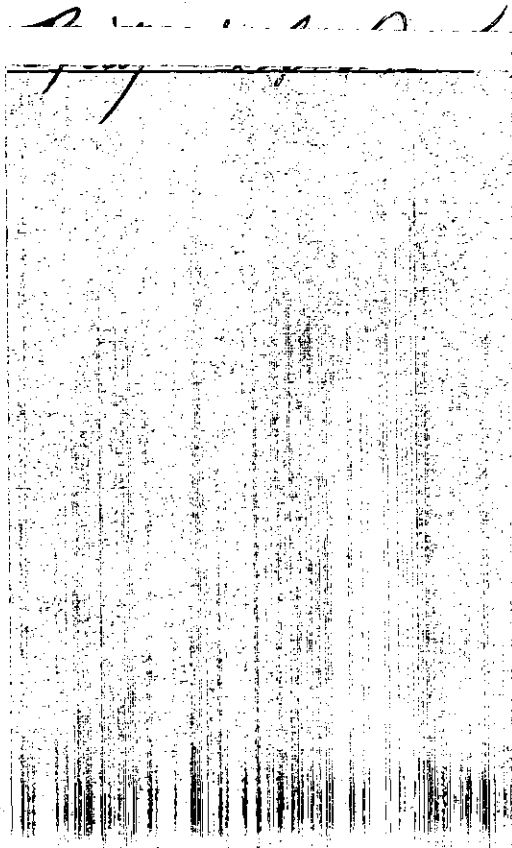


In presenting the dissertation as a partial fulfillment of the requirements for an advanced degree from the Georgia Institute of Technology, I agree that the Library of the Institution shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to copy from, or to publish from, this dissertation may be granted by the professor under whose direction it was written, or, in his absence, by the Dean of the Graduate Division when such copying or publication is solely for scholarly purposes and does not involve potential financial gain. It is understood that any copying from, or publication of, this dissertation which involves potential financial gain will not be allowed without written permission.



OPEN PIT MINING IN URBAN AREAS

A THESIS

Presented to

The Faculty of the Graduate Division

by

Billy Gordon Sanders

In Partial Fulfillment

of the Requirements for the Degree

Master of City Planning

Georgia Institute of Technology

May, 1965

OPEN PIT MINING IN URBAN AREAS

Approved:

*[Handwritten signature]*  
\_\_\_\_\_  
*[Faint handwritten text]*  
\_\_\_\_\_  
*[Handwritten initials]*  
\_\_\_\_\_

Date approved by Chairman: 5 May 1965

## ACKNOWLEDGMENTS

The author expresses appreciation to Professors Howard K. Menhinick and Malcolm G. Little, Jr., of the Graduate City Planning Program of the Georgia Institute of Technology, for their excellent advice and assistance. Appreciation is also expressed to Mr. Nelson Severinghaus, President of Consolidated Quarries Division of the Georgia Marble Company, for his helpful suggestions.

Special thanks are given to Miss Natelle Isley, Architectural Librarian of the Georgia Institute of Technology, for her continued encouragement and for her valuable assistance in obtaining necessary reference materials.

The author dedicates this thesis to his wife, Carolyn, whose understanding, encouragement and assistance made the completion of this work possible.

## TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS . . . . .	ii
TABLE OF CONTENTS . . . . .	iii
LIST OF TABLES . . . . .	v
ABSTRACT . . . . .	vi
Chapter	
I. INTRODUCTION . . . . .	1
Purpose	
Approach	
Thesis Organization	
II. OPERATION OF OPEN PIT MINES . . . . .	4
Aggregate and Crushed Stone Quarries	
Mining	
Processing	
Crushing	
Grading	
Washing	
Sand and Gravel Pits	
Mining	
Processing	
Coal Strip Mines	
Advantages of Coal Strip Mining over Underground Mining	
Mining	
Processing	
Phosphate Pit Mines	
Mining	
Processing	
Dimension Stone Quarries	
Mining	
Processing	
Summary	
III. PLANNING FOR THE LOCATION OF OPEN PIT MINES IN URBAN AREAS. . . . .	16
Considerations in Locating Urban Pit Mines	
Nature of Economic Mineral Deposits	
Protection of Surrounding Land Uses	

Chapter	Page
III. PLANNING FOR THE LOCATION OF OPEN PIT MINES IN URBAN AREAS (Continued) . . . . .	16
Planning Studies	
Geologic Survey	
Economic Analysis	
Transportation Study	
Major Streets and Highways	
Railroad Facilities	
Water Transportation Facilities	
Land Use Study	
Utilities Study	
Summary	
IV. METHODS OF CONTROLLING OPEN PIT MINING. . . . .	23
State Laws	
Validity of State Open Pit Mining Statutes	
Administration	
Permit Requirement	
Bonding Requirement	
Penalties	
Reclamation	
Backfilling and Grading	
Planting of Vegetation	
Prevention of Water Pollution	
Local Controls	
Excavation Ordinances	
Validity of Local Excavation Ordinances	
Administration	
Permit Requirement	
Bonding Requirement	
Penalties	
Operational Provisions	
Restoration Provisions	
Zoning Ordinances	
Matter of Right in Specified Districts	
Mineral District	
Approval Under Administrative Controls	
Nonconforming Uses	
Conclusions	
APPENDIX . . . . .	54
LITERATURE CITED . . . . .	75

## LIST OF TABLES

Table		Page
1.	State Open Pit Mining Statute Provisions. . . . .	25
2.	Sample Local Excavation Ordinance Provisions. . . . .	34
3.	Number of Zoning Ordinances Reviewed, by State and Region. . . . .	40
4.	Zoning Districts in Which Open Pit Mines are Permitted in Zoning Ordinances. . . . .	41
5.	Authority Issuing Special Permits . . . . .	44
6.	Methods Used in Zoning Ordinances to Control Open Pit Mines. . . . .	46

## ABSTRACT

This study was undertaken to produce a guide for open pit mine operators and planners to properly provide for necessary open pit mining in urban areas. The study distinguishes between occasional open pit mining and extensive open pit mining in urban areas, and includes recommendations for each type. Three aspects of open pit mining are discussed: (1) operation; (2) location; and (3) control.

The operation of open pit mines primarily includes removal of overburden, excavation of the minerals and preparing the products for the market. Both the removal of overburden and the excavation of mineral processes generally utilize the many and varied kinds of earth-moving equipment such as power shovels, explosives, draglines, bulldozers, dredges and high-pressure water jets. Processing generally involves crushing, grading and washing.

The two primary considerations in locating open pit mines in urban areas are: (1) providing the mining needs or site requirements, and (2) protection of the surrounding land uses. In order to properly provide for these two important features, in urban areas where mining is extensive the planning commission should undertake certain studies. These include a geologic survey, an economic analysis, a transportation study, a land use study and a utility study.

The methods of controlling open pit mines primarily include state laws and local regulations. The state open pit mining laws are designed to control the rehabilitation of the worked-out mines. Local zoning

ordinances generally regulate the location of open pit mines. Excavation ordinances have been adopted by many localities to control the mining operations and the restoration of worked-out mines.

The major conclusions of this study are: (1) occasional open pit mining in an urban area generally does not constitute a major problem since the adverse features of only a few mines usually can be controlled by normal regulations; (2) where mineral deposits are extensive in an urban community, the planning commission should include open pit mining in the land use plan and provide proper locations and effective controls for the open pit mines.

## CHAPTER I

### INTRODUCTION

Open pit mining has become a problem in many urban areas. Most types of open pit mining have adverse features such as noise, vibration, dust and unsightliness which make them incompatible with many other types of development, especially residential. Operators sometimes leave the mining area in an unsightly and unusable condition after the mineral deposit has been exhausted or the excavation has been discontinued. There are reasons, however, why open pit mining should take place in urban areas.

The materials excavated from rock quarries, sand and gravel pits and other aggregate mines are valuable and necessary for construction purposes. Since rock, sand and gravel deposits are fairly widespread and plentiful, the primary reason for locating these mines in urban areas is to reduce the high cost of transporting the bulky mined material to the construction markets. As more development takes place, more close-in mines are established to provide the necessary construction materials at a lower delivered price.

Other types of open pit mining take place in urban areas because a rare and valuable mineral deposit may happen to lie adjacent to or in the midst of urban development. Many open pit mines were originally located in rural areas, but were later surrounded by expanding urban development. Urban developers often compete with mining operators for

land which may contain valuable mineral deposits.

Where possible, the conflicts and incompatibilities that exist between urban development and necessary open pit mining should be resolved. This could best be accomplished by the combined efforts of the mining industry and the local government.

#### Purpose

There is a lack of cooperation and knowledge among city planners, mining operators and interested citizens in resolving the conflicts which exist between necessary urban open pit mining and urban development. The purpose of the study is to propose methods that could be used by city planners and mining operators to promote a more compatible relationship between open pit mining and orderly urban development.

#### Approach

The objective of this study was accomplished by determining the kinds of open pit mines which are frequently located in urban areas, by analyzing factors accounting for their location, reviewing open pit mining techniques, and by evaluating the necessity for controlling open pit mining in urban areas. Information for this study was obtained from a review of pertinent literature, local ordinances, state laws and court cases; an examination of selected open pit mines and personal interviews or correspondence with persons or agencies involved in or having knowledge of open pit mining operations in urban areas.

#### Thesis Organization

The following chapters are devoted to a detailed discussion of

open pit mining in urban areas. Chapter II discusses the operation of various types of open pit mines with special emphasis on mines that are frequently located in urban areas. Chapter III considers planning for the location of open pit mines in urban areas. Chapter IV sets forth certain legal tools that can be used to control and protect open pit mining and its surrounding land uses in urban areas.

## CHAPTER II

### OPERATION OF OPEN PIT MINES

The purpose of this chapter is to provide a general understanding of the operation of various types of open pit mines. No attempt is made to present a detailed technical description of the mining operations. Five types of mines are set forth and discussed: (1) aggregate and crushed stone quarries; (2) sand and gravel pits; (3) coal strip mines; (4) phosphate mines; and (5) dimension stone quarries. The first two types are frequently located in urban areas since they provide materials for building and construction purposes. The other three are commonly known types of open pit mines and are occasionally located in urban areas.

#### Aggregate and Crushed Stone Quarries

Crushed stone is a major commodity in terms of both tonnage and value. About 700 million tons of crushed stone are produced annually at a value of over \$1000 million.<sup>1</sup> Limestone is the most important rock, accounting for about 75 per cent of the total crushed stone production.<sup>2</sup> Granite, basalt and sandstone make up most of the remaining 25 per cent.

Accelerated highway, industrial and other construction consume the majority of the crushed stone. The remainder is for chemical and metallurgical purposes.

There are two primary steps in the production of crushed stone:

(1) mining and (2) processing.

### Mining

The first task in the mining process is the removal of the layer of topsoil or gravel called overburden between the surface and the stone to be mined. This overburden varies with the location of the mine. The method of removal also varies with the thickness and type of overburden. Where the overburden is shallow and consists of loose soil, it is often removed by a washing process called "hydraulicking." Where the overburden is thick or where hydraulicking is not feasible, power shovels and other earth-moving equipment are used to perform the stripping operation.

The stone is excavated from two different types of quarries, the pit quarry and the bank quarry.<sup>3</sup> The pit quarry is one in which the stone is extracted from below the general level of the surrounding area. The stone is blasted loose by explosives ranging up to 100,000 pounds or more per blast. In most cases, the total blast load is divided into several smaller blast loads of about 100 to 600 pounds which are detonated separately at milli-second intervals.<sup>4</sup> The total blast at any given instant is only that of the small blast load. This method of delay-action blasting is helpful in reducing the noise and vibration produced by the blast. Large power shovels load the loose rock into trucks which carry it to the processing plant. Then hoists, elevators or conveyor belts transport the products through the processing plant.

The bank quarry is one in which the stone is taken mostly from above the level of the adjacent countryside. The rock is broken loose by blasting similar to that performed in pit quarries. The broken rock

falls to the level of the processing plant.

### Processing

The processing plant may be located in the pit, at the surface or in another area some distance from the mine if local regulations permit mining in one district and processing in another.

Until recently the processing plant was a fixed facility that had to be built at each mine and torn down after mining was discontinued. Highly efficient portable plants, mounted on pneumatic-tired wheels, are now becoming more popular.<sup>5</sup>

Processing rock usually involves three operations: (1) crushing; (2) grading; and (3) washing.

Crushing. There are three processes that the rock is subjected to in the crushing operation.<sup>6</sup> First is the primary crushing process which breaks the rock into aggregates with a top size of five inches or more. Secondary crushing processes break the rock into aggregates of smaller maximum size. A third grinding process is used to produce fine or pulverized products such as agricultural lime and cement. All three methods usually produce great quantities of noise, vibration and dust if they are not properly controlled.

Grading. Grading or classification operations normally employ screens of various types. The stone is passed over these vibrating screens which separate the stone aggregates and classify them by size. Air separation is often employed in classifying fine, particle-sized material. Noise and dust are the main objectional features produced by the grading process.

Washing. Until recently stone was seldom washed. However, wash-

ing the stone is now generally practiced to control dust and remove impurities such as soil and clay.<sup>7</sup> A common method of washing is to use water jets upon the stone during its passage over the screens. This method is satisfactory if the stone is merely coated with dust, which is readily separated from the stone. Where the stone is covered with an adhering coating such as clay, scrubbers are used in the washing process. This process involves using churning and grinding action together with metal and chain scrubbing instruments. This phase of the processing operations requires vast amounts of water. It also places an extra load on the waste disposal facilities.

