard measures to monitor and/or mitigate the impact of these wastes (15). Although the finished study is not required by Congress until October 1983, a draft report may be available for review early in the year.

Radioactive Wastes

As noted in chapter 2, radiation control standards for phosphate rock mining conceivably could be issued in the near future under the hazardous waste provisions of the Resource Conservation and Recovery Act. Under jurisdiction of these provisions, the industry would be subject to all the attendant requirements for control, monitoring, recordkeeping, and reporting. The phosphate industry contends that such requirements would cost "literally millions of dollars" (9).

If regulations were developed for controlling exposure to low-level radiation at phosphate mines and on reclaimed land, substantial compliance costs should be expected because of the extensive solid waste and slime pond areas involved. In 1979, an EPA report concluded that capital costs for radiation controls at a representative Florida mine and beneficiation plant would be at least $2 million, with annual operating and maintenance exceeding $600,000 (33). The same report indicates that an additional cost of $1,100 per acre is needed to reduce exposure levels on reclaimed land. Other estimates by the EPA indicate that building homes on reclaimed land to adequately protect residents from low-level radiation would increase construction costs by at least $2,500 to $3,500 per 1,000 square feet of ground floor area (47). The industry maintains that the projected costs for radiation controls are underestimated (53).

Despite research such as that cited here and in chapter 2, there is not enough information to predict potential radiation control costs with any precision. Nevertheless, much published research reviewed for this study suggests that these costs could amount to several million dollars per mine.

MINE PERMITTING COSTS

In addition to the costs of meeting the environmental standards discussed thus far, the cost of the regulatory process itself deserves attention. The regulatory process referred to here consists of the procedures that a company must follow to gain authorization (permits) for mining from government agencies. These procedures often are governed by environmental protection policies, and entail two costs for the permit applicant: (1) the expenditures to obtain permits, and (2) the time needed to gain all necessary permits. These two cost categories are reviewed below.

Cash Expenditures

Table 7 itemizes the cash costs of applying for permits to open a new mine in Florida. It is estimated that the costs shown have nearly doubled since they were first published in 1978 (4). Various cost models for Florida phosphate mines indicate that such environmental permitting expenditures equal about 1 percent of total capital investment for mining and beneficiation (57).

Officials and consultants of phosphate mining companies in Idaho and Utah report that total permitting costs for recent mine expansion projects ranged from $50,000 to $350,000 (5, 16). They believe that these costs would not differ greatly from analogous costs for new Western mines. The discrepancy between the reported Western costs and the higher costs shown in table 7 is partly due to the misallocation of some Florida costs (e.g., "ground water" and "clay studies" listed in the table support mine development as well as permit requirements and, therefore, should not be wholly ascribed to permitting). However, the greater number of permit requirements in Florida, especially at the county and regional levels (chapter 2) suggests that permitting costs there usually are higher than in the Western States.

TABLE 7. - Cost of applying for phosphate mine permits in Florida (57)

	Average prestartup cost[1]
Monitoring, including studies and reports:	
Radiation monitoring	$25,000
Fluoride, SO_2, particulate	100,000
Water quality	50,000
Clay studies	20,000
Stream flow	50,000
Biological and archaeological surveys	50,000
Ground water	350,000-1,500,000
Surveys and photogrammetry	25,000- 50,000
Local and county permits:	
Mining ordinance (master plan)	75,000
Building permit	5,000
Mining permit	50,000
Regional:	
Southwest Florida Water Management District:	
Water use	50,000
Works of district	10,000
DRI	250,000
State:	
Department of Environmental Regulation:	
Air	30,000
H_2O effluent	25,000
Dredge and fill	50,000
Sanitary H_2O	500
Dike construction	75,000
Department of Natural Resources Master Reclamation plan	50,000
Federal:	
Environmental Protection Agency--National Pollutant Discharge Elimination System (EIS)	125,000
Corps of Engineers--dredge and fill	25,000
Oil spill prevention	2,500
Air (significant deterioration)	15,000
Total	$1,508,000-2,683,000

[1]Excludes management, legal fees, and public relations.

Time Requirements

Phosphate mine companies must apply to regulatory agencies at several levels of government for permits to initiate mining. Permits must be obtained from Federal, State, and local agencies; approval by regional (multi county) authorities is necessary in some areas. Many of these agencies are guided by environmental protection policies.

