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A Guide to Site Development and Rehabilitation of Pits and Quarries

By

Anthony M. Bauer

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FOREWORD

The preparation of this report was sponsored by the Mineral Resources Committee, appointed in 1969 by the Honourable Allan F. Lawrence, Minister of Mines. The project was financed jointly by the Regional Development Branch of the Ontario Department of Treasury and Economics and the Geological Branch of the Ontario Department of Mines.

The report was written and the figures largely prepared by Anthony M. Bauer, consulting landscape architect and formerly professor of landscape architecture at the University of Guelph. Photographs were collected and compiled by D. F. Hewitt. The Mineral Resources Committee appointed a subcommittee consisting of J. O. Spender, D. F. Hewitt, and D. C. Schmiegelow, to supervise the production of the report.

This report gives suggestions regarding possible methods for site planning and site improvements during operations. Individual site plans for operations will depend largely on prevailing conditions in the particular location where the pit or quarry is opened. Examples of rehabilitated pit and quarry sites are given in Chapter IV.

A Guide
to
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CHAPTER I

THE MINING AND REHABILITATION PROCESS

Introduction

It has become apparent that detailed planning of mineral extractive operations is essential if a degree of compatibility of the mining industry in the urbanizing landscape is to be achieved. As urbanization of Ontario proceeds, there are increasing social pressures bearing on the mineral extractive industry to improve their appearance and operating practices. Man is becoming increasingly aware of the necessity of maintaining and improving the quality of his environment. As this awareness spreads, it is important that the aggregate producer pays serious attention to improving his public image in the community.

The purpose of this report is to give suggestions on the process of site planning for the mining operation to be carried out, from time of initiation to the ultimate rehabilitation. Suggested improvements in operating practices are given and the limitations of unplanned rehabilitation are discussed. Chapter IV consists largely of photographs of rehabilitated pits and quarries in Southern Ontario.

The dictionary definition of "rehabilitation" is: to restore; to put into original condition; to repair; in effect it means to correct or fix something that has been damaged. However, in the context of this report, rehabilitation of mineral-bearing lands means *planned mining and land shaping*. The process of site planning means that mining and land shaping operations are planned and programmed in advance, before mining operations are initiated. As far as possible the extraction operation that makes an excavation, which may require repairs, should be combined with land shaping operations to convert the mined-out land into a different, attractive, and useful form during and after the course of the extractive operations.

There are limiting factors to the extent of rehabilitation that can be carried out, such as lack of top soil, low land values, poor access, and the lack of adequate earth shaping equipment. There are also opportunities for rehabilitation, because this concept of progressive land shaping is based on the very nature of the surface mining industry in the urbanizing landscape.

Five dominant characteristics, associated with the surface mining industry, influence the concept of planned excavation. They are:

1. The excavation and processing operations are of a heavy industrial nature that places them in conflict with many so-called "higher" urban uses.
2. The industry is exposed to more and more people as the result of increased population, with more leisure time, greater mobility, and a prolific demand for resources.
3. In extracting the mineral resources, the industry utilizes heavy earth moving equipment that can also be used to create usable land areas.
4. During the course of the extractive operation various amounts of earth materials of limited commercial value must be handled to extract the desired resources.
5. Many extractive operations are located within urban expansion areas where land values are relatively high or where the potential for high land values exists.

Objectives

In the face of these conditions, the objectives of planning the rehabilitation of mined-out sites before they are mined-out are:

1. Minimize objectionable operational characteristics.
2. Improve the appearance of the mine area during and after operations.
3. Make efficient use of available equipment, earth material, and site characteristics, in an effort to develop the highest economic potential of the mined-out site.
4. Create usable land areas and therefore more valuable real estate for the after-use of mined-out sites.

To achieve these objectives, and to gain the most benefit from the effort, one important factor must be considered in planning the rehabilitation of the sites before excavation is initiated. This is that the rehabilitation operation must be an integral part of the mining operation. The degree to which these two operations are integrated depends upon the nature of the mining operation, the site, and the environment. Thus, the function of the surface mining operation is to extract and process the mineable material *and* shape the land into a usable form. As illustrated in subsequent chapters, the rehabilitation of depleted sites, independent of the mining operation, can be inefficient and less effective in creating usable and resaleable land. Overburden will be misplaced, often necessitating excessive handling costs, and significant site characteristics may be ignored.

It is the purpose of this report to discuss and illustrate some of the procedures, techniques, and opportunities of planned rehabilitation. The following chapters contain information pertaining to:

1. The plans and information required in the preparation of a rehabilitation plan.
2. Techniques for gaining the most benefit from land reclamation activities.
3. Limitations of unplanned rehabilitation.
4. After-uses of depleted sites.

Site Planning

In order to conduct an organized, efficient, and compatible mining operation it is necessary to collect and analyze information about the *site, surrounding environment, deposit,* and *operations.* The excavation and rehabilitation program will be based on this information.

Following is a check list of information significant in a planned mining program.

The Site:	Location Boundary survey Easements Acreage Access Drainage Topography Vegetation Screened areas Exposed areas
The Environment:	Existing land uses Proposed land uses Road network Adjacent structures Utility extensions Zoning regulations Views into the site
The Deposit:	Type of deposit material Depth of deposit Shape of deposit Depth of overburden Character of overburden Groundwater elevation
The Operation:	Type of earth moving equipment Excavation pattern Rate of excavation Height of buildings Road plan for pit Plant area needs Office location Washing requirements

After collecting the information, it is analyzed to determine:

1. Screening requirements on the site.
2. Suitable location for the processing plant with respect to efficient mining practices *and* compatibility with adjacent lands.
3. Desirable areas for building future land forms.
4. Reclamation requirements.
5. Stripping and stockpiling patterns and locations.
6. Desirable excavation patterns with respect to efficient mining practices *and* compatibility with adjacent lands *and* efficient land shaping practices.
7. The use of mining equipment in shaping the land.
8. Ultimate shape of the mined-out deposit.
9. Progressive mining and rehabilitation schedule.

The site planning sketches illustrated include two examples of planned rehabilitation. The first example involves a quarry site utilizing an aerial photograph as a base. The second example demonstrates a sand and gravel site with a topographic base.

Site Description

The "Surface Features Map", Figure 1, illustrates the character of the proposed quarry site and adjacent lands. In general the aerial photograph and overlay indicate residential development encroaching upon the site from the north with potential residential development surrounding the property on the west and south. The area along the Provincial Highway is a commercial zone to a depth in the site of 300 feet.

The site is relatively flat with overburden ranging from 15 to 35 feet in thickness. The property is well screened along the western and southern property lines, partly screened along the Provincial Highway, and exposed to the encroaching residential development on the northern side.

Operation Description

The Operation Plan for quarrying the limestone deposit is given in Figure 2. Approximately 95 feet of limestone is to be quarried in two lifts in the deepest part of the proposed quarry. The plan shows the existing and proposed earth and tree screens, the proposed plant and stockpile area, and the areas to be quarried. The operation schedule is as follows.

OPERATION SCHEDULE

Phase I

Plant and construct screens.
Progressively strip overburden from Area 1 and stockpile in Area 2.
Progressively quarry the upper 60-foot lift of Area 1 proceeding west from the eastern boundary.

Phase II

Progressively strip overburden from Area 2 and move overburden to slope the northern, eastern, and southern faces of the 60-foot lift in Area 1.
Progressively quarry the upper 60-foot lift of Area 2.
As more overburden is stripped, use it to cover and shape the quarried Area 1.

Phase III

Progressively quarry the lower 35-foot lift from the area indicated in Area 2.
Establish pump station, in conformity with the regulations of the Ontario Water Resources Commission.

Phase IV (Rehabilitation)

Complete the reshaping and contouring of Area 1.
Slope the eastern edge of the quarried Area 2 to achieve a slope to the lake that will form in the quarried lower lift.
Remove the plant and stockpiles.
Complete rehabilitation of the site to give access to the lakeshore along its eastern edge.

Figure 3 is a cross-section of the proposed quarry along the section A-B shown in Figures 1 and 2. The elevation of the quarry floor is 660 feet. The water table has an elevation of 690 feet and the lower lift has a height of 35 feet. The elevation of the floor of the upper lift is 695 feet. The deposit of limestone is flat-lying.

REHABILITATION

Progressive rehabilitation and reshaping of Area 1 is carried out during the quarrying operation. The final configuration of the rehabilitated property is shown in Figure 4. The western part of the property is occupied by a lake that lies in the quarried Area 2. The eastern part of the property is reshaped and contoured to form a sloping area to the lakeshore.

Potential uses for the property are for single or multiple family housing, an office park, a research park, a small college campus, a resort, a local park, a sportsman's club, or a commercial recreation area.

Note: It is understood that each site has to be decided on its own merits, taking into account location, depth of overburden, slope of rock formation, depth of mineable rock, depth of water, and other factors. This is an illustration to show the type of planning that may be included with the site plan.