#### Sand and Gravel Pits

More sand and gravel are produced and consumed than any other mineral in the United States.<sup>8</sup> The annual output is more than 820 million tons at a value of about \$1 per ton. Sand and gravel pits and plants are located in every state. Because of the wide distribution, low cost and bulkiness of sand and gravel, production has occurred near points of consumption, primarily highway construction and urban development.

The two main processes involved in producing sand and gravel are mining or excavation and preparing the mined products for the market.

#### Mining

Sand and gravel excavation is essentially an earth-moving activity and utilizes all the equipment common to that industry such as power shovels, draglines, power scrapers, bulldozers, dredges and high-pressure water jets.<sup>9</sup> Most deposits can be mined by more than one method, employ-

ing the many and varied kinds of excavating equipment.

The removal of overburden covering sand and gravel deposits is not usually a big problem. If the topsoil covering is thin, it may be removed in the process of excavation and be permitted to pass through the processing plant to be removed by washing. Where the overburden is thick, it is removed by the same process as the sand and gravel--by earth-moving equipment such as bulldozer, power shovels and draglines.

Sand and gravel are obtained from bank deposits, pits and river or lake beds. The bank deposits are generally excavated by power shovels and draglines, with power scrapers and slackline cableways used to obtain the material from high banks. Another mining process frequently used in bank excavation is hydraulicking which is the process of moving material by the force of water in motion. In general, hydraulicking involves pumping water under pressure through a pipeline to a hydraulic nozzle which is used to direct the stream of water against the face of the bank to dislodge the material. The slurry is then drawn through a pump and moved by pipe to the plant for processing. Utilization of hydraulicking methods depends upon such considerations as the availability of water, type of material to be mined, disposal of runoff and the distance the material is to be moved.

Pit excavation is distinguished from bank excavation by the need for elevating the material and the possibility of encountering ground water. Such deposits are classified as dry or wet pits according to the absence or presence of subsurface or ground water. Nearly all dry pits are excavated by methods comparable to those practiced in bank excavation. Wet pit mining operations differ in that they employ dredges.

in addition to some of the equipment used in dry pit excavation.

Marine deposits are generally excavated by dredges mounted on barges or by special floating dredges. The mined products are loaded on barges which transport them to the processing plants. Processing plants are mounted on some of the large floating dredges. This is more efficient since plenty of water is available for the washing process and the processed material is ready for market when it is loaded on the barges.

#### Processing

The plant arrangement usually is tailored to meet the requirements of the deposits and market specifications of the product. The primary functions of the processing plant are to produce clean and properly sized materials. Processing methods and equipment for sand and gravel production vary according to methods of excavation, nature of the material as it occurs in the deposit and the demands of the markets in which it is to be sold.

Although some of the largest mineral processing plants in the country, handling over a million tons annually, are sand and gravel operations, the trend is toward smaller plants utilizing portable equipment.<sup>10</sup> These smaller portable plants can be moved from deposit to deposit as needed.

Plants range from simple frameworks using one or two screens and washers, to elaborate structures and complicated equipment. However, the average size plant utilizes the tools and equipment of ore dressing which include elevators, conveyors, washers, screens, crushers, scrubbers, dryers, settling tanks and basins and stockpiling equipment.

The washing and screening processes are two of the most significant operations in the production of sand and gravel. They are conducted together, and both require a large amount of water. The average amount of water needed for washing and grading gravel is about 400 gallons per ton.<sup>11</sup> Therefore, the average plant, which produces about 3,750 tons daily, requires a daily clean water supply of about 1.5 million gallons.

### Coal Strip Mines

Originally all commercial coal mining in this country was underground. However, in 1866 a new kind of coal mining, coal strip mining, was introduced. Surface strip mining now accounts for more than one-third of the total coal production.<sup>12</sup>

### Advantages of Coal Strip Mining over Underground Mining

The strip mining method has three major advantages over the underground mining method: (1) it permits more of the coal to be extracted from a seam; (2) the production cost is lower; and (3) it is safer for workers. Modern and automatic equipment has greatly increased the efficiency of coal strip mining. The world's largest power shovels and draglines with capacities up to 200 tons are used to remove overburden up to 100 feet or more in thickness.<sup>13</sup> Modern transportation equipment such as large trucks, conveyor belts and coal pipelines are used to transport the coal.

### Mining

Open pit mining or stripping of coal varies with topography. In mountainous areas where coal seams lie high upon mountain slopes, strip mining takes the form of contour benches and is appropriately called

contour strip mining.<sup>14</sup> Where the topography is level or rolling, stripping is continuous over large areas and is called area strip mining.<sup>15</sup>

In contour stripping, bulldozers excavate a footing for power shovels which remove the overburden and deposit it at the outer edge of the cut. The coal is then excavated by the power shovels. The width of the cut varies from 30 to 100 feet, depending on the steepness of slope and the amount of rock in the overburden. The worked-out mine consists of a relatively flat floor bordered on the uphill side by a vertical cliff (the high wall) and on the downhill side by a ridge of overburden. Contour mining is sometimes followed by auger or punch mining.<sup>16</sup> Augers drill holes up to seven feet in diameter into the exposed face of the coal seam removing coal from a depth of 200 feet. Punch mining involves narrow-seam cutting machines that can penetrate 1000 feet or more into the seam to remove the coal.

Where the topography is level and the depth of overburden is not too great, area stripping is generally used to mine coal. The overburden, which may be more than 100 feet thick, is loosened with explosives and then removed by power shovels, draglines or other excavating equipment. The first cut is a long trench across the area to be mined. After the coal has been removed an adjacent cut is made and the overburden is deposited in the previous cut. The worked-out area is a series of parallel ridges of overburden 30 to 100 feet high, depending on the depth of the cut. The last cut is usually left open.

#### Processing

Processing of coal is similar to the processing of aggregate or

crushed stone. The coal is crushed to desirable market sizes and then passed over a series of screens for grading and classification. The coal is washed as it is screened. Oil is sometimes sprayed on the coal to control dust. Many processing plants produce as many as 25 different sizes of coal.<sup>17</sup>

### Phosphate Pit Mines

Phosphate is presently being mined in Florida, Tennessee, Utah, Wyoming, Idaho and Montana. Florida leads in phosphate production.<sup>18</sup> There are primarily two types of phosphate deposits, pebble and rock, both of which are mined in a similar manner and are discussed together.

#### Mining

The overburden, consisting mostly of sands and clay, ranges from 4 feet to 60 feet in thickness. The phosphate deposit or matrix, as it is called, varies in thickness from 1 foot to about 25 feet.<sup>19</sup> Large draglines, with capacities up to 35 cubic yards, remove the overburden and excavate the phosphate matrix. In mining pebble deposits, the matrix is deposited into a sump and is broken down into a slurry mixture by high pressure water jets. The matrix slurry is then pumped to the processing plant. Rock phosphate is not broken down by water jets; it is loaded on trucks or conveyor belts and hauled to the plant.

#### Processing

Processing of phosphate employs washers, screens, classifiers, drying equipment and large settling ponds. The initial stages of phosphate processing are similar to sand and gravel processing with the material being passed over screens and being washed thoroughly to re-

move impurities.

Large settling ponds are used in the processing operation to allow the fine phosphate particles to settle out and be reclaimed. This settling process takes up to two years. At some mines hundreds of acres of land are devoted to settling ponds.

The phosphate matrix then goes through a drying or decomposing process to obtain products suitable for fertilizer and industrial purposes. There are primarily three types of drying or decomposing processes:<sup>20</sup> (1) acid treatment; (2) thermal reduction; and (3) thermal treatment without reduction. In acid treatment phosphate rock is mixed with sulfuric, phosphoric or nitric acid or a combination of all three. The thermal-reduction method is based upon the smelting of phosphate rock with coke and a siliceous flux in electric or blast furnaces. The process of thermal treatment without reduction consists of heating phosphate with other materials such as an alkali salt or magnesium silicate.

#### Dimension Stone Quarries

The principal types of dimension stones are limestone, marble, granite and sandstone. These stones are mainly used in buildings and monuments. All four are mined in a similar manner and are discussed together.

#### Mining

Dimension-stone mining usually follows a regular cycle of operations that consists of six steps:<sup>21</sup> (1) cutting the stone into large blocks with channeling machines, wire saws or air jets; (2) undercutting the blocks at floor level; (3) breaking the stone free by wedging;

(4) turning the stone down on the quarry floor; (5) subdividing the mass into smaller mill blocks which average about 10 feet X 4 feet X 4 feet in size; and (6) removing the blocks from the quarry floor by a derrick or hoist.

#### Processing

Dimension stone processing entails a series of operations whereby the mill blocks are cut to predetermined shapes as specified by the particular contract the company is fulfilling. These operations generally include sawing, planing, jointing, grinding, cutting, carving, sand blasting and packing for shipment.

#### Summary

Most open pit mines have similar operational features. For example, the excavation of sand and gravel, phosphate and coal involve almost the same type of earth-moving equipment--power shovels, draglines, bulldozers and high-pressure water jets. Blasting is primarily limited to aggregate and crushed stone quarries, with only light blasts being used in other types of mines such as coal strips and dimension-stone quarries.

Most mines utilize large quantities of water in the processing operations. Grading operations are necessary in processing all mine products except dimension stone. Grinding and crushing are characteristics of aggregate stone processing. Common problems of most open pit mines include noise, dust, waste disposal and restoration of the mined-out area.

These five types of mines were selected because they are common

examples of open pit mines and because they are occasionally located in urban areas, particularly aggregate and crushed stone quarries and sand and gravel pits. Many of the mines that were not included such as clay, barite, bauxite and fuller's earth employ practically the same techniques and equipment in their operations as those discussed in this chapter.

## CHAPTER III

### PLANNING FOR THE LOCATION OF OPEN PIT MINES IN URBAN AREAS

Since some types of open pit mines are necessarily located in urban areas and since these mines often constitute problem land uses, their location should be properly planned. Certain considerations that should be observed in locating open pit mines are presented in this chapter. Specific planning studies that would provide information concerning the place in the local land use plan where open pit mines could be properly located are also included.

#### Considerations in Locating Urban Pit Mines

Many factors should be considered in locating open pit mines in urban areas. These include primarily the nature of economic mineral deposits and the protection of surrounding land uses.

#### Nature of Economic Mineral Deposits

Mineral deposits are fixed by nature. Although this fact is important, the value of a deposit is determined by the scarcity and demand for the particular mineral. The quality and extent of the mineral deposit are also major considerations in locating open pit mines. Many mineral deposits, such as stone, sand and gravel are widespread and abundant. In locating these mines, the important consideration is not that the supply of the material is limited, but that the costs of transporting it to the consumer are high.

### Protection of Surrounding Land Uses

The protection of surrounding residents and land uses from adverse mining features such as noise, dust, vibration, traffic congestion and unsightliness should be a major factor influencing the location of open pit mines in urban areas. It might be feasible to conduct blasting tests and record the noise and vibration intensity in order to get a better understanding of how surrounding land uses would be affected. The Hitchcock Quarry Corporation conducted such tests in Fulton County, Georgia, in an effort to determine what effect the noise and vibration of their quarrying blasting would have on neighboring residents and surrounding land uses.<sup>22</sup>

In fitting open pit mines into the local land use plan, careful consideration should be given to the methods by which the worked-out open pit mines could be restored to fit properly into the plan. It is essential that there be as compatible a relationship as possible between necessary open pit mining and orderly community development.

### Planning Studies

Certain studies can help determine proper locations for open pit mines in an urban community. These include: (1) a geologic survey; (2) an economic analysis; (3) a transportation study; (4) a surrounding land use study; and (5) a utilities study.

### Geologic Survey

A geologic survey should be added to the basic planning studies that usually precede the formulation of the land use plan. Private decisions to mine land are invariably determined by the facts of economic

geology. Entrepreneurial decision-making in this field does not have the flexibility available to builders of houses, shops or factories. Because there is less flexibility in fitting open pit mining into the community, all available information concerning the minerals to be mined is needed. A geologic study would provide information on the location and types of local mineral deposits. The study would examine such of their qualities as impurities, depth and extent of deposits, thickness of the overburden and the economic useability of the minerals. Such a study would also point out which land should be reserved for mineral excavation where other land uses are competing for the mineral land.

Unfortunately, geologic study in the preparation of land use plans has been rare. One example of such a study, however, was prepared by the Mid-Willamette Valley Planning Council of Salem, Oregon.<sup>23</sup> The Planning Council, with the aid of the State Department of Geology and Mineral Industries and six of the leading gravel producers in the area, undertook a resource study of gravel and crushed rock within a ten-mile radius of Salem. For the geologic study, use was made of aerial photographs, geologic maps, agricultural soil surveys, maps published by the United States Department of Agriculture, water-well logs from the State Engineer's office and gravel laboratory tests made by the Oregon Highway Department. A geologic map was used to compile rock outcrops, gravels exposed at the surface and gravels with less than ten feet average overburden. All existing gravel pits and stone quarries were plotted on the map.