In Florida, nearly two dozen permits must be granted by at least six agencies before phosphate mining can begin (table 8). Florida probably has the most diverse array of permitting agencies to be found in any phosphate producing State. Nevertheless, the local-to-Federal hierarchy presented in table 8 has parallels in every phosphate mining region.[18] Also, proposals for mining on Federal lands must be approved by even more agencies (e.g., the Forest Service and the Bureau of Land Management) than those listed.

[18]County and local controls appear to be less strict in some Western mining areas.

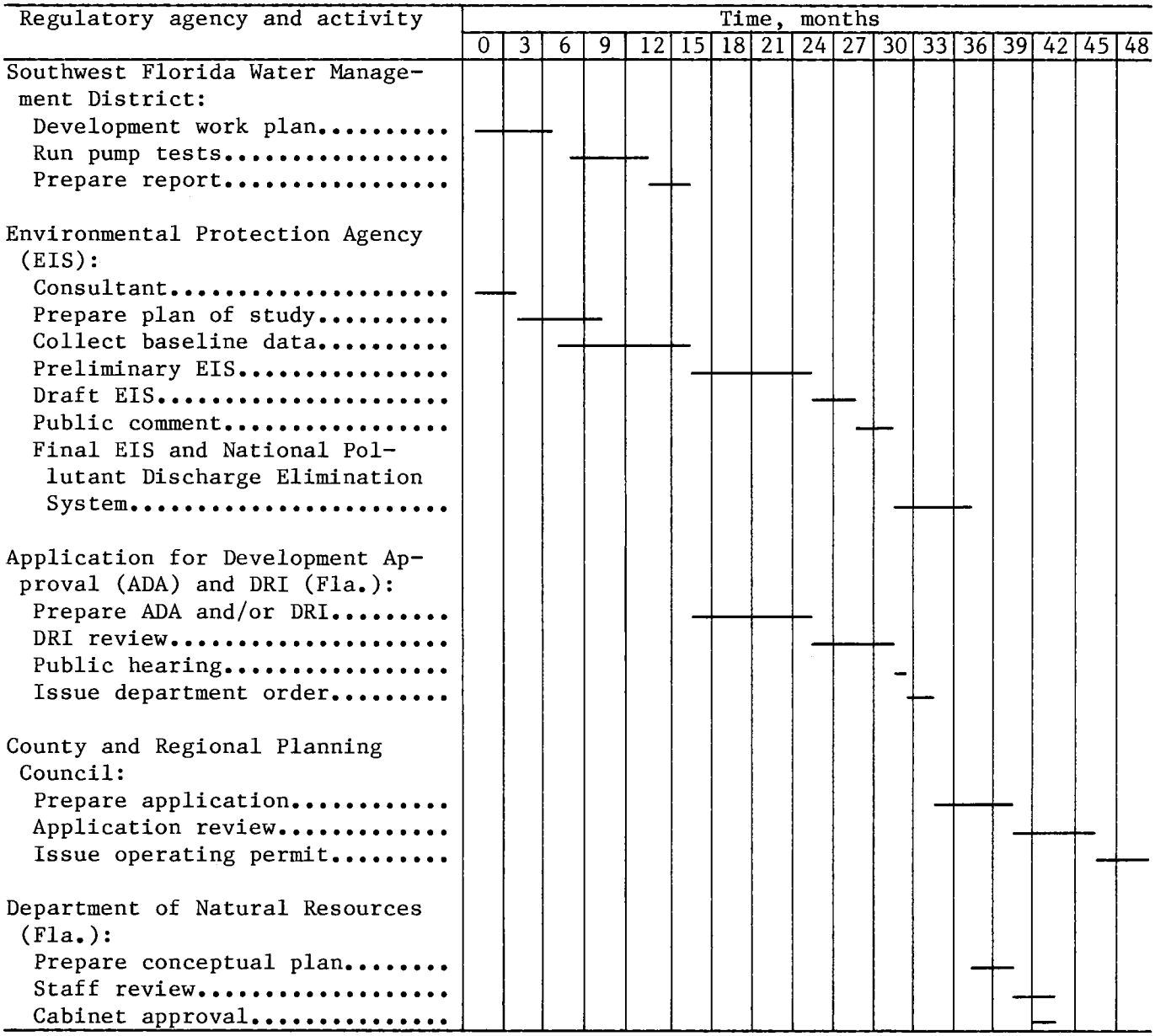
TABLE 8. - Permits required for phosphate mining in Florida (9, 57)