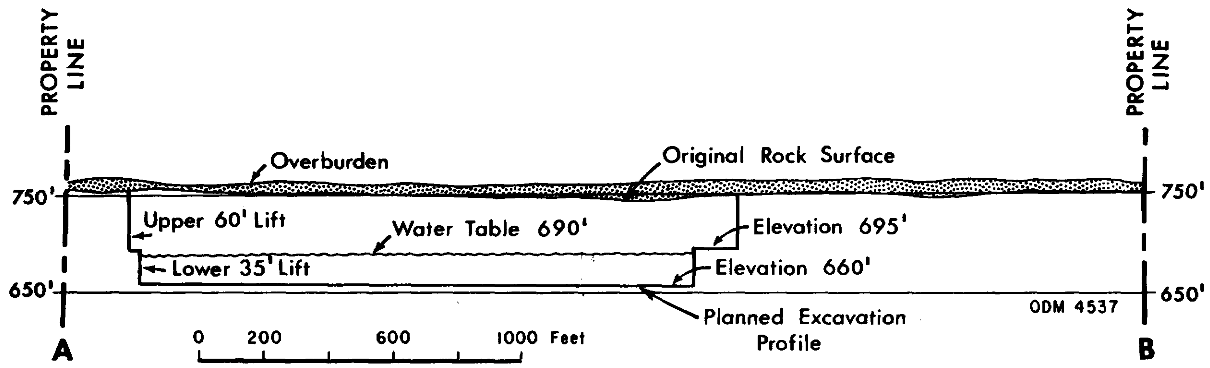
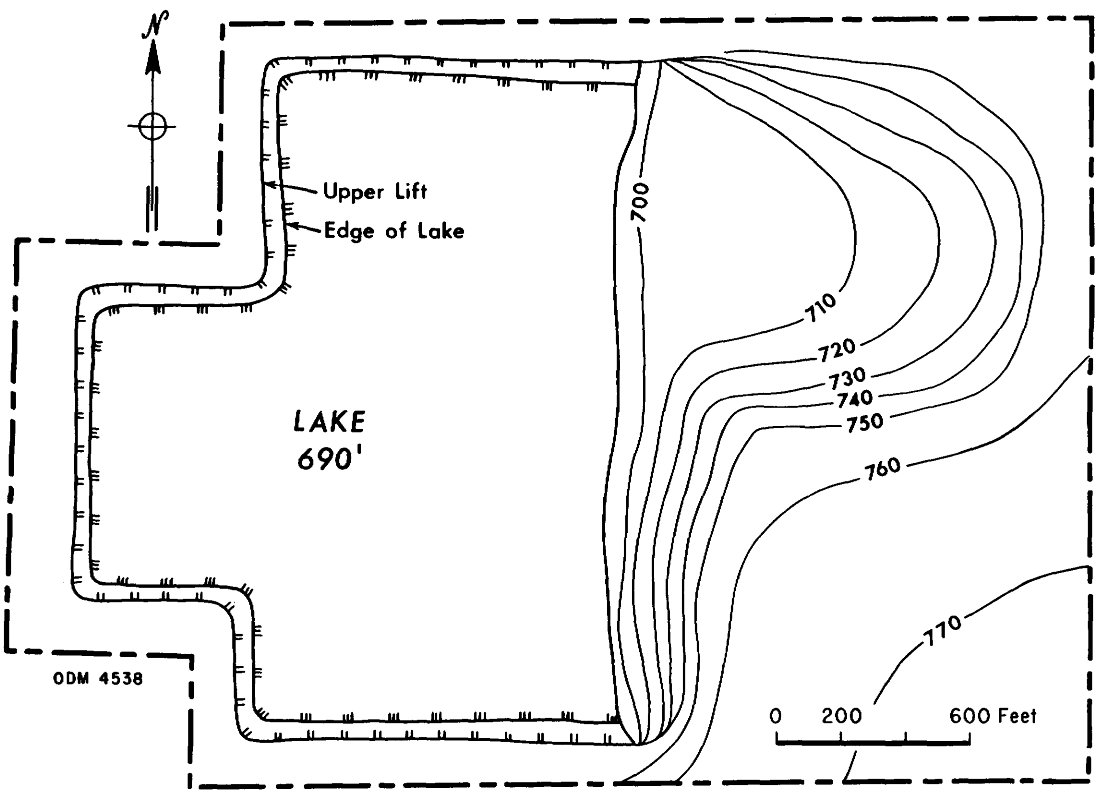


Figure 3 — CROSS-SECTION OF PROPOSED QUARRY SECTION A—B



POTENTIAL USES

Single Family Housing	Research Park
Multiple Family Housing	Local Park
Office Park	Sportsmen's Club
Small College Campus	Commercial Recreation Area
Resort	

Figure 4 — REHABILITATED PROPERTY

Proposed Sand and Gravel Pit

Figures 5 to 9 describe the proposed development and rehabilitation of a sand and gravel deposit. Figure 5 is a plan of the existing site of 421 acres in Calebridge Township. The site is bounded on the southwest by Hanlon Road along which there is residential development on the southwestern side. There is a proposed subdivision along the northwestern side of the site. The northeastern boundary of the site is an unpaved township road. The southeastern side of the proposed site is an agricultural area. The contours of the surface of the proposed site are given.

Figure 6 shows the operation schedule for mining the upper lift of gravel above the water table. A section through the deposit is given in Figure 8. The plant is sited in the northern corner of the property and excavation proceeds to the southwest towards Hanlon Road. Proposed tree and earth screens are shown in Figure 6.

The excavation below water is shown in Figure 7, which also shows the shoreline of the proposed lake. Figure 8 shows the proposed final grading of the site after excavation of the sand and gravel, and after land shaping operations have been completed.

A proposed residential development scheme for the property is indicated in Figure 9.

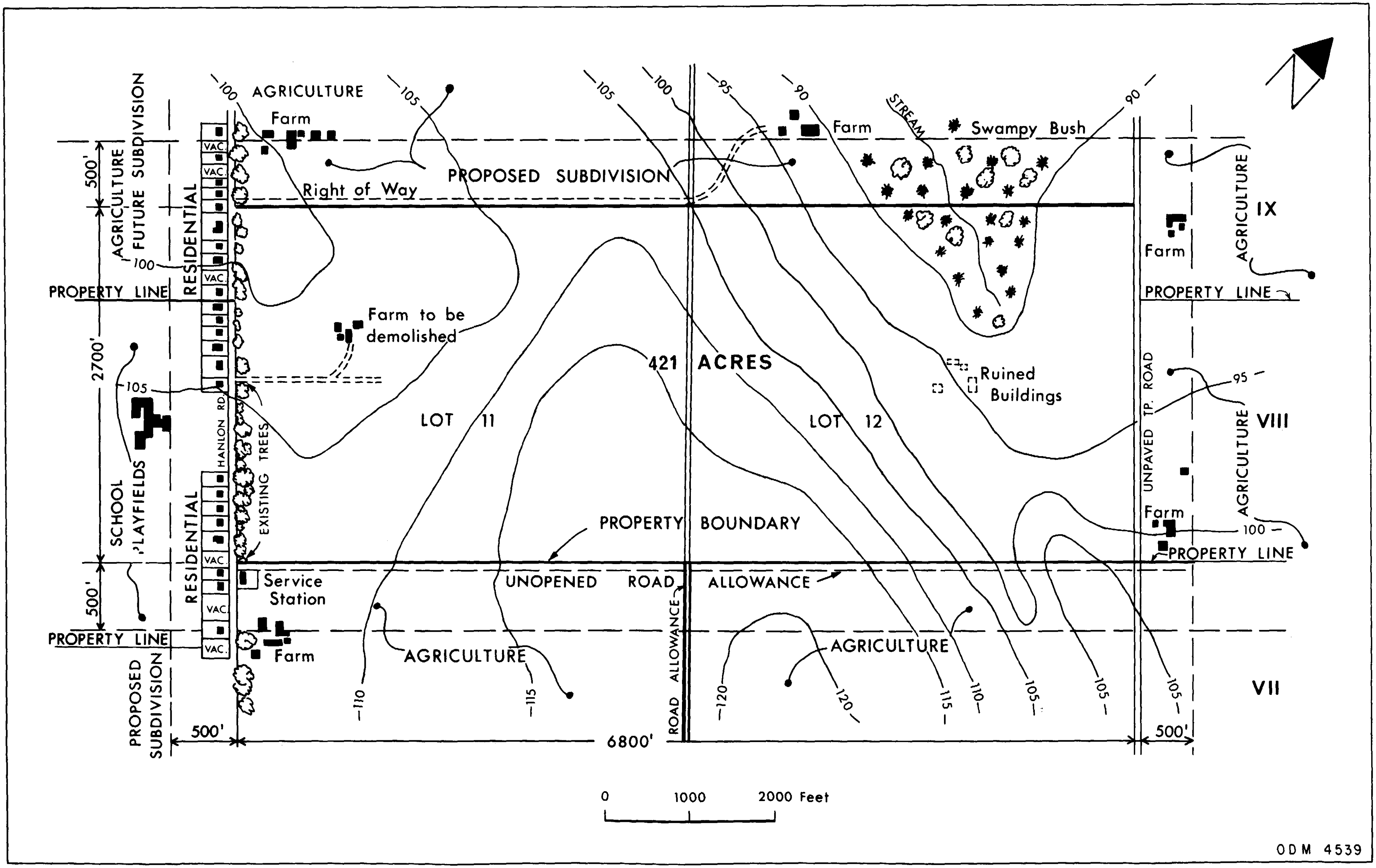
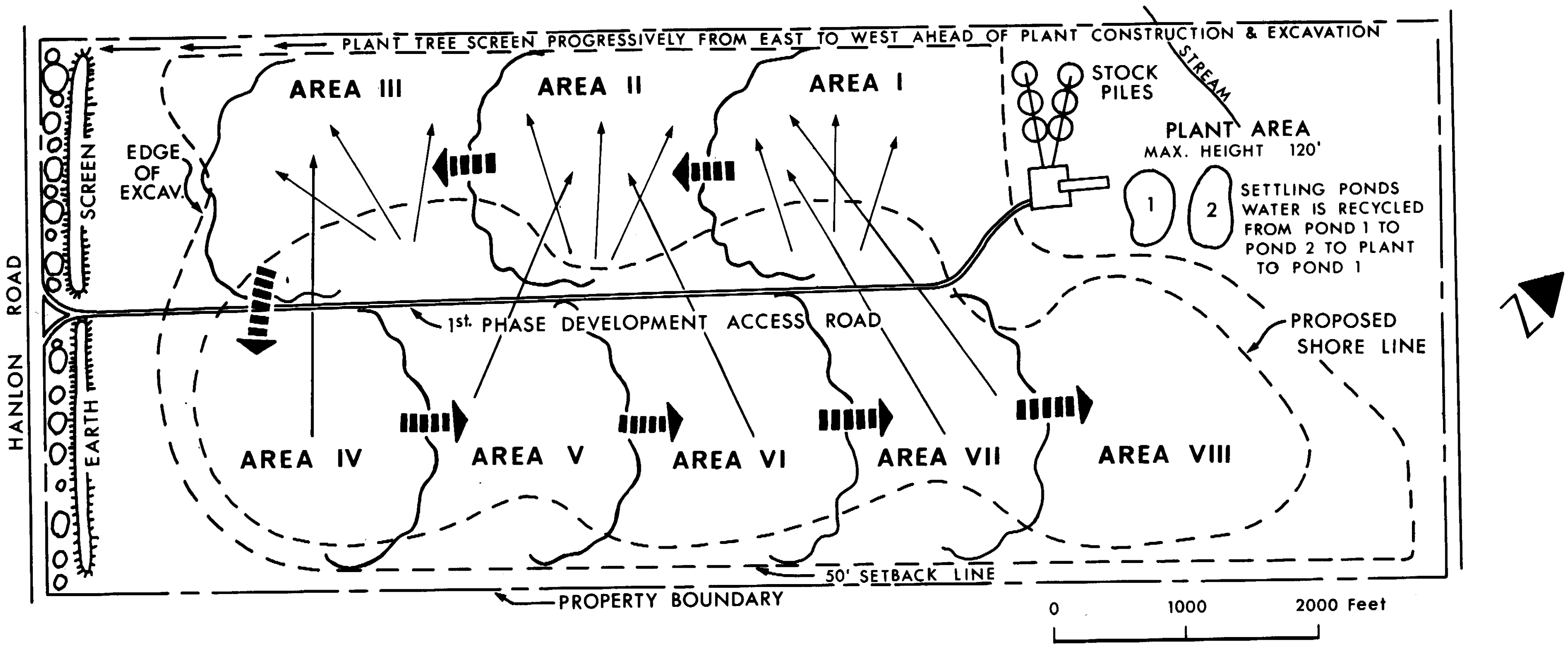