#### Economic Analysis

Most localities that are engaged in planning undertake an economic

analysis of their local area as one of the basic studies in formulating the land use plan. Most local economic studies are not, however, concerned with a detailed analysis of mineral deposits in the area. An economic analysis should forecast the needs for locally used materials such as stone, sand and gravel. The forecast should be based on an analysis of anticipated construction, cost of mineral land, transportation costs and technological changes in the use of building materials. Materials that may be exported from the locality should be analyzed according to their contribution to the local economy as a raw material sold elsewhere or used in support of local industries. Effects of mining on long-range land values and on local taxation should also be evaluated.

#### Transportation Study

It is important to plan the location of open pit mines with respect to the comprehensive transportation system. Most mined material are bulky and require major transportation facilities.

There are three basic components of the locality's transportation system which should be analyzed. These include:

- a. major streets and highways;
- b. railroad facilities; and
- c. water transportation facilities.

Major Streets and Highways. Existing major streets in the vicinity of mineral deposits and possible mine sites should be inventoried in terms of width, condition and volume of traffic carried. The ability of existing major streets to provide for the efficient movement of the mine products without interfering with other existing traffic should be deter-

mined. Any plans for major street improvements and construction of new thoroughfares should be co-ordinated with plans for the future development of mineral deposits.

Railroad Facilities. A survey of railroads and railroad facilities and their relation to possible mining areas would constitute another major phase of the transportation study. Planning for the location of open pit mines should naturally take into account the location of rail facilities since much of the mined material is normally shipped by rail. The attitude and policy of railroad operators to the extension of spur tracks to serve individual sites should be considered.

Water Transportation Facilities. A study of available harbor and shipping facilities and their relation to rail and highway transportation should be made. The number of barges using the terminal, the types of cargo handled, and any changes in dockage requirements to handle mined products should also be studied. The possibility of mining mineral deposits that lie adjacent to or under bodies of water should be given special consideration. This is important for two reasons. First, most open pit mining operations are large water users. Secondly, the advantage of water transportation for the bulky mined materials might be more fully realized.

#### Land Use Study

Essential to the planning for the location of open pit mines is a detailed land use survey and analysis of the areas surrounding possible mining sites. The exact use of every parcel of land in the vicinity of mineral deposits should be determined and mapped. The amount of acreage for residential, commercial, industrial and public uses should be

compiled. In addition to quantitative data of this type, there should be a qualitative inventory of land uses. Such an analysis would evaluate conditions of structures in the area and define and delineate areas of deterioration and blight.

Information derived from the two types of analysis would help determine the effect that adverse features of mining such as noise, vibration, dust and unsightliness would have on surrounding land uses. It would also provide a guide in determining the proper re-use of the worked-out pit mines.

#### Utilities Study

Open pit mines usually place additional burdens on existing public utilities. Many types of mines use large amounts of water in the excavation and processing of minerals. More and more electrical equipment is being used in mining and some open pit mines are almost completely electrically operated.<sup>24</sup> Waste and sewage treatment and water pollution are problems with many types of open pit mines, especially coal and phosphate mines which produce acid drainage.<sup>25</sup> Therefore, it is of primary importance that information be obtained on the location, capacity and condition of existing utilities in the vicinity of mineral deposits proposed for mining. Plans for utilities expansion should be noted. The utilities study should contain information on water supply and distribution, sanitary sewerage, storm sewers and outfalls, electricity and other related facilities.

#### Summary

Open pit mining of minerals is a land use that is often overlooked

in the process of formulating the local land use plan. Necessary open pit mining is a legitimate land use and should be provided for in a way that will produce as compatible a relationship as possible between open pit mining and orderly community development. This goal is not an easy one because when a planner tries to fit open pit mining into the land use plan, he has a set of objectives with built-in conflicts. These objectives are: (1) that he should make existing mineral resources available for use and reserve mineral lands for mining; (2) maintain low costs for mined construction materials so the public can benefit from lower cost construction; (3) provide land for expanding development; (4) protect residential areas from noise, dust, vibration, traffic congestion and unsightliness of open pit mines; and (5) reclaim worked-out mines for a new land use that will properly fit into the land use plan.

Before the land use plan is prepared it is essential that the mineral deposits, the economics of the mine products, the transportation system serving possible mining areas, the land uses surrounding possible mining sites and utilities in the vicinity of the mineral deposits receive intensive study. Information contributed by the studies discussed in this chapter will serve as a broad foundation to help resolve the built-in conflicts between open pit mining and other land uses. Thus, it will help considerably in providing the proper location for open pit mines in urban areas.

## CHAPTER IV

## METHODS OF CONTROLLING OPEN PIT MINING

There are primarily two significant methods of controlling open pit mining: (1) state laws and (2) local regulations. Each method will be discussed in sufficient detail to explain what it involves and what may reasonably be accomplished through its use.

Voluntary actions of the open pit mining industry, another method of controlling open pit mining, was not discussed in this thesis. Research indicated that most voluntary actions of the open pit mining industry, both individual mining operations and mining associations, are limited to complying with state and local regulations which are discussed in this chapter.

State Laws

Seven states have adopted open pit mining legislation. These are Kentucky,<sup>26</sup> Illinois,<sup>27</sup> Indiana,<sup>28</sup> Maryland,<sup>29</sup> Ohio,<sup>30</sup> Pennsylvania<sup>31</sup> and West Virginia.<sup>32</sup> The legislation was initially confined to coal mining. However, the Illinois Mining Act was declared unconstitutional in *Northern Illinois Coal Corporation v. Medill*, 379 Ill. 98, 72 N.E. 2d 844 (Illinois, 1947), for singling out coal mining operators. The Act was amended to include all types of open pit mines. Indiana, Kentucky and Maryland have also amended their mining acts to include various types of open pit mines. Coal mining, however, is still the major concern of all state open pit mining legislation. State mining statutes

regulate only the restoration of worked-out mines. No statute contains any provisions for the regulation of the location or operation of open pit mines.

#### Validity of State Open Pit Mining Statutes

Except in the case of *Northern Illinois Coal Corporation v. Medill*, which involved the scope of mines affected, the constitutionality of open pit mining legislation has generally been upheld. Two of the leading cases are *Dufour v. Maise*, 309 56 A 2d 675 (Pennsylvania, 1948) and *Windber Construction Company v. Coleman*, 139 A 2d 675 (Pennsylvania, 1958).

#### Administration

State open pit mining laws usually set forth provisions and administrative rules to be enforced by an administrative agency. The agencies responsible for administering the state open pit mining acts are given in Table 1.

The enforcement of a state open pit mining statute usually requires a large staff. The administrative body is usually authorized to hire the personnel needed to properly enforce the law.

#### Permit Requirement

Most states that regulate open pit mining require that the operator obtain a permit before commencing mining operations. The purposes of permit requirements are threefold. First, they furnish the state with a means of enforcing existing regulations relating to the restoration plan, size and type of mines by granting or refusing permits. Secondly, they provide a means of financing the inspections to insure compliance with the regulations. Thirdly, they provide a source of

Table 1. State Open Pit Mining Statute Provisions (Continued on next page)

State	Administrative Agency	Permit Requirement		Bond Requirement	Penalties
		Period	Fee		
Kentucky	Strip Mining and Reclamation Comm. Department of Conservation	1 Year	\$50 + \$15 per acre	\$1000 min. + \$100-\$250 per acre	\$500-\$1500 fine
Illinois	Department of Conservation	1 Year	\$50 one acre, up to \$413 for 50 + \$5 per acre over 50	\$1000 min. + \$200 per acre over 5	\$50-\$1000 fine
Indiana	Department of Conservation	1 Year	\$100 for less than 10 acres \$300 over 10 + \$2 per acre over 50	\$1000 min. + \$200 per acre over 5	\$1000-\$5000 fine
Maryland	Bureau of Mines	None	None	\$2000 min. + \$500 per acre	\$5000-\$10000 fine
Ohio	Division of Reclamation, Department of Natural Resources	1 Year	\$50	\$1000 min. + \$220 per acre over 5	\$300-\$1000 fine
Pennsylvania	Department of Mines and Minerals	1 Year	\$300	\$4000 + \$400 per acre over 10	\$500-\$5000 fine + up to 3 months imprisonment
West Virginia	Bureau of Mines and Department of Natural Resources	1 Year	\$100	\$1000 min. + \$150 per acre over 7	\$1000 fine

Table 1. (Concluded)

R E C L A M A T I O N				
State	Backfilling and Grading	Planting Vegetation	Prevention of Water Pollution	Time Period to Complete
Kentucky	None	"Suitable vegetable cover"	Must cover coal and toxic materials	1 Year
Illinois	Grade to "rolling topography"	Operator selects type of vegetation to be planted	None	3 Years
Indiana	Grade to "rolling topography"	Operator decides upon vegetation to be planted	Acid-forming materials must be covered to a depth of 2 feet	None
Maryland	Angle of pit bank not to exceed 45	Trees, shrubs or grasses	Cover exposed coal	1 Year
Ohio	Grade to gentle rolling topography	Trees, shrubs, legumes or grasses	None	1 Year
Pennsylvania	Angle of pit bank not to exceed 45 degrees	Trees, grasses or shrubs	Cover all exposed coal	1 Year
West Virginia	Grade of isolated peaks to a "rolling topography"	Trees, shrubs, grasses or vines	None	Reasonable Length of Time

revenue for the state.

The person applying for the permit is normally required to submit the legal description of the land, the number of acres to be affected, a topographic map showing the area to be mined, a statement of the right to mine the land and any other facts which the administrative authority deems pertinent. Permit fees, by state, are given in Table 1.

#### Bonding Requirement

All states that regulate open pit mining operations have provisions in their mining statutes for the posting of bonds by mine operators. The typical provision states that no permit shall be issued to any person for the purpose of open pit mining until that person has filed a surety bond of an amount approved by the administrative authority. The purpose of the bond is to insure compliance with the provisions set forth in the law. One important reason for bonding is to make certain that the worked-out mine areas are properly restored. As shown in Table 1, the amount of the bond varies from \$1000 in West Virginia to \$4000 in Pennsylvania.

Bond forfeiture is a problem in some states. Kentucky and West Virginia have been fairly successful in solving their bond forfeiture problems by using more stringent provisions than the other states. The minimum bond in Kentucky is \$1000 with an additional \$100 to \$250 per acre as set by the Strip Mining and Reclamation Commission. This gives the Commission discretion to set the amount higher in order to cover more costly reclamation work. An increase to the maximum usually reduces the attractiveness of bond forfeitures. To further discourage defaults and willful bond forfeitures, the Act stipulates that once a

permit has been revoked or bond forfeited, an operator will not be issued another permit until the infringement which caused him to lose his permit has been rectified.<sup>33</sup> A provision in the West Virginia mining law states that a permit will not be issued to any operator who previously has had a bond forfeited or a permit revoked.<sup>34</sup> A defaulting operator must either reclaim the land involved in the past violation or pay the administrative authority such sum as the authority finds necessary to adequately reclaim the land. Both methods curb bond forfeiting when the bonds do not cover the cost of reclamation. They could probably be used effectively by other states.

#### Penalties

As shown in Table 1, all state legislation concerning open pit mining sets forth penalties for violations of the statutes. The fines vary from a minimum of \$50 in Illinois to a maximum of \$10,000 in Maryland. Illinois imposes a fine for failure to secure a permit before engaging in operations. The other states impose fines for violations of any of the provisions of their open pit mining statutes. In some states each day constitutes a separate offense. The Kentucky statute authorizes the Attorney General to seek an injunction for any threatened violation of the Act.<sup>35</sup>

#### Reclamation

The major objective of state open pit mining legislation is to prevent operators from leaving worked-out pit mines in an unusable and unsightly condition. Table 1 shows that state mining statutes frequently set forth three items to be regulated under the reclamation provisions of the Act: (1) backfilling and grading; (2) planting of vegetation; and

(3) prevention of water pollution.

Backfilling and Grading. Provisions for backfilling and grading are included in almost all state open pit mining statutes. Most of the requirements, however, are vague and do not set forth strict standards to be followed. The Illinois and Indiana Statutes, for example, require the mining operator to grade the mining area to reduce peaks and ridges of overburden to a "rolling topography." The Ohio Act states that the overburden must be graded to a "gently rolling topography." No explanation is given in either statute as to what constitutes a "rolling topography" or "gently rolling topography."

More comprehensive standards for backfilling worked-out mines and grading overburden are outlined in the Pennsylvania Statute. It states:<sup>36</sup>

If the land prior to stripping (open pit mining) was used for growing of farms or where the operation is within 750 feet of any group of five dwellings or certain other structures, the backfill must begin at the top of the high wall and be sloped to the bottom of the pit at an angle not to exceed forty-five degrees.

It also requires that peaks and ridges of overburden be rounded to an extent that will permit the planting of certain types of vegetation. New legislation was introduced in the 1963 session of the Pennsylvania General Assembly to require an open pit mine operator to restore the mined land to its original contour.<sup>37</sup> This bill was not adopted, but the General Assembly is still considering similar legislation requiring the backfilling and grading of worked-out open pit mines.

Most provisions for backfilling and grading do not seem to be adequate to insure proper restoration of mined areas. However, the

provision proposed by Pennsylvania to restore the mined land to its original contour does not seem to be a practical solution. A better solution would be to have a predetermined appropriate re-use for the mined area and require that it be backfilled and graded to the specification of the new land use.