County and Regional.....	Zoning change. Master plan approval. Development order. Operating permit. Building permit.
State:	
Department of Environmental Regulation permits.....	Air quality. Industrial waste water. Dredge and fill. Drainage well. Dam construction. Potable water supply. Sanitary waste.
Water Management District permits.....	Consumptive water use. Water well construction. Works of the district. Management and storage of surface waters.
Department of Natural Resources.....	Reclamation standards.
Federal:	
Environmental Protection Agency.....	National Pollutant Discharge Elimination System (water quality) permit. Air quality standards.
Army Corps of Engineers permit.....	Dredge and fill. Dam construction in waters of the United States.

Several years are required to acquire all of the permits needed by a domestic producer to begin mining phosphate rock. Permitting for a new mine in Florida takes 4 to 5 years (39); a sample permit timetable is presented in table 9. Western phosphate mine operators report that the permitting process usually requires 2 to 3 years on private lands, assuming no litigation (5, 18). Permits for phosphate mining operations on Federal lands can take about 3 to 5 years. For at least one Western mine expansion project, however, all permits were granted in less than 1 year (18).

The permitting process can be lengthy for several reasons. Although individual permitting agencies may respond quickly to a mining application, information requested by these agencies for their decisions can require years of data collection and analysis by the applicant. The time needed to prepare such information is multiplied when similar analyses must be repeated for different permitting agencies. In addition, permit application at one or more agencies are hindered if they are contingent on prior approval by another agency which has had its actions delayed. Further delays may be encountered when different regulatory agencies have conflicting permit requirements.

TABLE 9. - Permitting schedule for a new phosphate mine in Florida (39)



As discussed earlier regarding Western Federal lands, lengthy regulatory delays entail certain costs and risks. At an annual inflation rate of 7 percent, costs can increase by as much as 40 percent in the 3- to 5-year period that a phosphate mining company must wait for all permits to begin mine construction. This situation, coupled with the risk that new permitting problems can arise during such a long period, does not encourage mine investment. If mining is deterred by delays in the permitting process, the forgone opportunity costs would include the value of the unexploited mineral resources; in some cases, such values may be more significant than any of the capital and operating costs discussed thus far.

CHAPTER 4.--THE IMPACT OF ENVIRONMENTAL PROTECTION CONTROLS

This chapter examines the cumulative effects of the individual regulations and costs discussed thus far. Conclusions and recommendations regarding these effects are presented at the end of the report.

SUMMARY OF REGULATORY EFFECTS

The preceding chapters and the studies cited below confirm that environmental protection controls have three immediate effects on domestic phosphate rock mining: The controls (1) increase capital and operating expenditures, (2) limit access to potentially significant mineral resources, and (3) can discourage investment by increasing financial uncertainty and risk. Each of these effects and their consequences are examined in the following discussion.

Increased Expenditures

A study for the Nonfuel Mineral Policy Review conducted by the Department of the Interior in 1979 reported that environmental protection controls will account for approximately 8 to 10 percent of domestic phosphate rock production costs in this decade (18). Cost estimates from the study are presented in table 10.[19] Unpublished data obtained for this report from phosphate producers (35) and Bureau of Mines consultants (54, 58) indicate somewhat lower control costs which vary from 5 to 10 percent of total expenses at individual mines.

[19]A comparison of 1977 data in this table and in table 3 of chapter 3 shows that most of the costs are attributable to water quality controls.

The estimates in table 10 do not include all environmental costs. Not included, for example, are environmental assessment costs and permitting expenditures, which total several million dollars for each new mine, as previously explained. Moreover, the estimates in table 10 do not indicate potential costs associated with solid waste and radiation controls, which could be implemented in the next few years. Such controls were anticipated by those who forecast the expenses shown in table 10, but estimates of these control costs were considered too speculative for inclusion in their projections (18). Nevertheless, for the reasons given in chapter 3, investigators agree that radiation and solid waste regulations could substantially increase future control costs at phosphate mines.