Figure 5 — PLAN OF EXISTING SITE



AREA I
1. STRIP AND CONSTRUCT OVERBURDEN SCREENS ALONG HANLON RD.
2. INITIATE EXCAVATION IN THIS AREA
3. EXCAVATE IN DIRECTION INDICATED BY ▮▮▮▮▶
4. STOCKPILE OVERBURDEN IN AREAS INDICATED BY ⟶

AREA II
1. EXTEND EXCAVATION

AREA III
1. CONSTRUCT ACCESS ROAD ALONG NORTH BANK OF PROPOSED LAKE
2. BEGIN SHAPING NORTH BANK: SPREAD OVERBURDEN ON BANK AND SEED (SEE CROSS-SECTION $A_1 - A_2$ FIGURE 8)

AREA IV
1. ABANDON EXISTING ACCESS ROAD
2. MOVE OVERBURDEN INTO AREA III
3. BEGIN SHAPING AND SEEDING OPERATIONS IN AREA III

AREAS V, VI, VII & VIII
1. MOVE OVERBURDEN FROM THESE AREAS TO AREAS I & II
2. BEGIN SHAPING & SEEDING OPERATIONS IN AREAS I & II
3. BEGIN SHAPING SOUTH BANK (SEE CROSS SECTION $A_1 - A_2$ FIGURE 8)
4. BEGIN TREE PLANTING PROGRAM ALONG SOUTHERN BANK, ALONG WESTERN BANK, AND ALONG DESIGNATED NORTHERN SHORELINE AND SITE BOUNDARY.

NOTES
1. AN "AREA" REPRESENTS APPROXIMATELY TWO YEARS' EXCAVATION
2. LENGTH OF OPERATION: 10 TO 15 YEARS
3. PLANT SITED 15 FT. BELOW AVERAGE EXISTING SITE ELEVATION AT ELEVATION 90.0

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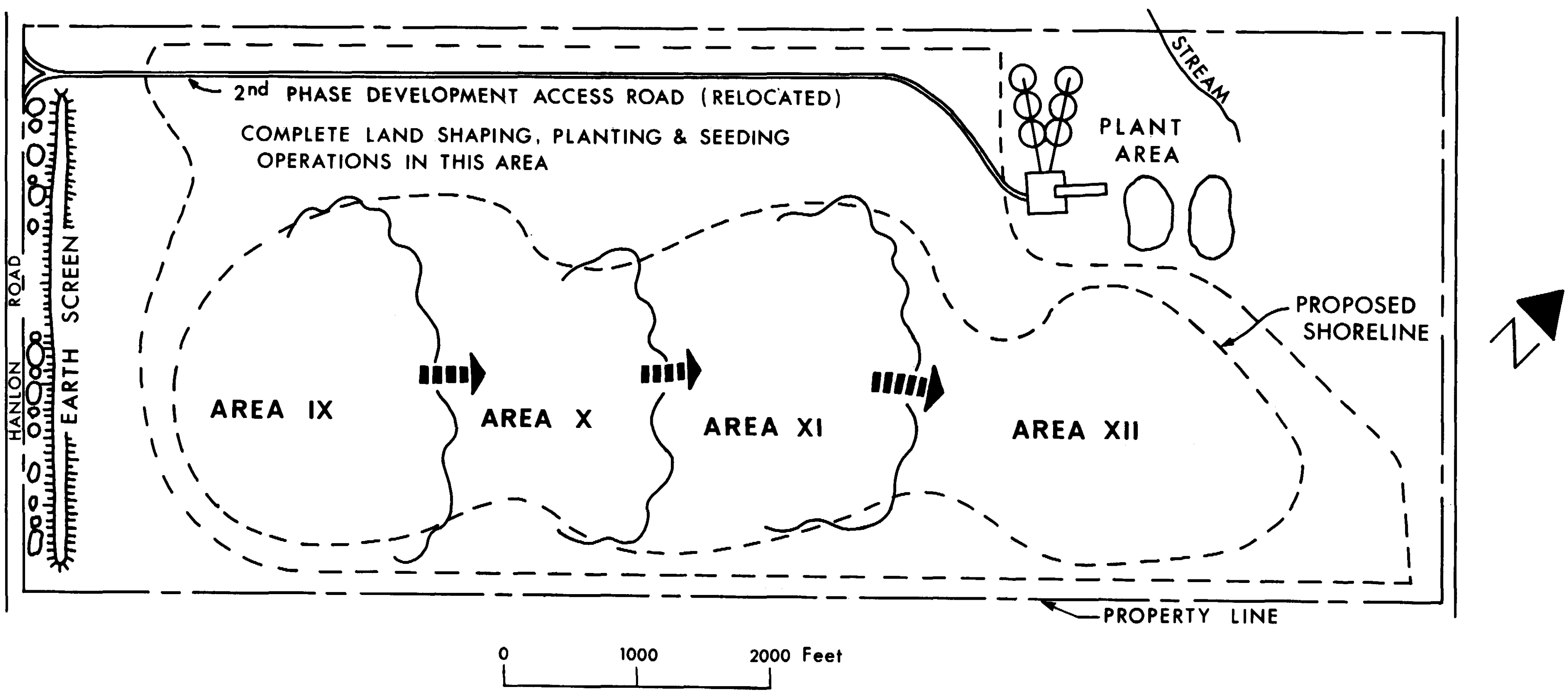
Figure 6 — PROPOSED SITE DEVELOPMENT



AREAS IX, X, XI & XII

1. BEGIN EXCAVATION BELOW WATER IN AREA IX
2. SHAPE & LANDSCAPE SHORELINE CONCURRENTLY WITH EXCAVATION IN ALL FOUR AREAS
3. COMPLETE LANDSCAPE OPERATIONS ON REMAINING SITE
4. REMOVE PLANT
5. REMOVE OVERBURDEN SCREENS ALONG HANLON ROAD

NOTES

1. AN "AREA" REPRESENTS APPROXIMATELY ONE YEAR'S EXCAVATION
2. LENGTH OF OPERATION 5 TO 8 YEARS
3. PLANT SITED 15' BELOW AVERAGE EXISTING SITE ELEVATION AT ELEVATION 90.0

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Figure 7 — PROPOSED SITE DEVELOPMENT