Planting of Vegetation. Table 1 shows that a provision for planting certain types of vegetation in the mined area is generally included in state open pit mining statutes. The purposes for planting vegetation include reducing erosion, improving the appearance of the mined area and making the area productive. The typical provision requires the mining operator to plant trees, grasses, shrubs or other types of vegetation approved by the administrative authority. Kentucky requires a "certain stand" before the bond is released. In Pennsylvania an operator may elect to pay the Secretary of Mines \$60 per acre mined instead of planting vegetation.<sup>38</sup> This appears to be a cost-sharing rehabilitation effort. This type of program is good because the state is usually better equipped than mining operators to restore mined-out areas. The state also has a better opportunity to insure that the area is properly restored in accordance with the overall conservation program.

Some state agencies are permitted to contract with open pit mine operators to provide the vegetation work. For example, the West Virginia University Experimental Station is authorized to plant vegetation in the mined areas, under contract with open pit mining operators.<sup>39</sup> Instead of requiring planting of vegetation in every case, a better solution might be to only require planting where it is necessary in the plan for the new land use that is to occupy the mined-out area.

Prevention of Water Pollution. Although water pollution is a critical problem in the reclamation of many types of open pit mines, especially coal mines, only a few states have included water pollution controls in their mining statutes. The typical water pollution control provision, where it is included, is that all exposed coal and toxic materials shall be covered. Pennsylvania has recently proposed a law providing greater penalties for polluting water. The proposed law states that an open pit mine operator found guilty of polluting water above a specified minimum may have his license revoked and all bonds forfeited, face possible imprisonment and be subjected to a claim for damages equal in amount to the value of any fish and plant life destroyed.<sup>40</sup> This type of water pollution provision appears to have more merit than just requiring the exposed coal or toxic material to be covered because there are other aspects of open pit mining which pollute water. If an operator is faced with rather harsh penalties for water pollution, he will probably make certain that all water polluting elements of the mine are properly controlled.

#### Local Controls

There are two types of local ordinances generally used for the regulation of open pit mining: (1) excavation ordinances and (2) zoning ordinances.

#### Excavation Ordinances

A sample local excavation ordinance survey was undertaken as part of the basic research for this section. A total of 56 cities and counties from all states except Hawaii and Alaska were contacted to see if

they had adopted excavation ordinances. The localities were selected on the basis of their proximity to known open pit mining areas and rate of development. The localities ranged in population from about 25 thousand to 3 million. Of the 44 localities that responded, only 13 had adopted excavation ordinances. These were located primarily in California and in the New England states. The significant provisions of the ordinances from these 13 localities are presented in Table 2. In addition to this survey, an intensive study of local regulation of excavations in California, conducted by the University of California Bureau of Public Administration, was used in the research for this section.

The laws of all 50 states were reviewed to ascertain the authority under which localities had the power to adopt excavation ordinances. Connecticut, Massachusetts and Pennsylvania are the only states having specific provisions in their statutes granting localities the power to regulate or prohibit open pit mining. These provisions are included in the general charter powers. Kentucky is the only state which specifically prohibits local regulation of open pit mining. Evidently cities in other states receive the power to adopt mineral excavation ordinances through a general charter provision. This provision generally states that local legislative bodies may adopt ordinances, regulations and bylaws for the well ordering, managing and directing of the prudential affairs and police of their respective jurisdictions not repugnant to the Constitution and the laws of the state, or of the United States. Counties use implied police powers to adopt excavation ordinances.

Local excavation ordinances are generally used to control the operation of the mines and the restoration of the mined land. They are

generally organized in somewhat the same manner and contain many of the same restoration provisions as the state mining statutes. In addition to the provisions which are similar to those in state statutes, local ordinances contain regulations of mine operation which place more emphasis on protecting the surrounding development from the adverse features created by open pit mining. These ordinances should be restudied periodically and amended, where appropriate, to incorporate new and better developments.

Validity of Local Excavation Ordinances. The power to regulate open pit mining operations through a local excavation ordinance is generally upheld. The leading cases concerning the constitutionality of local excavation ordinances are *Town of Hemstead v. Goldblatt*, 19 Misc. 2d 176, 189 N.Y.S. 2d (New York, 1947), aff'd 82 Sup. Ct. (U.S.) 987; *Farmington River Company v. Town Plan and Zoning Commission of Town of Farmington*, 197 A2d 653 (Connecticut, 1963); *Butler v. East Bridgewater*, 330 Mass. 33, 110 NE 2d 922 (Massachusetts, 1953); and *Town of Burlington v. Dunn*, 61 NE 2d 243 (Massachusetts, 1945).

Administration. The administration of local mineral excavation ordinances is usually performed by the building inspector or by an administrative body. Table 2 shows who administers the ordinances that were reviewed. Administrative rules and regulations are generally set forth in the body of the ordinance. Some ordinances give the administrative agency the power to impose additional requirements pertinent to each specific mine. The Pasadena, California, Ordinance, for example, outlines the items that must be approved by the administrative agency and authorizes the agency to require special precautions neces-

Table 2. Sample Local Excavation Ordinance Provisions

Locality	Administrative Agency	Permit Requirement		Bond Requirement	Penalties	Reduction of Noise and Vibration			Control of Dust and Dirt		Safety	Restoration Plan	Grading, Backfilling and Fill Material	Drainage and Erosion Control, and Prevention of Water Pollution	Appearance and Vegetation
		Time	Fee			General Statement	Buffers	Hours of Operation	General Statement	Sprinkling and Paving					
Farmington, Connecticut	Planning Commission	Until excavations completed	None	20% of estimated cost of excavation	\$100 fine	Adequate provision for control	None	None	Treat area to minimize dust	Access roads	Fence or embankment	Approved by Planning Commission	Graded to conform with restoration plan	Applicant must provide adequate safeguard against erosion. Provide proper drainage.	Screen operation. Seeded with suitable cover crop
Southampton, New York	Town Board	1 year	\$10 to \$25	Decided by Town Board	To \$50 or 6 months in jail or both	Kept at minimum	200 ft. front, 150 ft. side & rear	None	Kept at minimum	Access roads	6 ft. wire fence. Prevent attractive nuisance	Approved by Town Board	Filled to safe angle. No garbage, refuse, or combustible matter.	Pit banks at safe angle to prevent erosion. Ditches must be provided.	As approved in restoration plan
Fulton County, Georgia	County Commission	None	None	None	None	None	400 ft. buffer	7:00 AM-5:30 PM weekdays	None	Mining area, access road, loaded trucks	Only qualified personnel handle explosives	None	None	None	Screen operation
Santa Clara County, California	Planning Commission	None	None	None	None	Reduced to Minimum	25 ft. from all lines	6 AM-10 PM weekdays	None	Mining area, access roads	Fencing & posting	Approved by Planning Commission	Fill to eliminate unnatural steep banks.	Suitable measures must be taken. Proper drainage provided. Settling ponds.	Screen plantings; equipment in garage; mine area maintenance
Pasadena, California	Superintendent of Building	1 year	\$2 to \$5	None	To \$500 + two months in jail	None	None	None	None	None	As authority sees fit to impose	None	1 Horizontal foot to 1 vertical foot. Clean soil or earth	None	None
Belmont, California	Building Inspector	1 year	\$100	None	\$100 or 3 months in jail	None	None	None	None	None	Safe conditions, fencing	None	None	None	None
Los Angeles, California	Building Department	1 year	\$8 to \$10	None	\$300 or 3 months in jail	None	None	Daylight weekdays	Kept at minimum	None	Safe conditions	None	None	None	None
San Diego, California	Building Superintendent	1 year	\$25	Yes	\$500 or 6 months in jail	None	None	None	None	None	Safe conditions	None	1 1/2 Horizontal ft. to 1 Vertical foot	None	None
Easton, Connecticut	Planning Commission	None	None	\$1000 per acre	None	None	None	Daylight hours, weekdays	Exercise suitable control measures	None	Post warning signs and direct traffic	None	No sharp declivities or pits permitted	Must prevent wind and water erosion. Proper drainage provided	None
Denver, Colorado	Manager of Improvements & Parks	1 year	\$250	None	\$300 or 3 months in jail or both	None	20 feet setbacks	None	None	None	5 ft. high fence	None	Fill insofar as practical. No manure, offal, paper, rags, or garbage	Should be thoroughly drained. No excavation within 20 feet of stream	None
Duluth, Minnesota	City Engineer	1 year	\$3	\$10,000	Court decides	None	None	None	None	None	Suitable guard or fence	Approved by City Engineer	To be approved by City Engineer	None	None
Chattanooga, Tennessee	Building Inspector	None	None	None	\$50 fine	None	50 feet from any street	None	None	None	None	None	Graded smooth.	Proper drainage	Left free of unsightly rock boulders
Glendale, California	Superintendent of Buildings	Decided by Administrative Agency	\$15-\$375	100% of restoration cost	\$500 or 5 months in jail or both	None	None	None	None	None	Such provisions as authority deems necessary	Approved by City Engineer	Not more than 1 1/2 horizontal ft. to 1 vertical foot. Good sound earth or gravel	Proper drainage. Approved erosion control device.	As required

sary to protect surrounding property or public ways.<sup>41</sup>

Permit Requirements. Table 2 shows that local excavation ordinances usually require that a mining operator obtain a permit before starting an excavation. Most localities set forth, in the body of the ordinance, the requirements that must be met before a permit is issued. The excavation ordinance of the Town of Southampton, New York, for example, requires that the applicant submit a detailed statement of the proposed operation, a comprehensive plan for restoration of the worked-out mine and a topographic survey of the property showing contours at ten-foot intervals.<sup>42</sup>

Most ordinances set forth time limitations. These limitations normally pertain to the time period between the issuance of a permit and the initiation of work. Ordinances also state the period of time during which the permit is valid. The Pasadena Ordinance, for example, allows 180 days for work to be started and one year for the completion of the excavation.<sup>43</sup>

Permit fees range from \$2 in Pasadena, California, to \$250 in Denver, Colorado. Table 2 gives the excavation permit fees in all the localities that were surveyed.

Bonding Requirement. Evidently the requirement for posting bonds is not as universal in local excavation ordinances as it is in state statutes. Table 2 shows, however, that some local ordinances do contain bond requirements which range up to \$10,000 or more.

Bonding is a good safeguard against ordinance violations. States have used the bonding provision fairly effectively in their open pit mining laws and localities probably should also include a bond require-

ment to strengthen their excavation ordinances.

Penalties. Most local governments set forth certain penalties for violating the provisions of the excavation ordinance. Violations are generally punishable as misdemeanors and each day the violation is continued usually constitutes a separate offense. The fines range from \$50 in Southampton, New York to \$1000 in Redondo Beach, California. Some localities also impose penalties of imprisonment.

Operational Provisions. Many local excavation ordinances contain provisions to regulate the operation of open pit mines. The primary objectionable open pit mining features that are frequently regulated are: (1) noise and vibration; (2) dust and dirt; (3) safety hazards; and (4) unsightly appearance of the mine area. These are shown in Table 2.

Noise and vibration can be very objectionable features of open pit mining, especially where blasting is required in the excavation process. Most local ordinances, however, do not provide for strong regulation of noise and vibration. Many have no such controls at all; others simply state that noise and ground vibration shall be reduced to a minimum. Better provisions to control noise and vibration in densely developed areas are set forth in Fulton County, Georgia's quarry operation regulations. These provisions are presented in Appendix A. These and other such provisions should be amended when better ideas are developed and made available. For example, the United States Bureau of Mines has developed and will soon publish new blasting control criterion which should be incorporated into excavation regulations or ordinances.<sup>44</sup>

Provisions for controlling dust and dirt generally include sprinkling the mining area and access roads. Some ordinances require the

access roads to be paved. Most ordinances, however, simply state that dust and dirt shall be kept at a minimum. Some additional dust control provisions probably should include enclosed storage for fine products, covers on all delivery trucks, sprinkling all loads and moistening such operations as grading and crushing.

Local ordinances usually contain a fencing requirement for public safety. Many also contain a general statement requiring the mining operator to provide suitable safeguards for public safety. The primary purpose of safety provisions should be oriented to preventing a mine from becoming an attractive nuisance where young children are likely to be injured.

Many localities require the mining area to be either properly maintained or screened from public view. A wooded screen around the area of operation is a common provision in the excavation ordinance. In addition to containing a screening provision, the Santa Clara County Ordinance includes good regulations on the maintenance of the mining area. The ordinance states:<sup>45</sup>

Commercial excavations shall be operated in a neat and orderly manner, free from junk, trash or unnecessary debris. Buildings shall be maintained in a sound condition, in good repair and appearance. Weeds shall be cut as frequently as necessary to eliminate fire hazards. Salvaged equipment stored in a non-operating condition shall be suitably screened or garaged.

Restoration Provisions. Restoration provisions of local excavation ordinances are similar to state restoration provisions and generally include: (1) a restoration plan; (2) grading and backfilling including the type of fill material; (3) drainage; and (4) erosion control. These provisions are presented, by locality, in Table 2.

Of the 13 localities, only 4 require that a restoration plan be submitted and approved. A proper restoration plan should, however, be approved before a permit is granted. The plan should provide for grading and backfilling, proper drainage, erosion control and any other necessary restoration feature in a manner suitable to the new proposed land use. The planning commission is probably the agency most suitable for reviewing and approving the restoration plan since it can determine how the new use can properly fit into the overall land use plan.