As shown in table 10, environmental control costs are expected to increase in absolute terms, but are predicted to decline in relation to total phosphate mining expenditures during the 1980's. The forecast decline is credible, however, only if it is assumed that industry growth rates can exceed increases in control costs. Phosphate mine companies reportedly have plans to open new mines in the next several years (29). In the 1970's, rapid expansion of phosphate mine capacity due to sharply increased world demand allowed the industry to absorb large pollution control costs by passing them on to an expanding market. Thus, authors of the mineral policy study theorize that renewed expansion of the phosphate fertilizer industry in the mid-1980's will help to mitigate the adverse impacts of new control

TABLE 10. - Major environmental control costs and total production expenditures for domestic phosphate rock mining (18)

	1977	1980	1985	1990
Production costs.....million 1977 dollars..	702	747	865	987
Control costs.....do.....	79	72	74	77
Control costs/production costs.....percent..	11.2	9.6	8.6	7.8

costs (18). At present, however, world economic conditions and industry overcapacity offer little evidence that much expansion will occur. Even a study by the EPA has forecast minimal or no growth for U.S. phosphate mining in the 1980's (46).

There is no consensus regarding the precise impact that control costs have on the competitiveness of U.S. phosphate producers. Presumably, the costs depicted in table 10 will be passed on as higher prices to consumers whenever possible; these prices could affect competitive positions. According to the minerals policy study noted above (18), environmental control costs could reduce the competitiveness of domestic producers. A collateral report further contends that environmental costs will be a contributing factor in the growth of U.S. phosphate imports (21). Conversely, other studies indicate that fertilizer price increases must be very large to diminish demand, and that the environmental control costs of phosphate producers "could be absorbed in the marketplace" (3, 50). Despite these conflicting assessments, it would not be prudent to underestimate the effects of the costs shown in table 10 because such costs could encourage foreign competitors not subject to corresponding expenses.

Under a Bureau of Mines research grant in 1978, an attempt was made to measure certain effects of environmental control costs in the Florida phosphate mining industry (6). The resulting calculations suggest that, if control costs cause one mining company to close, total income-expenditure losses in Florida and the Nation would be at least $124 million (in 1976 dollars). Based on these computations, it appears that such a closure could have an even greater impact on U.S. balance of payments; a one-company shutdown would have reduced phosphate rock exports by $168 million (at 1975 prices.)

Control costs also could affect investment decisions by domestic phosphate producers according to a draft report for the Nonfuel Minerals Policy Review (21). According to this report, U.S. phosphate companies are only minimally involved in foreign operations (which are primarly Government-owned), and therefore are not expected to invest abroad. However, the report states that some investment may shift to other domestic mining activities, particularly in the West.

Resource Restrictions

Environmental protection policies and regulations that prohibit mining on various lands have gained attention in recent years as access to mineral resources has become more restricted. A review of the literature reveals that studies regarding these controls have focused on individual restrictions or relatively few deposits without recognizing the growing amount of resources affected by land-use regulations throughout the country. Land-use controls important to domestic phosphate mining are detailed in chapter 2.

The Florida case study presented in chapter 3 demonstrates the degree of impact that land-use restrictions for environmental protection could have on domestic phosphate mining. (It should be noted that the industry survey and MAS exercise in the case study are only intended to be general indicators of scale in the absence of more precise information.) The case study analysis indicates that environmental policies that prevent mining could affect the disposition of several hundred million tons of the phosphate reserve base in Florida alone. This tonnage constitutes a sizable portion of company holdings, is probably worth at least several hundred million dollars,[20] and would satisfy domestic consumption for more than a decade at current demand levels. Additional details regarding this analysis are presented in chapter 3.

The survey and MAS evaluation support the contention that environmental laws that prohibit mineral extraction could significantly restrict domestic phosphate

[20]Based on a conservative appraisal of $1 per ton of reserve, the same assessment given in a 1978 study (6).

mining, particularly in Florida. Many factors (such as ore grade) must be considered before assuming that deposits in all of the restricted areas would be mined if access were permitted. However, the deposits are economically minable, and companies have expressed an interest in mining some of the restricted areas. Moreover, the magnitude of resources that could be relinquished under the restrictions tested in the Florida case study emphasizes the need to fully consider the results of not exploiting significant resources before implementing environmental regulations that prevent mining.

The Western lands case study in chapter 3 highlights the significance of Federal environmental policies and regulations to domestic phosphate mining. The coincidence of Federal lands and phosphate resource areas indicates that environmental controls governing access to minerals on the public domain could affect most of the known phosphate in Utah, Wyoming, and Idaho. In Idaho, mining firms have been seeking phosphate leases on Federal Lands for more than a decade. These States account for approximately one-third of the Nation's phosphate reserve base (table 4).