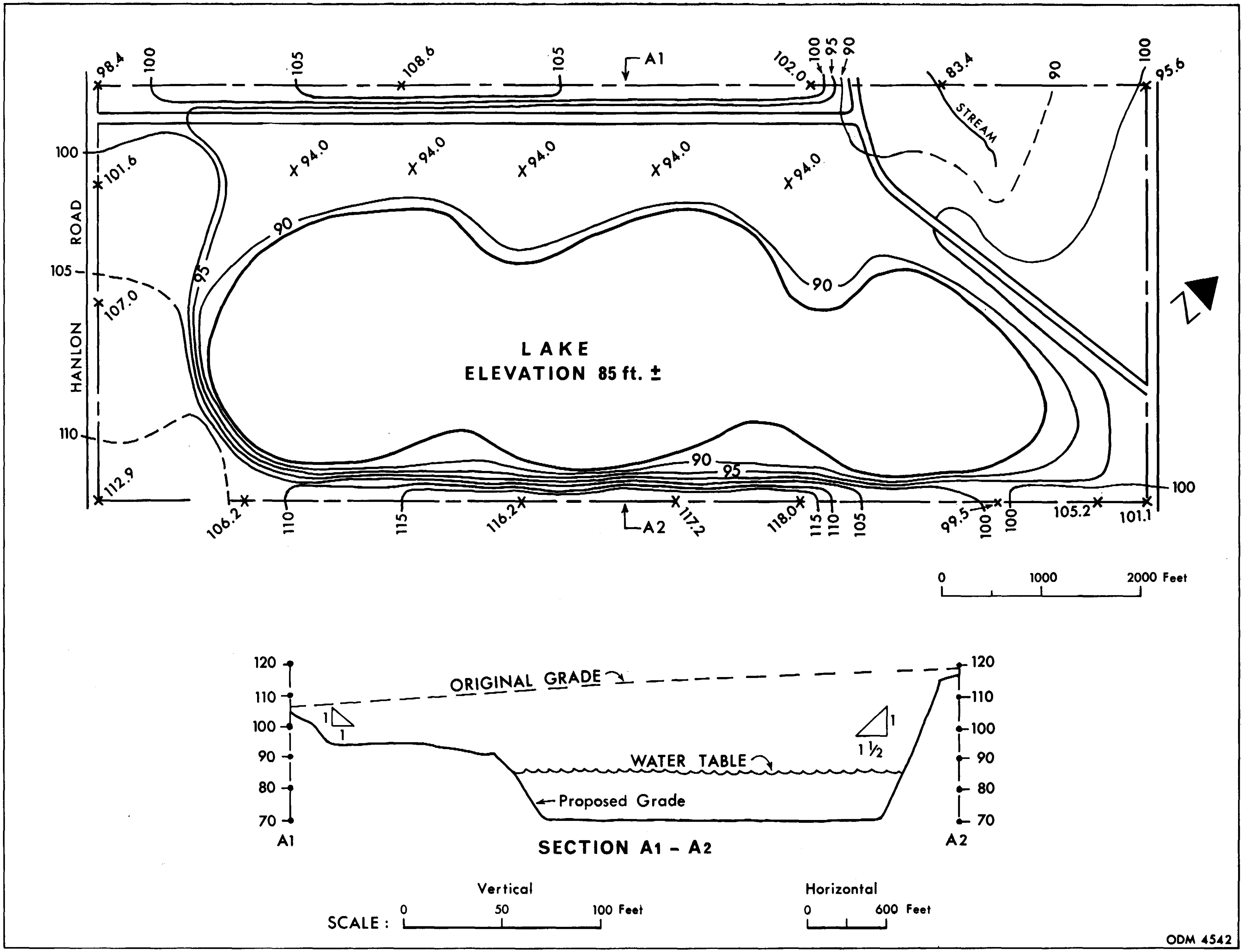

Figure 8 — PROPOSED FINAL GRADING

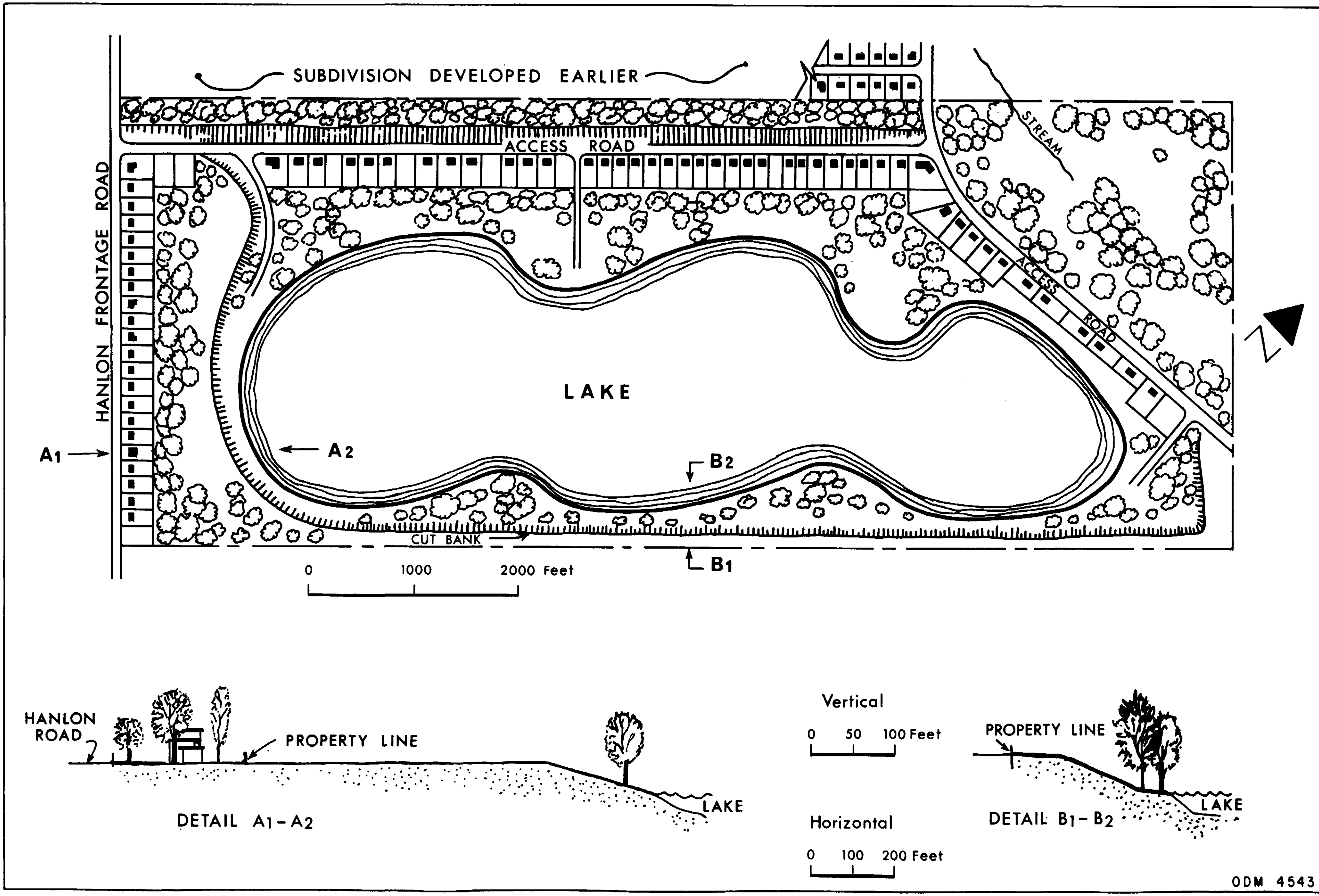

Figure 9 — PROPOSED RESIDENTIAL DEVELOPMENT SCHEME

CHAPTER II

OPERATING PRACTICES

As indicated in the Introduction, the objectives of "planned rehabilitation" include minimizing the nuisance features of a surface mining operation and efficiently using the earth moving equipment and deposit characteristics in reshaping the land. This chapter discusses some of the techniques mining operators can consider in their efforts to minimize objectionable features and gain the most benefit from their land shaping activity.

Compatibility of Plant and Extractive Operations

Commonly, industrial features that stimulate public resentment can be avoided or muted in the planning process. This includes the processing plant area as well as lands disturbed by excavation.

It is necessary to point out that there is a wide variation in what is considered objectionable, and each site should be reviewed with this in mind. What may be acceptable in one locality may be undesirable in another. For example, aggregate stockpiles in predominently industrial areas are not likely to leave the same impression as aggregate stockpiles in suburban or rural areas. In another example, mine sites considered acceptable today may be very objectionable in the course of a few years as a result of changing land use patterns on surrounding lands.

The mining operator can maintain an acceptable position in the changing landscape if he includes this aim as an objective in his planning program. Furthermore, he will have more flexibility, in terms of his operations, if changing land use patterns and associated community relations problems are considered before the operations are established on the site. As an example, if the potential for residential development exists on one side of the mine site the operator might consider:

1. Locating the processing plant on the opposite side of the property.
2. Constructing earth and (or) dense vegetation screens along the concerned boundary.
3. Initiating extractive operations near the concerned boundary so that that part of the deposit is mined-out and rehabilitated by the time the anticipated residential development occurs.

But whether it is an existing or future operation the following conditions and techniques should be considered.

There are two basic issues:

1. Exposure of the mine area to the public.
2. Incompatibility of the buildings, grounds, and operations with adjacent land uses.

The more a plant is exposed, the greater the need for an attractive, well maintained complex. In the same light, the more incompatible the mining complex is with adjacent land uses, the greater the need for effective screening. This applies to dust and sound conditions as well as to views.

Many of the "image" problems can be avoided by proper siting of the processing plant. Existing site characteristics such as terrain and vegetation may offer excellent opportunities to screen the plant area from adjacent developments. Thus, in selecting a site for the processing plant, the operator should, in addition to considering access, plant area, and operational requirements, take into account the nature of existing terrain and vegetation. Figures 10 and 11 illustrate two examples of utilizing natural screens.

In the effort to minimize public opposition, planning the excavation pattern is as significant as selecting the plant site. As in the case of the plant site, existing site conditions can be an asset in screening extractive operations. By taking advantage of a hill, a hollow, or vegetation, the excavation may be screened from public view throughout most of the operation. Thus, operating procedures and deposit features taken into account, site conditions may influence the starting point of the excavation and the direction it moves.