Table 2 shows that several ordinances contain provisions relating to grading and backfilling, drainage and erosion control. The typical grading and backfilling requirement is that all banks must be graded and filled to a safe angle. The backfill material must be free from paper, rags, garbage or similar matter. The typical provisions for drainage and erosion control is that they must be properly provided for. The proper method for determining the amount of grading and backfilling, proper drainage, erosion control and any other desirable restoration features should be whatever the restoration plan prescribes to properly fit the new proposed land use.

#### Zoning Ordinances

The extraction of minerals is now regarded as a use of land which may be regulated or prohibited in a zoning ordinance. The Supreme Court of Massachusetts was one of the first courts to reverse the early precedent that zoning cannot be employed to prevent an owner from taking earth products from his land. In *Town of Seekonk v. John J. McHale & Sons, Inc.*, 90 N.E. 2d 325 (Massachusetts, 1950), the court said:

But all zoning restricts an owner in the uses he could other-

wise make of his property. There seems to us to be no difference in principle whether the restriction takes the form of preventing an owner from building a factory or from establishing a gravel business.

This has become the predominant view concerning the control of open pit mining through zoning. Most courts have followed this precedent.

An exhaustive survey of zoning ordinances was made as a basic part of the research for this thesis. An attempt was made through this undertaking to: (1) reveal whether open pit mines are generally provided for in zoning ordinances today; (2) determine where in the community open pit mines are permitted; and (3) determine what measures of control are being exercised through zoning ordinances.

A total of 476 zoning ordinances were selected and reviewed. Every ordinance in the survey carried a date of 1950 or later. This method of analysis gave a good cross-section of the United States open pit mine zoning provisions since all states except Nevada were included in the survey. The distribution of the zoning ordinances reviewed is presented in Table 3. This survey included ordinances from communities of all sizes ranging from Georgetown, Georgia with a population of 554 to New York City, with a population of almost 8 million.

The answer to the question of whether open pit mines are generally provided for in zoning ordinances today is shown in Table 4. Of the 476 ordinances, 145 (30.5 per cent) do not list open pit mines as a permitted use.

Each ordinance was reviewed to ascertain the highest or most restricted district in which open pit mines are permitted. This was done to determine where in the community open pit mines are permitted. The

Table 3. Number of Zoning Ordinances Reviewed, by State\* and Region

Region	State	Number of Ordinances	Region	State	Number of Ordinances
<u>New England</u>	Connecticut	40	<u>South-east</u> (Contd.)	Mississippi	8
	Maine	2		N. Carolina	13
	Massachusetts	14		S. Carolina	5
	New Hampshire	4		Tennessee	11
	Rhode Island	6		Virginia	10
	Vermont	3		W. Virginia	3
	Subtotal	69		Subtotal	122
<u>East</u>	Delaware	1	<u>South-west</u>	Arkansas	6
	Dist. of Columbia	1		Louisiana	3
	Maryland	6		Oklahoma	6
	New Jersey	14		Texas	13
	New York	16		Subtotal	28
	Pennsylvania	14	<u>Rocky Mountain</u>	Arizona	9
Subtotal	52	Colorado		10	
		Idaho		2	
<u>North Central</u>	Illinois	20	Montana	2	
	Indiana	11	New Mexico	3	
	Michigan	15	Utah	3	
	Ohio	10	Wyoming	2	
	Wisconsin	12		Subtotal	31
Subtotal	71				
<u>Midwest</u>	Iowa	8	<u>Far West</u>	California	49
	Kansas	8		Oregon	7
	Minnesota	9		Washington	5
	Missouri	6		Subtotal	61
	Nebraska	3			
	N. Dakota	3	Alaska	5	
	S. Dakota	2	Hawaii	1	
Subtotal	39		Subtotal	6	
<u>South-east</u>	Alabama	34		U. S. TOTAL	476
	Florida	10			
	Georgia	18			
	Kentucky	10			

\* Nevada is not represented.

Table 4. Zoning Districts in Which Open Pit Mines  
Are Permitted in Zoning Ordinances

Highest Permitted Zone		Number of Ordinances	Per Cent of Total Surveyed
Agricultural	(no requirements)	10	2.1
	(with requirements)	11	2.3
Residential	(no requirements)	1	0.2
	(with requirements)	19	4.0
Commercial	(no requirements)	3	0.6
	(with requirements)	8	1.8
Industrial	(no requirements)	110	22.9
	(with requirements)	114	24.0
Flood District	(no requirements)	2	0.4
	(with requirements)	1	0.2
Unrestricted District		4	0.9
Mineral District	(no requirements)	5	1.1
	(with requirements)	1	0.2
Any District	(no requirements)	0	0.0
	(with requirements)	<u>42</u>	<u>8.8</u>
TOTAL		331	69.5
Open Pit Mines Not Listed as a Permitted Use		<u>145</u>	<u>30.5</u>
		<u>476</u>	<u>100.0</u>

results are given in Table 4. The survey revealed that zoning for open pit mines is handled in three ways: (1) as a matter of right in specified districts (Residential, Commercial and Industrial); (2) as the principle use in mineral or mining districts; and (3) as a use subject to administrative controls in certain districts.

Matter of Right in Specified Districts. In this simple method, open pit mines are listed as uses permitted as a matter of right and unrestricted in certain districts. This approach seems to be more feasible if the mineral deposits are located in industrial or agricultural districts. Table 4 shows that of the 476 ordinances reviewed, only one permitted open pit mines in residential areas and three in commercial districts, while 110 ordinances permitted them as a matter of right in industrial districts and 10 permitted them in agricultural districts.

Courts have generally upheld prohibiting open pit mines in districts where the mines are not listed as a permitted use. Some of the leading cases are *Davidson County v. Rogers*, 184 Tenn. 327, 198 S.W. 2d 812 (Tennessee, 1956); *Smith v. Juillerat*, 161 Ohio 424, 119 NE 2d 611 (Ohio, 1954); *Struyk v. Samuel Braen's Sons*, 17 NJ Super 1, 85 A 2d 279, 280-83 (New Jersey, 1951); and *Morton v. Superior Ct.*, 124 Cal. App 2d 577, 269 P 2d 81 (California, 1954).

Mineral District. Since the location of mineral resource deposits can be determined and mapped, some localities find it feasible to create a special mineral district in their zoning ordinance. Such a district is a good method to control the location of open pit mines since it gives legal identity to mineral reserves set aside for future development and alerts landowners and developers to the existence of sites on which

mineral extractions are permitted. Mineral deposits should be rather extensive and carefully surveyed and mapped before such a district is established. Also, the mineral industry must be willing and able to excavate the deposits and have a market for the mined products.

In this zoning ordinance survey only six mineral districts were discovered. Two of these (Township of Montgomery, New Jersey, and Luzerne County, Pennsylvania) were single purpose mineral districts which permitted only mineral excavation and processing. Two were multipurpose mining districts (Los Angeles, California, and Weber County, Utah). The Los Angeles district was designated a "Q" or Quarry District and permitted industrial, agricultural and other uses in addition to open pit mining. The Weber County district was a suburban Residential-Gravel District in which all uses related to residential, agriculture and gravel excavation were permitted.

A modification of the special mineral district, a temporary mineral district, accounted for the two remaining districts (Marion County, Indiana, and Fairfax County, Virginia). The object of a temporary mineral district is to allow a specified time period for the excavation of mineral deposits. At the end of the specified period the open pit mine operator is required to restore the area so it can be used for other purposes in conformity with the local land use plan. In the Marion County ordinance, buildings and structures necessary for mining operations must be removed within five years after they are constructed. After mining is discontinued, other types of uses such as industrial or residential will be permitted in the district. Mineral excavation is limited to ten years in one of Fairfax County's Natural

Resource (NR) Districts and 15 years in the second NR District which is farther from the urban development than the former.

Approval Under Administrative Controls. The survey pointed out some of the measures of administrative controls that are being exercised through zoning ordinances. Some type of administrative controls were set forth in 196 of the total 476 ordinances that were reviewed. This approach provides for mining as a special exception or a conditional use in certain districts subject to review and approval by the local governing body, planning commission or zoning board of appeals. Table 5 presents the breakdown of which authorities grants approval of the administrative controls in the ordinances that were surveyed.

Table 5. Authority Issuing Special Permits

Authority	Number of Ordinances
Governing Bodies	22
Planning Commission	71
Zoning Board of Appeals	<u>103</u>
Total	196

The primary function of administrative controls is to regulate the location and operation of mines in those districts where they are not permitted as a matter of right. This approach may be adequate when a locality expects to use it only a few times. However, where open pit

mining is extensive, administrative controls are not feasible methods for regulating mines. Extensive open pit mining should be included in the local land use plan and be permitted as a matter of right in appropriate areas, preferably in separate mining or mineral districts.

One type of administrative control is a special exception. The administrative authority usually has the discretion to attach special provisions or conditions to this locational approval. As shown in Table 6, 81 or 17 per cent of the 476 ordinances provide for the location of open pit mines by the special exception method.

The other type of administrative control frequently used in zoning ordinances to regulate open pit mines is the conditional use permit. In this method certain conditions are set forth that must be met before a permit to establish an open pit mine is granted. Table 6 shows that 115 or 24.2 per cent of the 476 ordinances reviewed provide for open pit mines by conditional use permits. The conditions set forth as prerequisites to issuing permits range from one statement in the Augusta-Richmond County, Georgia, Ordinance to 15 pages in the Fairfax County, Virginia, Ordinance. Table 7 shows some examples of the conditions or special requirements set forth in zoning ordinances which must be complied with by the applicant of an open pit mine conditional use permit. Many ordinances such as the ones in Fairfax County, Virginia; Mequon, Wisconsin; Fort Wayne, Indiana; and 27 of the ordinances reviewed from Connecticut contain lengthy provisions which are the same or similar to those set forth in excavation ordinances. The open pit mining provisions of five such ordinances are presented in the Appendix--Mequon, Wisconsin, Appendix B; Rocky Hill, Connecticut, Appendix C; Fort Wayne,

Table 6. Methods Used in Zoning Ordinances  
to Control Open Pit Mines, by Region

Region	Total Number of Ordinances Reviewed	Ordinances Requiring Use Permits		Ordinances Requiring Special Exceptions		Ordinances Permitting Mines as a Matter of Right	
		No.	Per Cent of Total	No.	Per Cent of Total	No.	Per Cent of Total
New England	69	36	52.2	7	10.1	14	20.3
East	52	5	9.6	0	0	16	30.8
North Central	71	6	8.5	13	18.3	20	28.2
Midwest	39	8	20.5	3	7.7	15	38.5
Southeast	122	21	17.2	46	37.7	22	18.3
Southwest	28	6	21.4	5	17.9	14	50.0
Rocky Mountains	31	11	35.5	2	6.5	11	35.5
Far West	61	20	32.8	2	3.3	23	37.7
Alaska & Hawaii	6	2	33.3	3	50.0	0	0
TOTAL	476	115	24.2	81	17.0	135	28.4

Table 7. Examples of Specific Requirements for  
Open Pit Mines in Zoning Ordinances

Physical Feature	Name of Locality and Date of Ord.	Requirements
Noise Control	Salt Lake County, Utah 1957	Gravel pits and all their accessory uses shall be designed, equipped and operated at all times in such a manner as to minimize and muffle noise to the extent possible by the application of modern design and modern operating methods, and by the utilization of modern equipment.
Dust Control	Los Angeles County, California 1958	All private truck roads connecting rock quarries, processing plants or stock piles, shall be wetted while being used or shall be oiled or hard surfaced and maintained so as to prevent the creation of dust.
Bonding Requirement	St. Paul, Minnesota 1951	All persons, firms or corporations to whom a permit is granted for open pit mining under the terms of this ordinance shall furnish a bond in the amount of \$5,000.
Screening	Augusta-Richmond County, Georgia 1963	Rock, sand or gravel excavating and processing shall be conducted within an area enclosed on all sides with a solid wall, compact evergreen screen or painted board fence not less than six feet in height.
Minimum Area	San Antonio, Texas 1954	Rock quarries, sand, gravel and earth excavations are permitted in any district on zoning lots not less than three acres in area.
Set Back Lines	Weber County, Utah 1958	Gravel pits, excavation and structures or buildings shall be located and operated not closer than 100 feet from any public street and not closer than 50 feet to any property line.

Table 7. (Continued)

Physical Feature	Name of Locality and Date of Ord.	Requirements
Hours of Operation	Los Angeles County, California 1958	A plant shall not be operated on any property except between the hours of 6 a.m. and 10 p.m. except in the case of public emergency, or whenever any reasonable or necessary repairs to equipment are required to be made.
Streets Not To Be Used	Albany, Georgia 1961	Truck access to the quarry shall not make use of established minor residential streets.
Transportation Facilities	Omaha, Nebraska 1952	Stone mills or quarries will be permitted on property abutting railroad trackage and on the Omaha Belt Railway with an industrial district or within a planned industrial development.
Drainage and Public Safety	Livonia, Michigan No Date	No soil, sand, clay, gravel or similar material shall be removed in such a manner as to cause water collection or as to result in a menace or danger to the public health, safety or welfare.
Grading and Backfilling	Albuquerque, New Mexico 1962	At such time that gravel operations are discontinued, no slopes shall be allowed to remain which are steeper than a 45 degree angle.
	Salt Lake County, Utah 1957	Areas from which gravel has been removed shall be recontoured as early as practicable so as to eliminate unsightly remains and encourage natural vegetation to reappear.