Uncertainty and Risk

As shown in chapter 3, at least 3 to 5 years normally are needed to acquire all of the government authorizations necessary to open a phosphate mine in the United States. Many mine permit requirements prompted by environmental protection policies and concerns lead to lengthy, expensive resource assessments and unexpected delays.

During interviews conducted for this report, phosphate mine company representatives expressed anger and frustration with the increased costs and uncertainties introduced by a long permitting process. An official of one firm asked why a single agency could not act as a clearinghouse for permits to coordinate all agencies involved, and thereby reduce permitting time. The views expressed are not uncommon in other sectors of the minerals industry. Inexplicable permitting delays were the subject of many complaints registered by various mining firms in a public comment period for the Nonfuel Minerals Policy Review (21). Mining companies reported that it was not unusual to wait 2 years or more to receive a prospecting permit, and that permitting delays had lengthened mine projects by as much as 42 percent (21, 40). Faced with such delays, mining firms are hesitant to engage in long-range planning.

Phosphate mining companies have encountered similar delays and uncertainties, which increase costs. At an annual inflation rate of 7 percent, mine development costs could increase by as much as 40 percent in the 3 to 5 years that phosphate companies usually must wait for all mine permits to be granted. In some cases, cost increases can be even more dramatic: Investment costs (according to the Producer Price Index) have grown by 136 percent in the last 10 years that leases and permits have been pending for phosphate mining on Federal lands in Florida and Idaho.

In addition to the implicit financial risks, other uncertainties are introduced by a lengthy permitting period. A phosphate mine operator contacted for this report indicated that he believes the long permitting process increases possibilities for more changes in permit requirements that further add to costs. Such apprehension, coupled with the knowledge that mining may not be approved despite many permitting expenditures, is another disincentive for investors.

If investment is deterred by the permitting process, certain opportunity costs are incurred. These costs include the value of mineral resources relinquished, unfulfilled employment potential, production forgone, etc. Together, such costs may outweigh even the large capital and operating costs of environmental controls.

CONCLUSIONS

The following can be concluded from the information and analyses presented in this report:

1. Domestic phosphate mining has been confronted with substantial environmental control costs in the past decade and may be subject to large increases in such costs during the 1980's. As noted earlier, environmental protection standards for new mines and potential regulations under provisions of the Resource Conservation and Recovery Act are the most probable sources of additional new control costs. There is evidence that the phosphate mining industry may not be able to absorb new control costs as well as it did in the 1970's. Consequently, careful attention should be given to the adverse effects that additional control costs could have on U.S. phosphate mining during the next several years.

2. Environmental protection controls introduce significant costs and disincentives to the development of new phosphate mine projects. Investment is discouraged when 5 years and millions of dollars are required to obtain a permit for mining. Examples of the financial risks and uncertainties induced by delays in current mine permitting procedures are given in chapters 3 and 4. By discouraging investments, these subtle effects of the permitting process may prove to have greater impact on the industry than the obvious capital and operating costs for environmental controls. Thus, shorter and more efficient permitting practices are needed.

3. Environmental policies governing land-use controls that prohibit mining have affected the disposition of sizable phosphate resources. As previously shown, impacted resources could total several hundred million tons in Florida alone. A review of pertinent literature reveals that studies of land-use restrictions on phosphate mining tend to focus on limited policies or individual resource areas rather than on the cumulative effect of many restrictions throughout the country. The combined impact of these restrictions must be examined further in order to comprehend the total effect of mining prohibitions on the Nation's capacity to produce phosphate.

4. The coincidence of Federal lands and Western phosphate rock resources indicates that environmental policies that prevent mining on the public domain are key factors that could significantly limit the development of those resources. Consequently, environmental controls that govern access to Federal lands must be considered carefully before it can be assumed that development of Western phosphate resources will compensate for the production losses resulting from restrictions on mining in the Eastern States.

5. Although the precise effects of regulatory impacts on the competitveness of domestic phosphate mining are not well defined, it would be imprudent to ignore such impacts in view of the many costs described in this report. Regulations that account for approximately one-tenth of production costs, diminish access to resources, and retard investment are apt to encourage competition from foreign producers not subject to similar restraints.

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