Noise and dust are not uncommon characteristics of the mining operation. The more populated the adjacent lands, the more irritable these conditions will be. There are two site planning factors to consider in attempting to minimize this particular problem. They are:

1. Prevailing winds.
2. Distance between the source and the objectors.

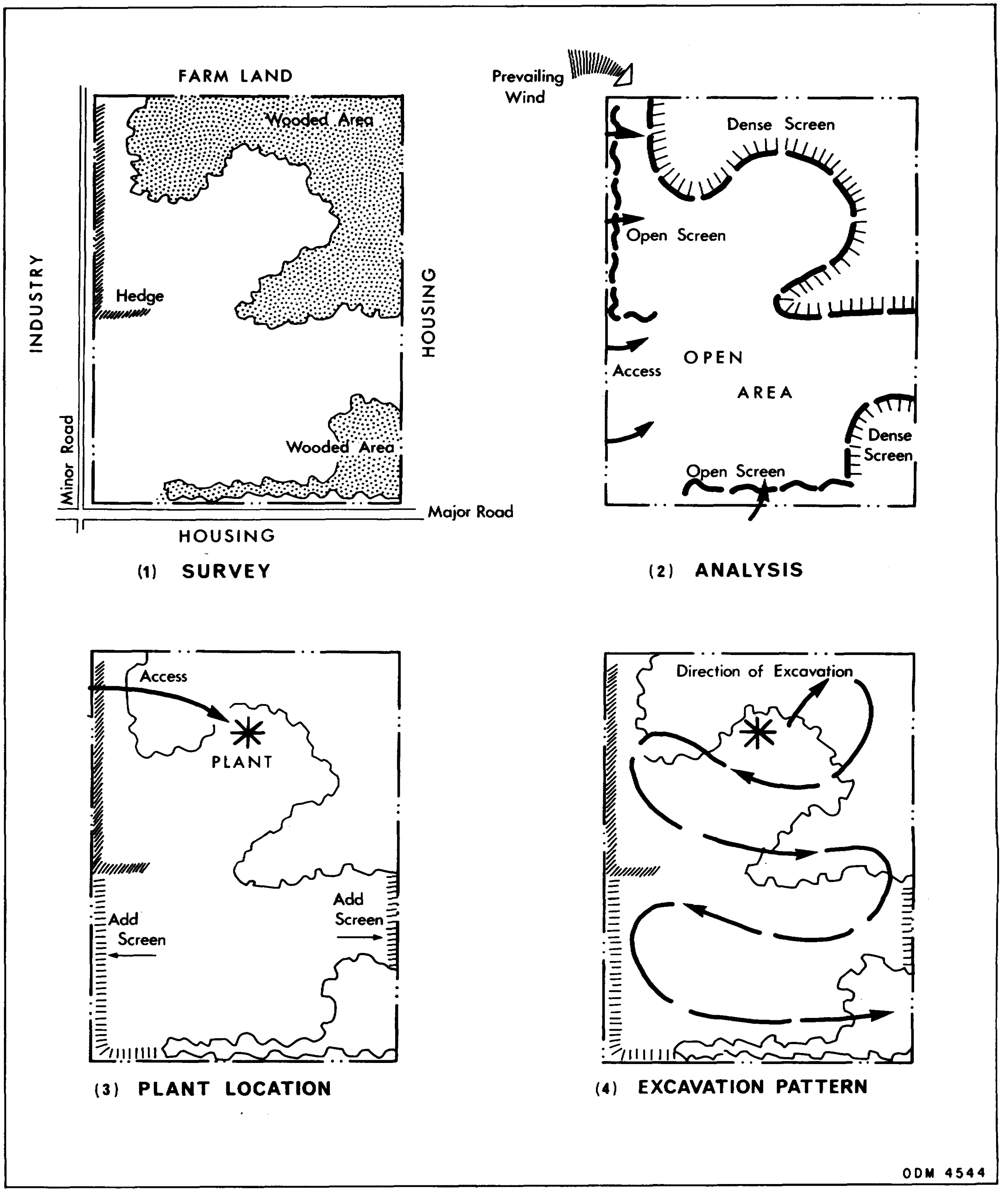

Figure 10 — VEGETATION SCREENS

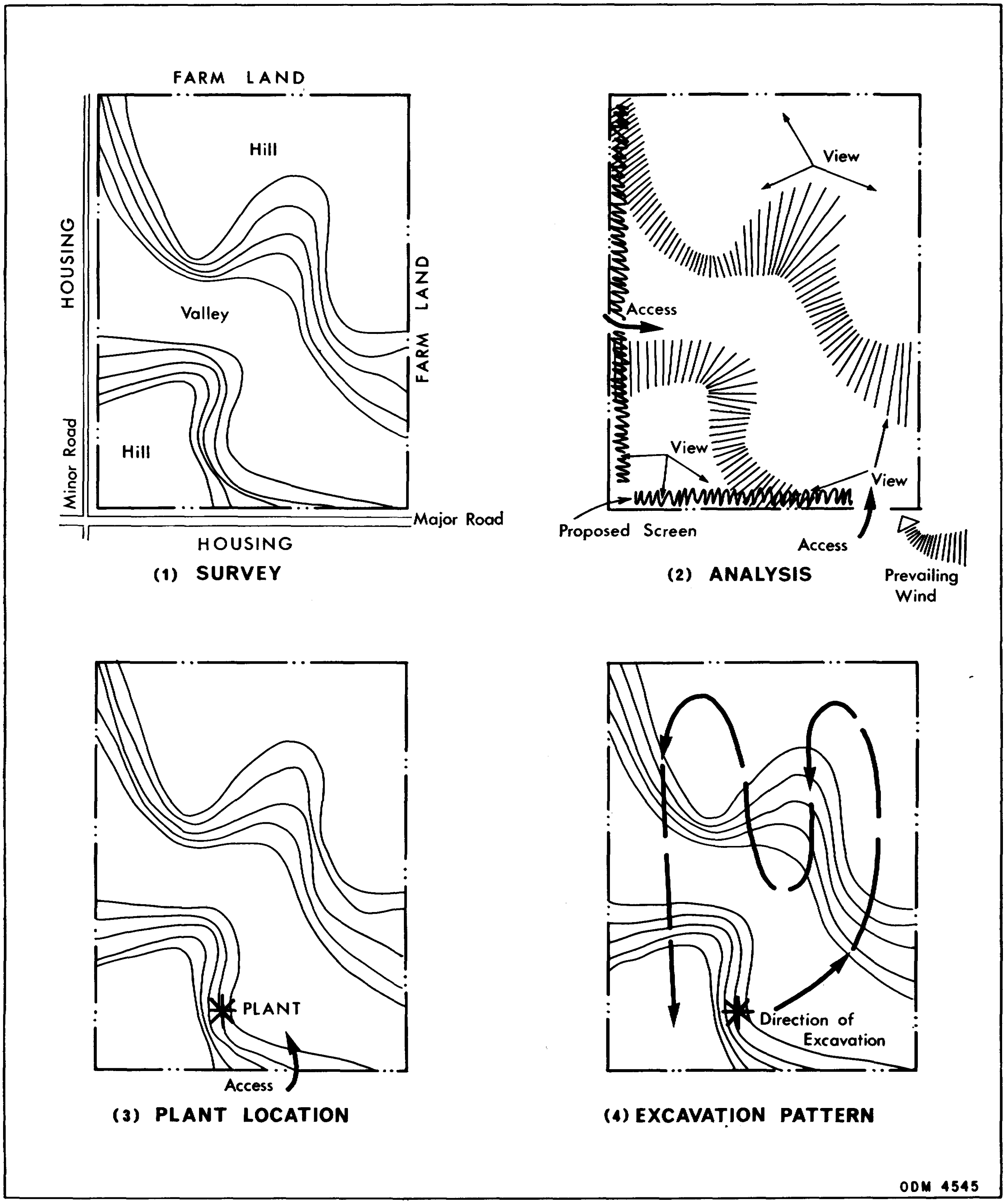

Figure 11 — TERRAIN SCREENS

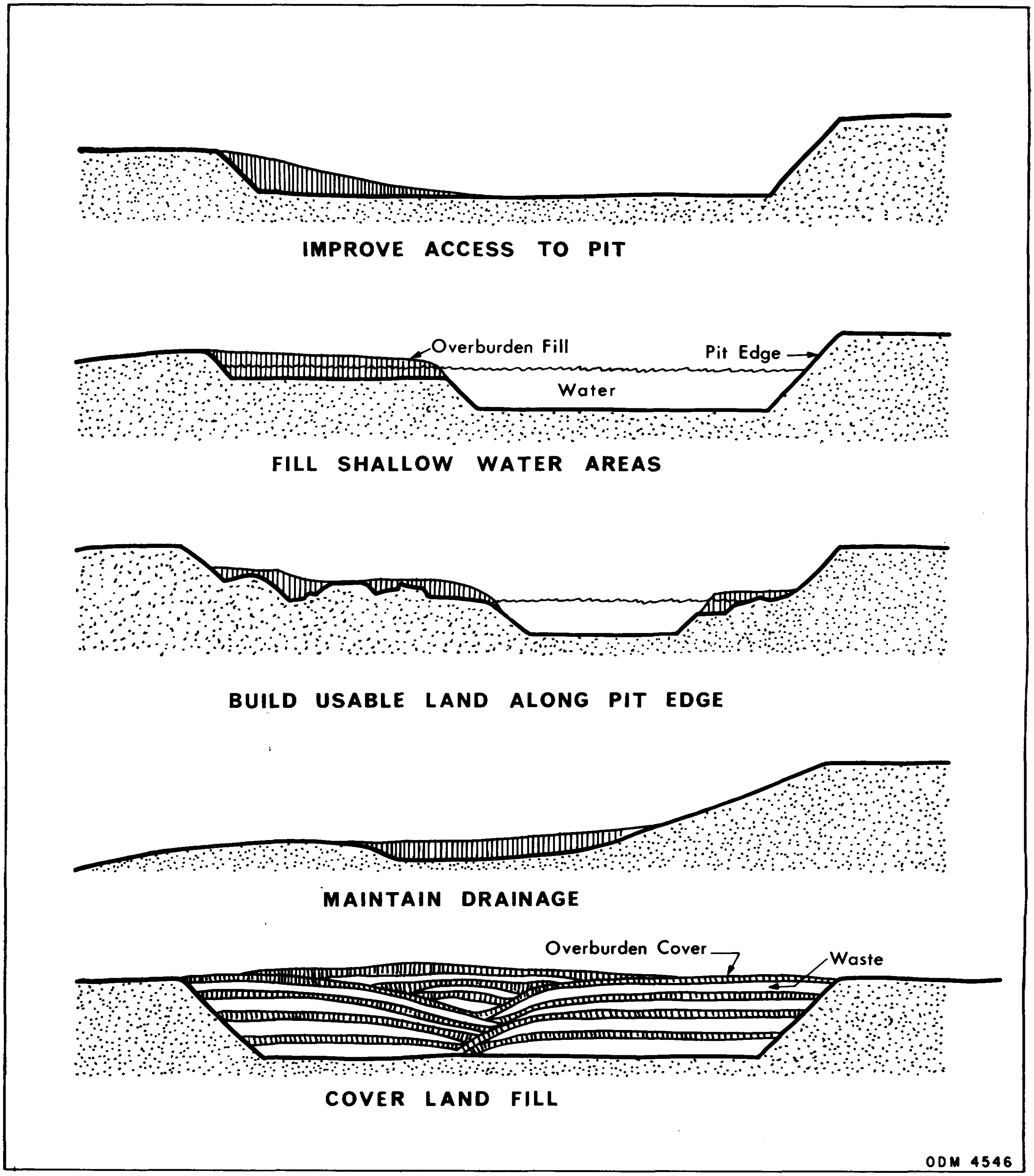

Figure 12 — OVERBURDEN USES

No hard and fast guidelines exist for attacking this problem by way of site planning. However, if, for example, a residential development is down-wind from the mine site it is obvious that the farther up-wind the plant is located the less impact noise and dust will have on the residents. Again, site features, such as hills and woodlands can be utilized to a significant advantage. Whenever efforts are made to minimize this particular problem through site planning, there is no substitute for good housekeeping and grounds maintenance practices.

USE OF OVERBURDEN

Overburden is the material that must be excavated and transported to excavate the primary resource. It is also a material that has many uses in a land shaping program. For example, it can be used as:

1. Fill to improve pit access.
2. Fill for shallow water areas.
3. Fill to build and shape land around excavated lakes.
4. Fill to maintain adequate surface drainage.
5. Cover material in sanitary land-fill operations.
6. Screens to buffer sounds and views.
7. Base for re-establishing vegetation.

Overburden is an essential material in any land shaping operation and therefore, *should not* be removed from the mine site. Also, because the reestablishment of a vegetative cover is a critical problem in any rehabilitation program and because topsoil is essential for healthy vegetative growth the operator should give serious consideration to separating the topsoil from the subsoil in the overburden stripping operation.

The alternative to this is the creation of unproductive soils as a result of mixing the topsoil with the subsoil in the stripping operation. The result varies, but this procedure often creates a soil with a low organic content and poor physical structure that cannot support a good vegetative stand. To a certain extent this problem can be overcome with various soil improvement practices. But, each situation must be reviewed on its own merits. Therefore, it is often appropriate to obtain the advice of a soil scientist about a management program for maintaining or improving the fertility of stripped overburden.

USE OF VEGETATION

Vegetation serves three important functions for a pit or quarry operator. It can be used to:

1. Screen unsightly areas.
2. Improve the appearance of the site.
3. Control dust and erosion.

However, vegetation does not provide an instant solution. It takes years for plants to mature to a size when they will be effective. Therefore, it is important to undertake a planting program as early in the development of the mining operation as possible.

In selecting plants, the operator should be aware of plant characteristics that will best serve his needs. There are several general guidelines to follow:

1. The plants should be hardy in the local area. Many plants common in Niagara Falls will not survive in the Ottawa region.
2. The plants should be fast growing.
3. The plants should be selected on the basis of local soil conditions. Some plants will do well in wet soil, others in dry soil, and others in poor soil.
4. The plants should be of a form that will provide effective screening. Columnar trees or low growing plants require special consideration for screening purposes.
5. The plants should require a minimum amount of maintenance.

Operators should recognize that most plantings will require some maintenance, particularly during the first year or two after planting. This is particularly important if there is an extended dry spell when watering of recent plantings would be essential to maintain a suitable plant survival percentage.