Indiana, Appendix D; Monroe, Connecticut, Appendix E; and Fairfield, Connecticut, Appendix F.

Nonconforming Use. Zoning ordinances usually provide for the continuance of nonconforming uses and structures with the limitation that no change, alteration or expansion shall be made in any building or land or part thereof unless such use is in conformity with the provisions of the ordinance. Mining was not mentioned in most early zoning ordinances because early court decisions prevented regulation or prohibition of excavation of earthen products. However, since regulation or prohibition of mining is now generally upheld in courts, many ordinances include mining and quarrying as uses subject to regulation or prohibition. Thus, the mines that were operating in conformity with early ordinances may not be in conformity with more recently adopted or amended zoning ordinances. The term generally used to describe such uses is "nonconforming" uses.

Many courts have held that there is a distinction between a nonconforming extractive industry and other nonconforming businesses. In *Hawkins v. Talbot*, 80 N.W. 2d 863, 920 83 (Minn., 1957), the court held that a nonconforming excavation operation should be considered as a diminishing asset. Their reasoning was that in open pit mining, the land itself is a material or resource; it is a diminishing asset and is consumed in the very process of use. This means that all of that part of the owner's land which contains a particular mineral, and not merely that area in which operations were actually being mined at the time of the adoption of the ordinance, is part of the nonconforming use.

This diminishing asset principle established in *Hawkins v. Talbot*, was also upheld by the court in *McCaslin v. Monterey Park*, 329 P. 2d 522,

11 T23 (Cal. App. 1958). In allowing the extension of a quarry within the original property lines, the court said:

The nature of an extractive business requires using the entire parcel of land containing the mineral and may not be restricted to the immediate area excavated at the time the ordinance was passed.

In a recent Illinois case, *County of DuPage v. Elmhurst Chicago Stone Co.*, 165 N.E. 2d 310, 12 ZD 401 (Illinois, 1960), the court took this principle further. It stated that land may be reserved for future mining in a district in which mining is prohibited if it can be proven that the reserved land is an integral part of the property on some part of which a nonconforming extractive process is already established. The court even used the principle of diminishing assets to override certain setback lines that were established in the ordinance.

In some cases, courts have upheld regulations which prevented an extension of a nonconforming open pit mine to the opposite side of a highway. In *Davis v. Miller*, 126 N.E. 2d 49, 7ZD 146 (Ohio, 1955), the court refused to allow such an extension although both sides of highway had been leased for quarrying before the adoption of the zoning resolution. In a 1957 case, *New York Trap Rock Corporation v. Clarkstown*, 166 N.Y.S. 2d 82, 10ZD 183 (New York, 1957), the New York Court of Appeals upheld a lower court decision which prevented extending a quarry across a road into land owned prior to the adoption of the ordinance.

The Massachusetts Supreme Judicial Court, however, has held that nonconforming mineral extraction uses may be regulated in the same manner as other uses. In *Burlington v. Dunn*, 61 N.E. 2d 243 (Mass. 1945), the court decided that a nonconforming gravel pit could continue the

existing operation, but that stripping soil to obtain more of the gravel deposit would be an extension of the nonconforming use and could not be permitted. In a later case, *Town of Billerica v. Quinn*, 71 N.E. 2d 235 (Mass. 1947), the same court ruled that the mere intention to mine the remainder of the land did not amount to an existing use of it.

Courts have generally held that a nonconforming open pit mine, which constituted a nuisance, could be required to cease operations. In *Livingston Rock and Gravel Company, et. al. v. County of Los Angeles*, 43 C. 2d 121, 272 P. 2d 4 (California, 1954), the court upheld a local action which required the operation of a sand and gravel processing plant in a residential area to be terminated. The plant was considered to be detrimental to the public health and was thus a nuisance.

Even though courts generally permit nonconforming open pit mines to be expanded to the limits of the deposits, mining operators should comply with the operation and restoration regulations. Abuse of the nonconforming privilege could result in the mining operation being discontinued by the nuisance abatement power of localities. It could also be used as a favorable argument for the growing movement to terminate all nonconforming uses.

#### Conclusions

Open pit mining is an important and necessary land use in most urban areas. Many types of mines such as sand, gravel and stone mines must be located near urban markets to provide the needed construction materials at lower costs. Other types of open pit mines are located in urban areas because some valuable mineral deposits happen to lie in

or near the urban development.

Planners and mining operators should realize, however, that open pit mines have certain features that may adversely effect surrounding development. If there are only a few mines in the area, these adverse features can be offset by proper controls. However, where mineral deposits are extensive in urban areas, the planning commission should determine what areas should be devoted to open pit mining. In order to determine the proper locations, effective controls and suitable surrounding land uses for the mines, the planning commission should undertake a geologic survey, an economic analysis, a transportation study, a land use study and a utilities study.

Effective state and local controls are needed to provide as harmonious a relationship as possible between open pit mining and other land uses. These controls should include regulation of mine locations and operations, and the rehabilitation of the worked-out mines.

State controls are primarily used to regulate the rehabilitation of open pit mines. The controls usually require the mining operator to restore the mined-out areas. Two states, however, use a different and probably better method. They require the operators to pay the cost of restoration to the administrative agencies, who restore the area in conformity with their state conservation programs.

Local regulations should be used to control the location and operation of open pit mines. Zoning ordinances should generally be used to control the locations of open pit mines. The zoning districts in which mines are most suitable are agricultural or industrial. Where the mineral deposits are extensive, open pit mining should be provided for in

separate mineral or mining districts. The operation of mines and the restoration of worked-out mines should be controlled by a mineral excavation ordinance. The ordinance should contain provisions for controlling such operational features as noise, vibration, dust, traffic congestion, water pollution, safety hazards and unsightliness.

Excavation ordinances may also include rehabilitation provisions more restrictive than those set forth by state statutes. The restoration regulations should provide that a rehabilitation plan be submitted to and approved by the planning commission before a permit to operate is granted. The new use should fit properly into the local land use plan.

If a locality properly provides for the location, operation and rehabilitation of open pit mines, these uses can more easily fill their proper role without adversely affecting surrounding land uses. Thus, the primary objective of making as compatible a relationship as possible between open pit mining and orderly community development can be more fully realized.

APPENDIX

## APPENDIX A

Fulton County Georgia, Resolution

"Regulation of Quarry Operations"  
(Provisions to Reduce Noise and Vibrations)

1. Hours of Operation

- a. Quarry work including blasting or crushing of rock shall not begin before 7:00 A. M. and shall end on or before 5:30 P. M.
- b. No work shall be permitted on Sundays.
- c. Blasting and the explosion of dynamite and explosive materials shall be limited between the hours of 9:30 A. M. and 1:00 P. M.

2. Personnel

Only those people qualified to handle explosives shall be employed in the loading holes, spacing holes, wiring holes and the exploding operations.

3. Charges

- a. No single blast shall exceed 500 pounds of explosives at any given instant nor more than a total of 6000 pounds of explosives for any series of blasts.
- b. No dobey shots or secondary blasting shall be permitted.

4. Weather Conditions

Blasting operations shall be conducted only when the ceiling is broken or open. No blasts shall be made during a rain or overcast.

5. Reports

- a. A written report shall be filed within three days with the Director of Public Works to cover each blast made.
- b. Such report shall show the weather conditions, the number of holes exploded, the pounds of explosive used, the direction of the wind and the supervisor in charge.

6. Notice of Blast

- a. The Quarry superintendent shall notify the office of Director of Public Works one day in advance of his intent to set off a blast.
- b. The Quarry superintendent shall likewise notify the Director of Public Works at least two hours in advance of the actual blasting operation.

## APPENDIX B

Mequon, Wisconsin Zoning Ordinance"Quarrying Regulations"

## (6) Quarrying:

(a) Use Restricted: As defined in this ordinance, quarrying operations shall be permitted only as conditional uses and where so permitted shall be subject to the general regulations applicable to such grant as set out in Section 4.12 of this ordinance, and to the specific regulations as hereinafter set forth.

(b) Permit: No quarrying operation shall take place in any district until a quarrying permit has been secured from the Common Council. Such permit shall be for an initial period as is deemed appropriate to the specific situation but not to exceed 5 years, and may be renewed thereafter for periods not to exceed 3 years provided application therefore shall be made at least 60 days and no more than 120 days before expiration of the original permit. Application after such date shall be treated as an original application.

(c) Application: Application for a Quarrying Permit shall be made on forms supplied by the City Clerk and shall be accompanied by:

1. A fee of \$25.00 to defray the cost of notification and holding of public hearing and administrative processing.
2. A full and adequate description of all phases of the contemplated operation and the specific mention of type of machinery and equipment which will be or might be necessary to carry on the operation. Where the operation is to include the washing of sand and gravel, the estimated daily quantity of water required, its source and its disposition shall be made a part of this description.
3. A legal description of the proposed site with a map showing its location with indications of private access roads, existing or proposed, and of public highways adjacent to the site which will be affected by the operation.
4. A topographic map of the area at a minimum contour interval of 5 feet extending beyond the site to the nearest public street or highway or to a minimum distance of 300 feet on all sides of

the property.

5. A restoration plan as hereinafter required.

(d) Referral to Plan Commission: The application and all data and information pertaining thereto shall be referred to the Plan Commission for public hearing and report and recommendation back to the Common Council within 30 days after the public hearing.

(e) Public Hearing: The Plan Commission shall hold such public hearing within 30 days after an application has been referred to it. In addition to the normal posting and publishing, notices also shall be sent through the mail or otherwise placed in the hands of all owners within a half mile radius of the approximate center of the proposed quarrying operation. These notices shall be mailed or delivered at least 10 days prior to the date of hearing. Substantial compliance with the notice requirements of this section shall be deemed sufficient.

(f) Action by Common Council: The Common Council shall, within 30 days after receipt of the recommendation of the Plan Commission grant or deny a permit for the proposed quarrying operation. The determination shall be based upon the standards set out in Section 4.12 of this ordinance and with particular consideration of the following factors:

1. The effect of the proposed operation on existing roads and traffic movement in terms of adequacy, safety and efficiency.
2. The effect of the proposed operation on drainage and water supply.
3. The possibility of soil erosion as a result of the proposed operation.
4. The degree and effect of dust and noise as a result of the proposed operation.
5. The practical possibility of restoration of the site.
6. The effect of the proposed operation on the natural beauty, character, tax base, land value and land uses in the area.
7. The most suitable ultimate land use for the area with particular consideration for future residential use.

(g) Additional Conditions: Any conditions accessory to the granting of a permit shall be in writing and copies made a part of the permit and a part of the records of the City.

(h) Renewals: The procedure as designated in paragraphs (d),

(e), (f), and (g) above shall apply to applications for renewal of a permit. Determination in regard to renewal shall be based particularly on an evaluation of the effect of the continuance of the use with relation to changing conditions in the area. Where renewal is not granted, the reasons for refusal shall be presented to the applicant in writing and made a part of the records of the City.

(i) General Requirements:

1. No part of the quarrying operation shall be permitted closer than 1,000 feet, nor shall any accessory access road, parking area or office building be permitted closer than 500 feet to a district zoned Residential at the time of the grant of permit except with the written consent of the owners of all residentially zoned properties within 1,000 feet, but in no case shall such operation be permitted closer than 200 feet to a Residential District.

2. No quarrying operation shall be permitted if 30 or more families reside within a half mile radius of the center of the proposed site.

(j) Setback Requirements: No part of the quarrying operation other than access roads shall be located closer than 200 feet nor shall any accessory parking area, stock pile, or office building be located closer than 100 feet, to the Base Setback Line along any street or highway.

(k) Offset Requirements: No part of the quarrying operation shall be permitted closer than 200 feet, nor shall any accessory access road, parking area, or office building be permitted closer than 50 feet to any property line except with the written consent of the owner of the adjoining property, or where said line is abutting an Industrial District or abutting an existing quarrying operation, but in no case shall such operation be closer than 20 feet to any property line except by agreement between abutting quarrying operations, or be in conflict with the provisions of Section 4.08 (4) relating to Preservation of Topography.

(l) Operational Requirements:

1. Fencing or other suitable barrier shall be erected and maintained around the site or around portions of the site where in the determination of the Plan Commission such fencing or barrier is necessary for the protection of the public, and shall be of a type approved by the Plan Commission.

2. All machinery and equipment used in the quarrying operation shall be constructed, maintained and operated in such a manner as to minimize dust, noise and vibration. Access and haulage

roads on the site shall be maintained in a dust-free condition by surfacing or treatment as directed by the City Engineer.

3. The crushing, washing, refining or other processing other than the initial removal of material, may be permitted as an accessory use only as specifically authorized under the terms of the grant of permit or as otherwise provided in an Industrial District.

4. In stone quarries the production or manufacturing of veneer stone, sills, lintels, cut flagstone, hearthstones, paving stone and similar architectural or structural stone and the storing or stock-piling of such products on the site shall be considered a permissible part of the operation provided such production does not require the use of crushing or other heavy machinery except as may be otherwise specifically authorized under the terms of the grant of permit or as otherwise provided in an Industrial District.