Information about plant characteristics can be obtained from the Department of Lands and Forests and from forestry and horticulture departments at various universities. Tables 1, 2, and 3 indicate plant materials suited to many of the conditions of surface mines. It is by no means a complete list of hardy plant materials.

Screen plantings will be located primarily around the edge of the mine site. These plants will be aligned, more or less, in a lineal pattern if total screening is required. Variation in the lineal form can be accomplished by introducing a variety of species into the planting scheme. To be of maximum benefit, plant materials should be installed prior to the operations and be of sufficient size and density to achieve relatively quick results. Token plantings of small size and wide spacings provide minimum results and the basic reasons for the plantings cannot be achieved when desired. By planting a combination of plant materials a quicker and more attractive screen can be achieved. One such example would be to plant a row of shrubs in front of a row of deciduous trees. Figures 13, 14, and 15 illustrate several screening considerations.

Not all areas require "instant" screening. For example, when a particular section of the site will not be disturbed for a long period of time smaller and less expensive plants can be installed far in advance of any anticipated conflict, thus providing a mature and effective screen when the need arises.

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Photo 1—Nelson Crushed Stone, Burlington, Ontario. Photo courtesy of Nelson Crushed Stone, Division of King Paving and Materials Limited. Photos 1 and 2 illustrate the effective use of rows of evergreen and deciduous trees as tree screens for the plant area. Photo 1 *shows the spacious lawns near the plant site.*

Photo 2—Nelson Crushed Stone, Burlington, Ontario. Photo courtesy of Nelson Crushed Stone.

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Photo 3—This photo shows the spacious lawn and trees on the Nelson quarry property at Burlington. Effective use has been made of landscaping. Photo courtesy of Nelson Crushed Stone.

Photo 4—Nelson Crushed Stone, Burlington, Ontario. The company has an evergreen nursery on the property to supply trees for their planting program. Photo courtesy of Nelson Crushed Stone.

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Table 1 HARDY TREES

Plant Name	Soil Conditions			Effective Screen	Fast Growing
	Wet	Dry	Poor		
Acer rubrum (Red Maple)	X	X	...	...	X
Acer saccharinum (Silver Maple)	X	X	...	...	X
Alnus glutinosa (European Alder)	X	...	...	...	X
Fraxinus americana (White Ash)	...	X	...	...	X
Juglans nigra (Black Walnut)	X	...	...	...	X
Juniperus (species) (Juniper)	...	X	X	X	...
Picea abies (Norway Spruce)	...	...	X	X	...
Picea glauca (White Spruce)	...	...	X	X	X
Pinus resinosa (Red Pine)	...	X	X	X	X
Pinus strobus (White Pine)	...	X	...	X	X
Pinus sylvestris (Scotch Pine)	...	X	...	X	X
Populus (species) (Poplar)	X	...	X	...	X
Quercus borealis (Red Oak)	...	...	X	...	X
Robinia pseudoacacia (Black Locust)	...	...	X	X	X
Salix babylonica (Weeping Willow)	X	...	...	X	X
Thuja occidentalis (White Cedar)	X	...	...	X	...
Tilia cordata (Little Leaf Linden)	X	...	...	...	...

Table 2 HARDY SHRUBS

Plant Name	Soil Conditions			Effective Screen	Fast Growing
	Wet	Dry	Poor		
Cornus stolonifera (Red-Osier Dogwood)	X	...	...	X	...
Elaeagnus angustifolia (Russian Olive)	...	X	X	X	...
Ligustrum (species) (Privet)	...	...	X	X	X
Lonicera tartarica (Honeysuckle)	...	X	...	X	X
Physocarpus opulifolius (Ninebark)	X	...	...	X	X
Rhamnus frangula (Buckthorn)	...	X	...	X	...
Rhus (species) (Sumac)	...	X	X	X	X
Rosa multiflora (Japanese Rose)	...	X	...	X	X
Syringa vulgaris (Lilac)	...	...	X	X	...
Viburnum (species) (Viburnum)	X	...	X	X	X

Table 3 HARDY GROUND COVERS

Plant Name	Soil Conditions				Soil Improver	Planting Season
	Wet	Dry	Poor	Fertile		
Canada Bluegrass	...	...	...	X	...	Sept.
Fescues	...	X	X	X	...	Sept.
Kentucky Bluegrass	...	...	...	X	...	Sept.
Red Clover	...	...	X	...	X	Sept.
Redtop	X	X	X	X	X	Sept.
Ryegrass	...	...	X	X	...	Mar.
Trefoil, v. Empire	...	...	X	...	X	Apr.

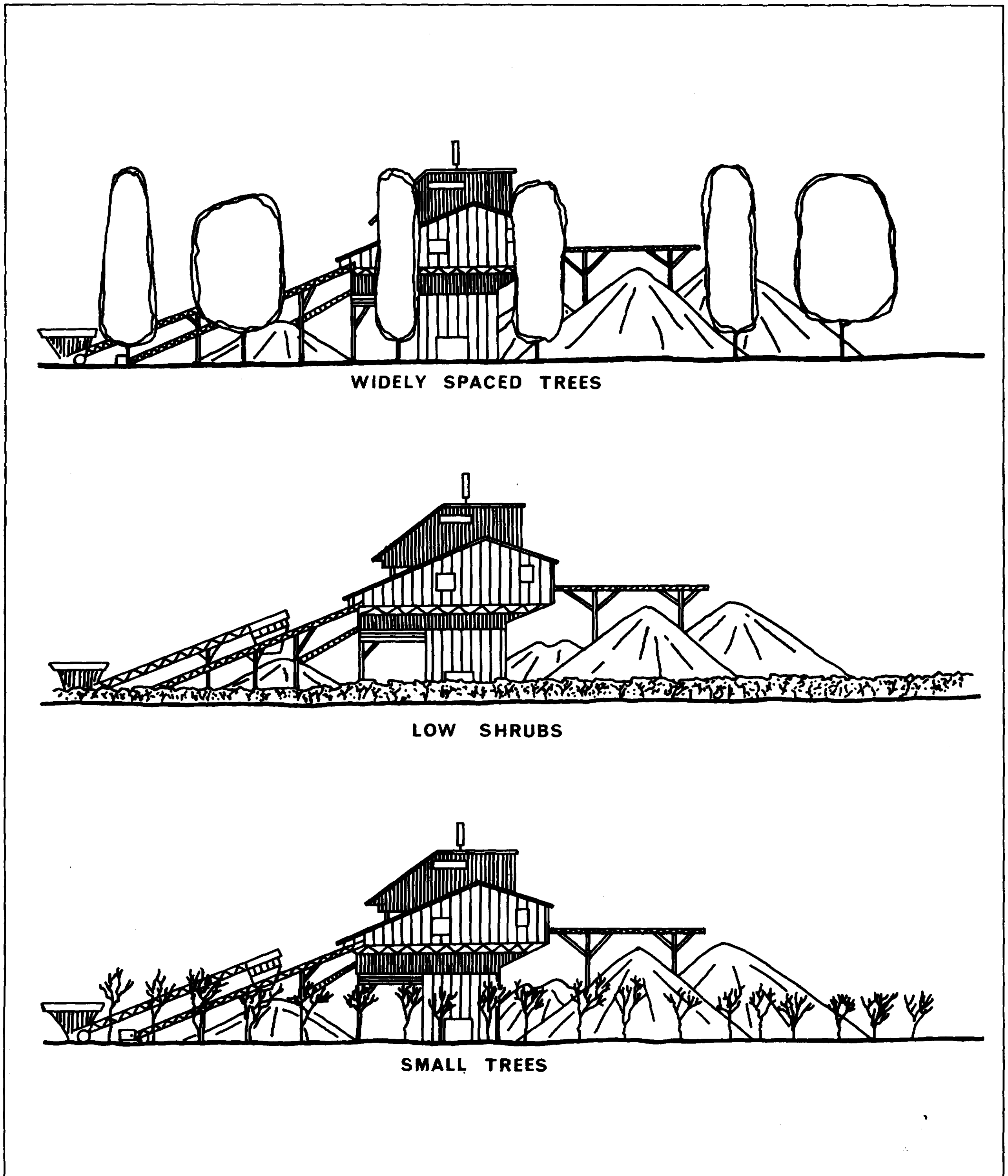


Figure 13 — INEFFECTIVE SCREENS

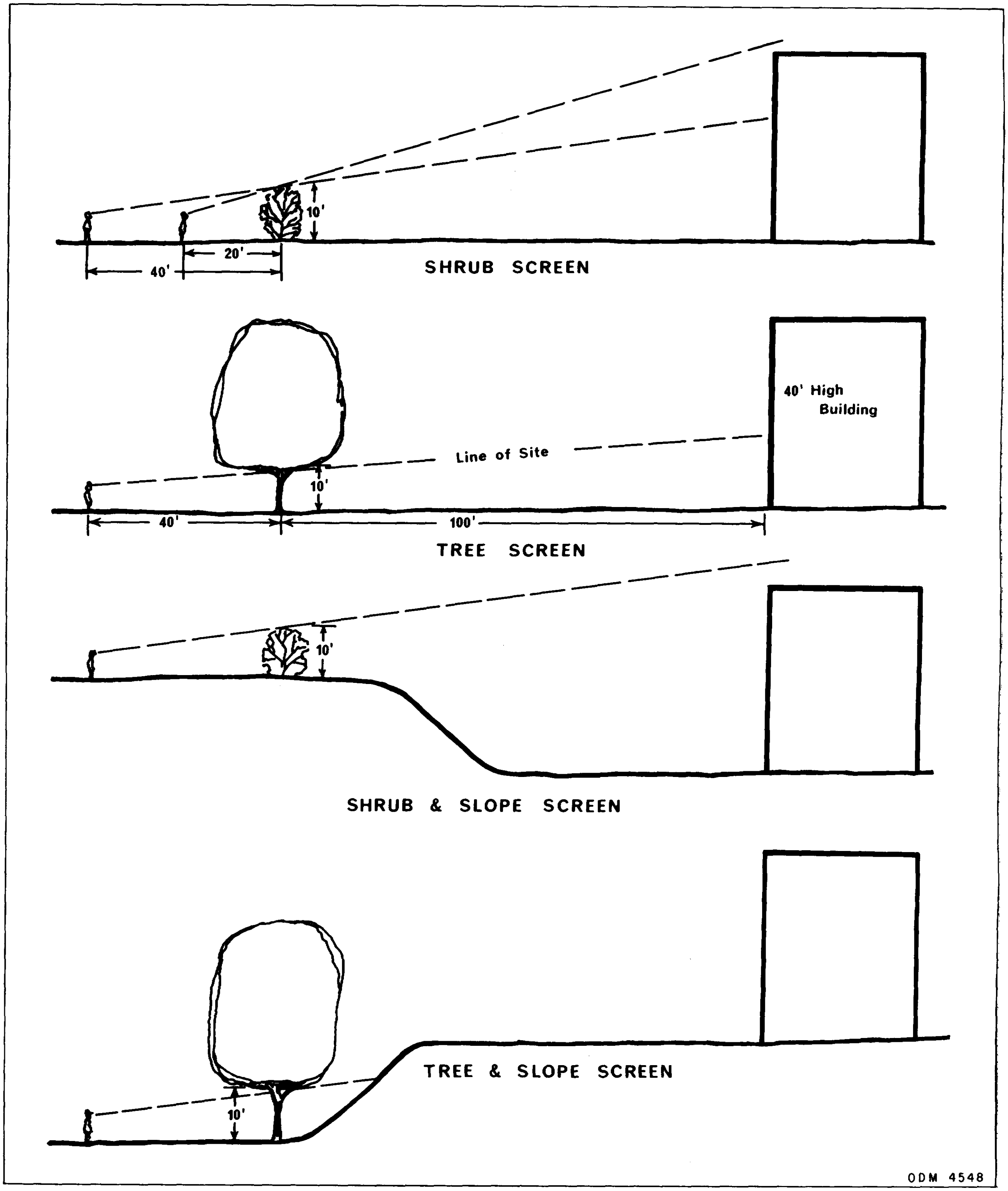


Figure 14 — SCREENING TECHNIQUES

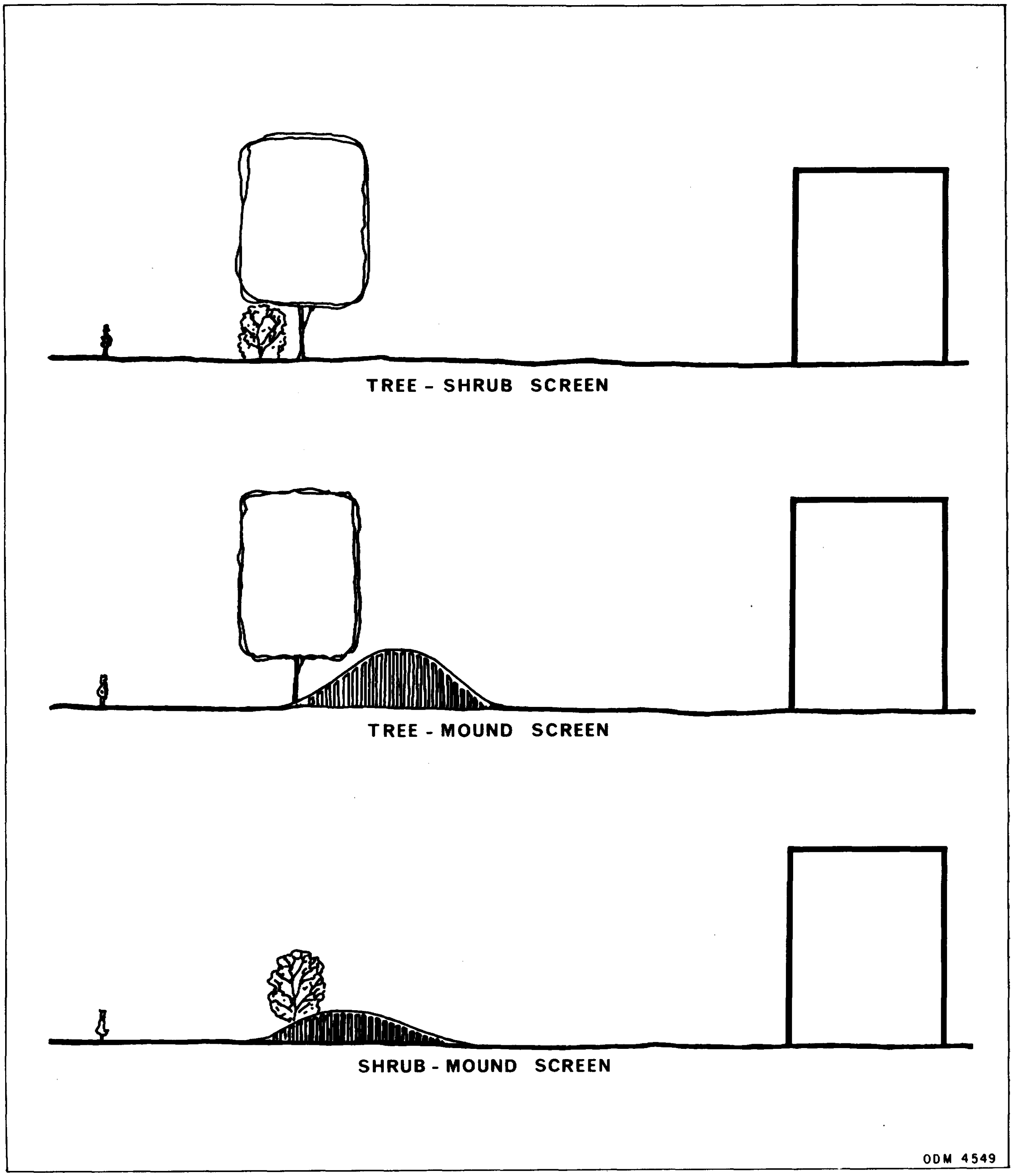


Figure 15 — SCREENING TECHNIQUES

In planning the arrangement of screens the mining operator should take into account the following factors:

1. The desired density of the screen.
2. The height and location of the object(s) to be screened.
3. The future shape and height of the plant material selected.

The plant screen need not be a continuous dense mass of trees and shrubs. Often the plantings can be arranged to make the processing plant structures more interesting and attractive. In many instances it would be desirable to provide variety in the selection and arrangement of plant materials. Figures 16, 17, and 18 illustrate these points.

In addition to screens, plants can be used to enhance the entrance area as illustrated in Figures 18 and 19. They can also have some affect on noise abatement and can definitely be used to control dust, both around the processing plant and in the pit. For example, trees planted adjacent to areas where dust is stirred up, such as along a haul road, will help contain the dust in a relatively small area (see Figure 20).

Planting Schedule

The primary considerations with respect to determining planting season are temperature and moisture. Seeding operations should take place in early spring (March 15 to May 30) or in September; preferably the latter period.

The same condition holds true for planting trees and shrubs with the exception that the most suitable season for planting evergreens is late September or October.

Source of Plant Materials

For a great variety of ornamental trees and shrubs the private nurseries can offer the widest selection. The Department of Lands and Forests is also a major source of plants that should be used by the industry; under certain conditions they will provide and plant large numbers of trees for a very nominal cost.

In addition, some operators have started their own nurseries for future plantings. Also, it is possible, on a limited basis and with suitable equipment, to transplant trees from woodlots on the mine site.

Land Shaping Considerations

One of the realities of planning land rehabilitation programs before mining starts or nears completion is that it is often impossible to determine specific land uses when the mining operation continues for 10 or more years. Unless land use patterns and trends are firmly established in the immediate area of the pit even 5-year projections can go astray. Following this line of thought it might be easy to conclude that there is no value in planning site improvement programs until near the completion of the mining operation. This is a mistake.