5. The manufacture of concrete building blocks or other similar blocks, the production or manufacture of lime products, the production of ready-mixed concrete and any similar production or manufacturing processes which might be related to the quarrying operation shall not be permitted except as otherwise provided in an Industrial District.

6. The washing of sand and gravel shall be prohibited in any operation where the source of water is of doubtful capacity or where the quantity of water required will, in the opinion of the Engineer, seriously affect the supply for other uses in the area, or where disposal of water will result in contamination, pollution, or excessive silting.

7. The planting of trees and shrubs and other appropriate landscaping shall be provided where deemed necessary by the Plan Commission to screen the operation so far as practical from normal view, to enhance the general appearance from the public right-of-way, and generally to minimize the damaging effect of the operation on the beauty and character of the surrounding countryside. Such planting shall be started as soon as practicable, but no later than one year after quarrying operations have begun and shall be done according to the recommendations of the Plan Commission.

8. Except in an Industrial District, quarrying operations shall not begin before the hour of 7:00 A.M. and shall not continue after the hour of 6:00 P.M. and no operations shall take place on Sundays or legal holidays. During periods of national or unusual emergency, time and hours of operation may be altered at the discretion of the Plan Commission and through the issuance of a special permit which shall be renewable at 30 day intervals.

(m) Restorative Requirements:

1. In order to insure that the area of quarrying operation shall be restored to a condition of practical usefulness and reasonable physical attractiveness, the owner or operator shall prior to the issuance of a permit submit to the Plan Commission a plan for such restoration in the form of the following:
  - a. An agreement with the City whereby the applicant contracts to restore the premises to a condition and within a time satisfactory to the City.
  - b. A physical restoration plan showing the proposed contours after restoration, plantings and other special features of restoration, and the method by which such restoration is to be accomplished.
  - c. A bond written by a licensed surety company; a certified check, or other financial guarantee satisfactory to the City in an amount sufficient in the opinion of the City Engineer to secure the performance of the restoration agreement.
  - d. Such agreement and financial guarantee shall be in a form approved by the City Attorney.
2. In the event of the applicant's failure to fulfill this agreement, such bond, check, or other financial guarantee shall be deemed forfeit for the purpose of enabling the City to perform the restoration.
3. Restoration shall proceed as soon as practicable and at the order and direction of the Engineer. However the owner or operator may, at his option, submit a plan for progressive restoration as the quarrying operation is being carried on. The required financial guarantee in such case may cover progressive stages of the restoration for periods of not less than 2 years.
4. At any stage during the restoration the plan may be modified by mutual agreement between the City and the owner or the operator.
5. Where there is any backfilling, the material used or the method of fill shall not be such as to create a health hazard nor which would be objectionable because of odor, combustibility, or unsightliness. In any case the finished grade of the restored area except for rock faces, outcroppings, water bodies, or areas of proposed building or paving construction shall be of sufficient depth of earth to support plant growth.

6. Within one year after the cessation of the operation, all temporary structures (excepting fences), equipment, stock piles, rubble heaps, or other debris shall be removed or backfilled into the excavation so as to leave the premises in a neat and orderly condition.

7. In any restoration procedure which takes place in sand or gravel pits or on other sites where the material is of a loose or friable nature, no slope shall be left which is steeper than a ratio of 1-1/2 horizontal to 1 vertical. In no case shall any slope exceed the normal angle of slippage of the material involved.

(n) Exceptions:

1. Incidental Use: The provisions of this subsection, 4.09 (6), shall not apply to an operation which is incident to another permitted use of the premises provided such operation does not involve the commercial disposal of the material removed.

2. Permitted Modification or Waiver: The Plan Commission may, consistent with the intent of these regulations, modify or waive any or all of the provisions of this subsection 4.09 (6), in the following cases provided, however, that except as allowed under subparagraph 1 above, the specific grant of conditional use shall be required and shall be properly recorded:

a. Operations incident to another permitted use of the premises where the material removed is sold or otherwise commercially disposed of.

b. Sod removal, provided no such operation shall be permitted which adversely affects the drainage of the area and provided adequate provision is made to prevent erosion.

c. Topsoil removal, except that no such operation shall be permitted except as incidental to another permitted use of the premises, and provided such operation will not adversely affect the drainage of the area, or exceed 18 inches in depth, and provided adequate provision is made to prevent erosion.

d. In an Industrial District modify the provisions relative to permitted hours of operation.

e. Where the character of terrain, of surrounding development, or other special conditions would justify such modification, permit a reduction in the required setback or offset provided however that in no case shall the setback be less than 100 feet, or the offset be less than 100 feet for quar-

rying operations or 20 feet for any accessory access road, parking area or office building except as may be otherwise provided by paragraph (k) of this subsection.

(o) Existing Operations:

1. Permit: Within 60 days after the adoption of this ordinance all existing quarrying operations shall be required to register with the City Clerk submitting pertinent data relative to the present operation, including the boundaries of the actual operation and of the ownership. A Quarrying Permit shall be granted to such existing operation subject to compliance with the Operational Requirements, Paragraph (l) of this subsection where they can be reasonably applied under existing circumstances.
2. Plan for Restoration: There shall be required within one year after adoption of this ordinance, the submission of a plan for restoration of the site of an existing quarrying operation as provided by Paragraph (m) of this subsection. The plan for restoration in such case shall not, however, impose requirements which are economically or engineeringly unreasonable with respect to conditions resulting from operations prior to enactment of this ordinance.
3. Renewal Permit: Within 3 years after the date of this ordinance any such existing operation shall be required to make application for a renewal permit the same as for reapplication in the case of a new operation under this ordinance.

## APPENDIX C

Rocky Hill, Connecticut Zoning Ordinance"Removal of Soil Provisions"

10.1 The removal of sod, loam, soil, clay, sand, gravel or stone from any land is hereby prohibited except by permit of limited duration from the Commission after a public hearing and issued under such conditions as said Commission may impose to prevent damage to adjoining property and to protect the health, safety, convenience and welfare of the community. Such conditions shall include, among others: (a) the submission of a reference map to a scale of 1" = 200' showing the area proposed for excavation, property lines and the names of adjoining property owners and the tie-in to the nearest street intersection; (b) the submission of a map to a scale of not less than 1" = 40' of the premises and surrounding area within 100' showing the existing and the proposed contour lines at intervals of not more than 2 feet resulting from the proposed removal of soil in relation to the topography of the premises, said map to be prepared by a registered professional engineer or licensed surveyor; (c) provisions for temporary and permanent drainage of the site; (d) limitation of excavation to cuts which are not to exceed 10' at any one time; (e) regrading of all or parts of the slopes resulting from such excavation; and (f) replacement of some stated depth of topsoil over all or parts of said land. Also, as a condition precedent to the granting of such permit, the Commission shall require a bond, in an amount determined by said Commission, to be posted to assure fulfillment of any condition imposed within such time as said Commission may set.

10.11 Where any excavation will have a depth of ten (10) feet or more and create a slope of more than 1 in 2, there shall be a substantial fence, at least six (6) feet in height with suitable gates. Such fence shall be located 50 feet or more from the edge of the excavation. All operations shall be screened if located near residential areas or highways.

10.12 The portion of access road within the area of operation shall be provided with a dustless surface which shall be maintained in good condition at all times.

10.13 The screening, sifting, washing, crushing or other forms of processing shall be conducted on the premises only if located within a manufacturing district.

10.2 These regulations shall be deemed not to prohibit the removal of sod, loam, soil, clay, sand, gravel or stone necessary to be exca-

vated from the foundation locations of buildings or other allowable structures for which building permits have been issued, or to be excavated from the locations of ways in accordance with the lines, grades and profiles on plans approved by the Commission. Nor shall these regulations be deemed to prohibit the transferral of sod, soil, clay, sand, gravel or stone from one part of lot, tract or parcel of land to another part of the same lot, tract or parcel of land in the same ownership.

10.3 All applications for a soil removal permit shall be accompanied by a fee of \$50.00 in the form of a check payable to the Treasurer, Town of Rocky Hill and shall follow substantially the standard procedures and rules required for a proposed subdivision and as described more fully in the Subdivision Regulations of the Town of Rocky Hill.

10.4 Any excavation involving the removal of sod, loam, soil, clay, sand, gravel or stone which is in existence upon the effective date of this section (10.4) of the zoning regulations and which does not have a valid permit shall within thirty (30) days thereafter comply with the requirements of these regulations (Section 10). The granting of the thirty day period shall in no way relieve the owner from any of the provisions of Section 1.21 of the Zoning Regulations for the Town of Rocky Hill.

## APPENDIX D

Fort Wayne, Indiana Zoning Ordinance"Gravel, Rock, Stone and Sand Extraction Regulations"

## (a) Excavation:

- (1) Final slopes of sand or gravel shall not be steeper than one (1) foot horizontal or one (1) foot vertical.
- (2) Temporary operating cut slopes of sand and gravel steeper than one (1) foot horizontal to one (1) foot vertical shall in no case be brought closer to an exterior property line, right-of-way line of any street, road, way or alley, as existing or as proposed in the Comprehensive Development Plan than 50 feet where a sight screen is provided or 75 feet in the case where no provision is made for sight screening.
- (3) Explosives shall be used only between sun-up and sun-down except in the case of an emergency.
- (4) Final sloping of quarry or sand and gravel pit excavations shall be accomplished within the time specified in the quarry or sand and gravel pit permit or as extended by the Board of Zoning Appeals.

## (b) Drainage of Premises:

The finished excavation shall be graded where possible, in such a manner as to prevent the stagnation of storm waters or natural seepage.

## (c) Refilling, Erosion Control and Screen Planting:

- (1) Dikes or other barriers and drainage structures shall be provided, to prevent silting of natural drainage channels or storm drains in the area surrounding the quarry or sand and gravel pit.
- (2) All final cut slopes shall be treated to prevent erosion; topsoil shall be replaced on such slopes to support vegetation; ground cover shall be planted within twelve (12) months after a cut slope is excavated to its final position; and such ground cover shall be maintained for a period of time sufficient to provide vegetation or a density that will prevent erosion.

(3) Where required, suitable plant material shall be placed and maintained to screen out slopes from public view.

(4) Whenever quarrying or sand and gravel pit operations on any property has been completely exhausted, all buildings, structures or equipment not authorized under the permitted uses for the district in which the property is located, shall be entirely removed from such property within one (1) year after such completion.

(d) Maintenance and Operation:

(1) Quarries and sand and gravel pits shall be maintained at all times in a neat and orderly manner.

(2) Quarries and sand and gravel pits shall be operated so as to keep dust and noise to a minimum, and access roads shall be maintained as dust-free surfaces from the public street to within one hundred (100) feet of the loading point within the quarry or sand and gravel pit.

(3) Vehicles carrying materials from quarries or sand and gravel pits shall be loaded in such manner as to prevent spilling rock, gravel, sand or other materials of a mineral nature while in transit upon roads and highways.

(4) Quarry or sand and gravel pit excavations which may penetrate near or into a usable water bearing stratum shall be conducted in such a manner that any such stratum so approached or encountered will not be subject to pollution by operations or the excavation of a sand and gravel pit or subsequent to the abandonment of stone quarry or sand and gravel pit.

(e) Continuance of Existing Quarry or Sand and Gravel Pit.

A quarry or sand and gravel pit operation lawfully existing upon the effective date of this amendment to this chapter may be continued so long as such continued use complies with the requirements of Subsections (a), (b), (c) and (d) of Section 1 of this amendment to this chapter.

## APPENDIX E

Monroe, Connecticut Zoning Ordinance"Grading and Removal of Earth Regulations"

- 10.1 General Regulation: There shall be no excavation or removal of earth, loam, topsoil, sand, gravel, clay, or stone for sale or for use other than on the premises on which such excavation or removal shall be made, except in connection with the bona fide construction or alteration of a building on such premises for which a building permit has been issued or in connection with the construction of improvements and the changing of contours in accordance with subdivision construction plans and contour maps approved by the Town Planning and Zoning Commission for such premises. The Board of Appeals, however, may grant a special exception authorizing such excavation or removal upon the conditions hereafter specified.
- 10.2 Application: Before any special exception shall be granted, a written application shall be submitted to the Board of Appeals together with maps and plans showing the following:
- 10.2.1 The area to be excavated;
- 10.2.2 Existing contour lines on the premises and proposed contour lines resulting from the intended excavation or removal, shown on a map drawn to a scale not less than 100 feet to the inch and with a contour interval not to exceed two (2) feet, except that the Board of Appeals may, in its discretion, waive the requirements of this subparagraph when said Board of Appeals shall deem the submission of a contour map to be an unnecessary expense or unreasonable hardship to the applicant;
- 10.2.3 Existing and proposed drainage on the premises;
- 10.2.4 Surrounding properties and streets; and
- 10.2.5 Proposed truck access to the property.
- 10.3 Conditional Approval: The Board of Appeals may grant a special exception for a limited period of time, not exceeding two (2) years if it shall find that such excavation or removal will not result in the creation of any sharp declivities, pits, or depressions, soil erosion or fertility problems, depressed land values,

or create any drainage or sewerage problems or other conditions which would impair the use of the property in accordance with the Zoning Regulations and that such excavation or removal will be in harmony with the general purpose and intent of the Zoning Regulations. An exception shall be granted only upon the following conditions:

- 10.3.1 That the premises shall be excavated and graded in conformity with the proposed contour plan as approved;
- 10.3.2 That slopes shall not exceed thirty (30) degrees to the horizontal;
- 10.3.3 That no fixed machinery shall be erected or maintained within 300 feet of any property or street line and that no buildings shall be erected on the premises except temporary shelters for machinery and field office;
- 10.3.4 That there will be no sharp declivities, pits or depressions and that proper drainage will be provided to avoid stagnant water;
- 10.3.5 That after excavation or removal the premises shall be cleared of debris;
- 10.3.6 That the top layer of arable soil for a depth of six (6) inches shall be set aside and retained on the premises and shall be respread over the premises, upon completion of the excavation or removal, in accordance with approved contour lines;
- 10.3.7 That the applicant shall file with the Board of Appeals, a performance bond, in form and with surety acceptable to the Board, in such amount as the Board shall deem sufficient to insure the faithful performance of the work to be undertaken pursuant to the conditions of approval; and
- 10.3.8 That the applicant shall pay to the Town a permit fee of \$10 for one acre or less, to be excavated plus \$5 for each additional acre or fraction thereof.

## APPENDIX F

Fairfield, Connecticut Zoning Ordinance"Regulations of Removal of Soil, Sand and Gravel"

Division 2--REGULATIONS OF REMOVAL OF SOIL, STONE, SAND, AND GRAVEL WITH-  
IN THE TOWN OF FAIRFIELD, CONNECTICUT.

- (1) No person shall excavate or remove any earth, loam, topsoil, sand, gravel, clay, or stone in amounts in excess of 100 cubic yards from premises located in any zoning district of the Town of Fairfield, except as hereinafter provided.
- (2) This Regulation shall not apply
  - (a) to premises used in connection with the bona fide construction or alteration of a building for which a building permit has been issued;
  - (b) to the construction of improvements and the changing of contours in accordance with subdivision construction plans and contour maps approved by the Town Plan and Zoning Commission for such premises;
  - (c) to premises located within flood plain districts as described by the Zoning Regulations;
  - (d) to publicly held land.
- (3) The Town Plan and Zoning Commission shall grant a special permit authorizing the excavation or removal of earth, loam, topsoil, sand, gravel, clay or stone subject to the standards and conditions hereinafter specified in Paragraphs 4, 5, 6, 7 of this Regulation.
- (4) Before any special permit shall be granted, a written application shall be submitted to the Town Plan and Zoning Commission together with an application fee of \$25.00 and maps and plans showing the following:
  - (a) The area to be excavated;
  - (b) Existing contour lines on the premises and proposed contour lines resulting from the intended excavation or removal, shown on a map drawn to a scale not less than 100 feet to the inch and with a contour interval not to exceed two (2) feet;

- (c) Existing and proposed drainage on the premises;
  - (d) Existing rivers, streams or watercourses on or adjacent to the premises;
  - (e) Surrounding properties and streets;
  - (f) Proposed truck access to the property;
  - (g) Proposed time of completion of project;
  - (h) Such additional information as the Commission shall deem necessary in order to decide upon such application.
- (5) Upon receipt of such application the Town Plan and Zoning Commission shall hold a public hearing thereon within 90 days after receipt of such application, and shall approve, modify and approve or disapprove any such application within a reasonable time after such public hearing.
- (6) The Town Plan and Zoning Commission may after a public hearing grant a special permit for a limited period of time, not exceeding two (2) years, if it shall find that such excavation or removal will not result in the creation of any sharp declivities, pits, or depressions, soil erosion or fertility problems, depressed land values, or create any drainage or sewerage problems, or other conditions which would impair the use of the property in accordance with the Zoning Regulations, and that such excavation or removal will be in harmony with the general purpose and intent of the Zoning Regulations, and if the Commission further finds that the permit to be granted is capable of being completed within the time provided in the permit.
- (7) A special permit shall be granted only upon the following conditions:
- (a) That the premises shall be excavated and graded in conformity with the proposed contour plan as approved;
  - (b) That slopes shall not exceed thirty (30) degrees to the horizontal;
  - (c) That no fixed machinery shall be erected or maintained within 300 feet of any property or street line, and that no buildings shall be erected on the premises except temporary shelters for machinery and field office;
  - (d) That there shall be no excavation or removal within fifty (50) feet of any street or property line except that where the property is considerably above street grade at the street line, removal may take place at a lesser distance from the street line if the Town Director of Public Works certifies that the work proposed by the applicant will not result in:

- (1) Weakening of lateral support of any public right of way or contiguous private property;
  - (2) The deposition of debris on any public right of way, nearby private property, or existing drainage course; and
  - (3) The interference with any existing drainage course.
- (e) That there shall be no excavation or removal in the bed or within an area adjacent to the banks of any river, stream or watercourse without a report by the Flood and Erosion Control Board that such excavation or removal as may be shown on the maps and plans accompanying the application has been reviewed by said Board, a copy of said report shall accompany the application;
  - (f) That there shall be no sharp declivities, pits, or depressions and that proper drainage will be provided to avoid stagnant water;
  - (g) That after excavation or removal the premises shall be cleared of debris within the time provided in the permit;
  - (h) That the top layer of arable soil for a depth of six (6) inches shall be set aside and retained on premises and shall be re-spread over the premises, upon completion of the excavation or removal, in accordance with the approved contour lines; and that such work be completed within the time provided for in the permit.
  - (i) That the Commission prepare or approve a schedule to be filed with the records of such application and permit showing the following:
    - (1) Limitations on the day of the week or the hours of the day during which any work may be performed on the premises;
    - (2) Limitations as to the size and type of machinery used on the premises;
    - (3) Place and manner of disposal of excavated material;
    - (4) Requirements as to the control of dust, noise, fumes and lighting if permitted, so as to prevent results injurious or offensive to the general public.
  - (j) The Commission may vary or alter any conditions provided for in this section if in its opinion such variance or alteration is in harmony with the original purpose and intent of the permit granted.

(k) That the applicant shall file with the Town Plan and Zoning Commission either (a) a performance bond, in form and with surety acceptable to the Commission, in such amount as the Commission shall deem sufficient to insure the faithful performance of the work to be undertaken pursuant to the conditions of approval; or (b) a first mortgage in favor of the Town of Fairfield in an amount and in a form acceptable to the Town Plan and Zoning Commission upon real estate owned by the applicant and located in the Town of Fairfield other than the property on which the excavating is to take place. No such mortgage shall be accepted by the Town unless the Commission finds the value of the real estate securing such application to be sufficient to protect the interests of the Town or until the applicant shall have filed with the Commission a certificate of title to the property together with a full report of title on the property to be secured. Such bond or mortgage shall be conditioned upon the completion of the conditions established by the Commission at the time of the granting of the permit or any subsequent changes of such conditions.

(1) No such bond or mortgage shall be released nor shall the applicant be deemed to have complied with the conditions provided for herein until the applicant has filed with the Commission a written certification from the Department of Public Works of the Town of Fairfield that the said conditions have been performed and that such bond or mortgage be released.

(8) Revocation & Suspension

(a) Any permit issued pursuant to the provisions of this regulation may be revoked by the Town Plan and Zoning Commission after notice in writing and a hearing for

(1) Violation of any conditions of the permits;

(2) Violation of any provision of this regulation, or any other law or other regulation relating to the work permitted;

(3) The existence of any condition or the doing of any act constituting or creating a nuisance or endangering the life or property of another.

(b) The notice shall describe the violation charged and may be either delivered personally or deposited in the United States mail in a sealed envelope postage prepaid directed to the address appearing on the application.

- (c) Any permit may be suspended by the Department of Public Works for a period not exceeding five days without a hearing but no more than one such suspension may be ordered within the duration of a permit. All work under any permit shall be suspended following notice of a hearing to revoke as provided for in this Section.
- (9) The Director of Public Works or any persons designated and authorized by the Director shall be the enforcing officer of the provisions of this regulation.
- (10) In addition to any other provisions contained herein, the Town of Fairfield acting through the Selectmen, Town Plan and Zoning Commission or the Director of Public Works, may take such civil action as may be deemed necessary to enforce any of the provisions of this regulation.

Said amendment and change shall become effective on Monday, January 15, 1962, at 12:00 noon.

## LITERATURE CITED

1. U. S. Department of the Interior, Bureau of Mines. *Mineral Yearbooks*. 1963 ed., Vol. 1, Metals and Minerals. Washington: U. S. Government Printing Office, 1964, p. 1054.
2. \_\_\_\_\_. *Mineral Facts and Problems*. 1960 ed. Bulletin 585. Washington: U. S. Government Printing Office, 1960, p. 803.
3. The American Institute of Mining and Metallurgical Engineers. *Industrial Minerals and Rocks*. 2d ed. Seeley W. Mudd Series. York, Pennsylvania: The Maple Press Company, 1949, p. 271.
4. The American Institute of Mining, Metallurgical and Petroleum Engineers. *Industrial Minerals and Rocks*. 3rd ed. Seeley W. Mudd Series. York, Pennsylvania: The Maple Press Company, 1960, p. 294.
5. U. S. Department of the Interior, Bureau of Mines. *Mineral Facts and Problems*. *op. cit.*, p. 807.
6. The American Institute of Mining and Metallurgical Engineers. *op. cit.*, pp. 280-81.
7. U. S. Department of the Interior, Bureau of Mines. *Mineral Facts and Problems*. *op. cit.*, p. 807.
8. \_\_\_\_\_. *Mineral Yearbooks*. 1963 ed. Vol. I, *op. cit.*, p. 967.
9. \_\_\_\_\_. *Mineral Facts and Problems*, *op. cit.*, p. 706.
10. *Ibid.*, p. 707.
11. *Ibid.*, p. 708.
12. \_\_\_\_\_. *Mineral Yearbooks*. 1963 ed. Vol. 11, Mineral Fuels. Washington: U. S. Government Printing Office, 1964, p. 89.
13. "New Developments in Coal Mining Technology," *Mining Engineering*, Vol. 15, No. 2, February, 1963, p. 90.
14. Tennessee Valley Authority. *An Appraisal of Coal Strip Mining*. Knoxville, Tennessee: The Authority, February, 1963, p. 5.
15. *Ibid.*
16. *Ibid.*

17. Illinois Coal Strippers Association. *The Open Cut Coal Mining Industry of Illinois*. Chicago: The Association, n. d., p. 15.
18. U. S. Department of the Interior, Bureau of Mines. *Mineral Yearbooks*. 1963 ed. Vol. 1, *op. cit.*
19. "New Mining Methods Rehabilitate Florida's Strip Mines," *Mining Engineering*, Vol. 15, No. 4, April, 1963, p. 50.
20. U. S. Department of the Interior, Bureau of Mines. *Mineral Facts and Problems*, *op. cit.*, p. 634.
21. *Ibid.*, pp. 795-96.
22. White, Harold. *Blasting Vibration Intensity, Fulton County Quarry Site*. Joplin, Missouri: Harold White Consulting Engineers, March, 1958, pp. 1-6.
23. Schlicker, H. G. *Gravel Resources in Relation to Urban Development in the Salem Area*. Portland, Oregon: Department of Geology and Mineral Industries, May, 1961, pp. 1-2.
24. The American Institute of Mining, Metallurgical and Petroleum Engineers, *op. cit.*, p. 655.
25. Council of State Governments. *Surface Mining--Extent and Economic Importance, Impact on Natural Resources, and Proposals for Reclamation of Mined Lands*. Chicago: The Council, June, 1964, pp. 19-20.
26. Kentucky, *Revised Code, Annotated* (1963), Art. 350.
27. Illinois, *Code Annotated* (1962), C. 93 Art. 180, sec. 6.
28. Indiana, *Code Annotated* (Supplement 1963), Art. 46, sec. 1505.
29. Maryland *Code Annotated* (1959), Art. 66c.
30. Ohio, *Revised Code Annotated* (Supplement 1962), Art. 1513, sec. 01.
31. Pennsylvania, *Code Annotated* (Supplement 1962), Title 52, Art. 1396.
32. West Virginia, *Code Annotated* (Supplement 1963), Art. 2461.
33. Kentucky, *Revised Code Annotated*, *op. cit.*, sec. 060.
34. West Virginia, *Code Annotated*, *op. cit.*, sec. 61.
35. Kentucky, *Revised Code Annotated*, *op. cit.*, sec. 990.
36. Pennsylvania, *Code Annotated*, *op. cit.*, sec. 10.

37. Meiners, Robert G., "Strip Mining Legislation," *Natural Resources Journal*, Vol. 3, No. 3, January, 1964, p. 463.
38. Pennsylvania, *Code Annotated, op. cit.*, sec. 11.
39. The Council of State Governments, *op. cit.*, p. 38.
40. Meiners, *op. cit.*, p. 466.
41. McCarty, John F. and Duggar, George. "Ordinance No. 4313," *Local Regulation of Excavations, Grading, and Quarrying in California*. Berkeley: Bureau of Public Administration, University of California, October, 1956, p. 31.
42. Southampton, New York. *Ordinance No. 42*. Southampton: The City, Adopted May 5, 1964, sec. 4.
43. McCarthy, *op. cit.*, p. 29.
44. "Blasting Damage Research," *Pit and Quarry*, Vol. 57, No. 10, April, 1965, pp. 96, 147.
45. Santa Clara County, California. *Quarry Standards*. Planning Commission Resolution No. 6178. Santa Clara: The Planning Commission, Passed and adopted August 16, 1961, p. 4.