Although it may be impossible to determine specific land uses it is entirely possible to shape land to accommodate a wide range of uses. In the final analysis this is what is generally done by the operators.

The major consideration is to avoid creating unusable land. In other words to avoid creating shallow water areas, land too close to water table, land too narrow, steep or fragmented land, or inaccessible land.

There are no specific formulae for determining buildable land but in analyzing various categories of uses it is not difficult to identify a range of common site requirements. In preparing land for future development the producer must consider access to the land, slope, drainage, water table, and area. Table 4 and Figure 21 provide general land shaping guidelines for the producer.

Generally, the larger and flatter the land the greater the range of development. However, variable slope and area conditions can provide unique opportunities for the imaginative developer.

INFLUENCE OF DEPOSIT CHARACTERISTICS

The nature of the mined-out site as well as zoning regulations, land values, and environmental factors can influence the selection of a specific use for the mined land. However, it is likely that deposit characteristics will have a greater affect on the character of the proposed use than on the type of use developed.

Deposit conditions that limit but do not necessarily eliminate specific land uses include:

1. Land areas less than 150 feet wide.
2. Ground water within 2 feet of the surface.
3. Shallow water of less than 5-foot depth.
4. Irregular topography such as waste piles and excavation remnants.
5. Lack of topsoil.
6. Access to the site restricted by steep terrain, water, and narrow land units.
7. Pit area in relation to pit depth. The restrictive nature of this condition is difficult to specify but, in general the smaller the area and deeper the pit the less flexibility there is in accommodating new land uses. A 10-acre tract 30 feet deep has less development potential than a 10-acre tract 10 feet deep.

Although there are certain limiting factors, there are also many opportunities for future development, depending on how the deposit features are used. The examples illustrated in Chapter IV affirm this fact.

ODM 8295

Photo 5—Nelson Crushed Stone, Burlington, Ontario. A trout pond is located at the quarry. The photo also shows earth fill placed over the abandoned part of the quarry face. The slope will be seeded and planted. Photo courtesy of Nelson Crushed Stone.

Photo 6—Nelson Crushed Stone, Burlington, Ontario. This photo shows fill placed at the quarry face; the fill has been covered by topsoil, seeded, and planted with poplar and spruce. Photo courtesy of James C. Fish, Burlington.

ODM 8296

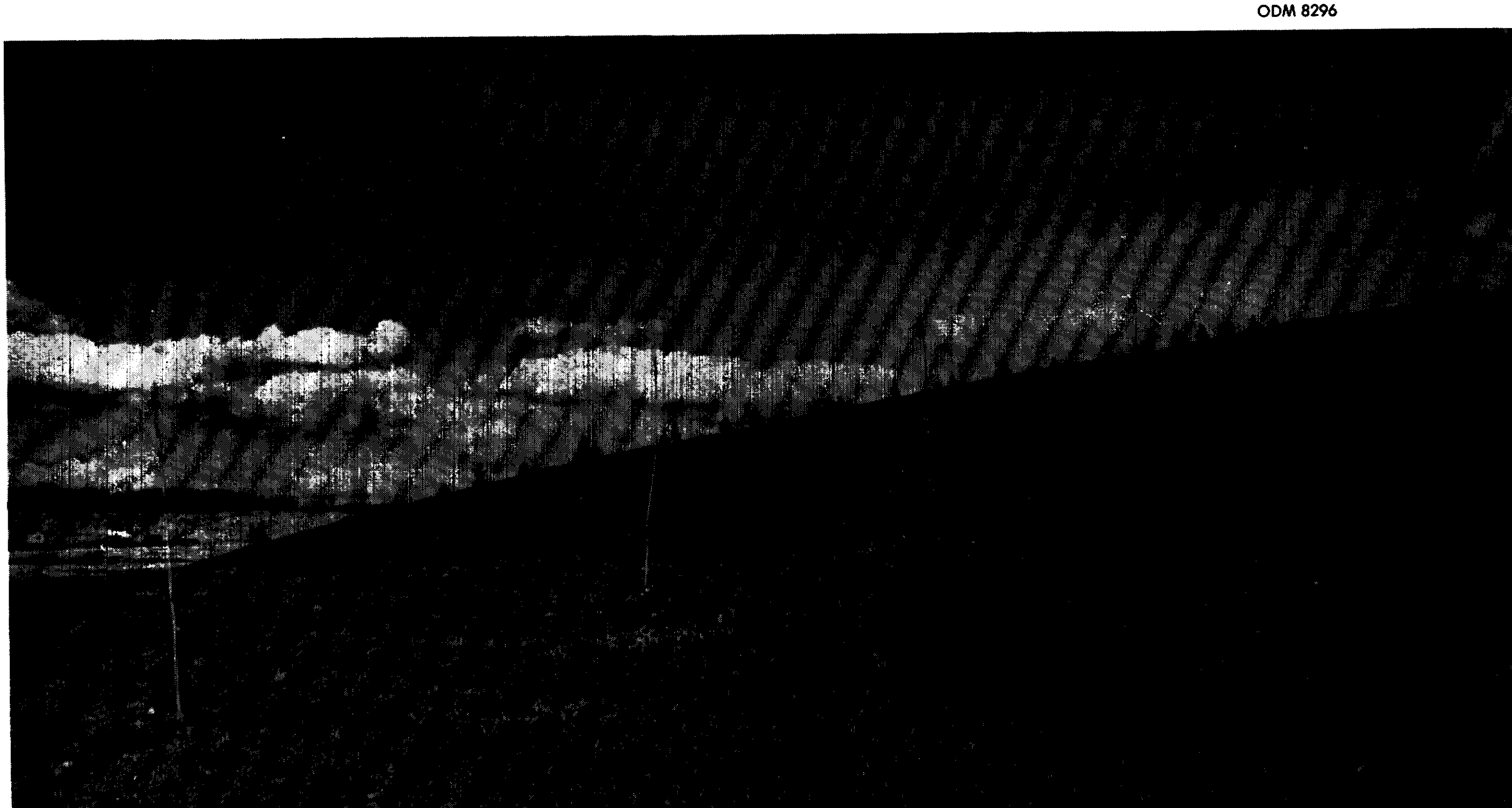


Table 4 SITE REQUIREMENTS

Use	Slope	Minimum Area	High Water Table	*Open Water
Residential	1—15%	¼—1 Acre	Within 3 ft. of surface.	Desirable
Commercial	1—10%	1—5 Acres	Within 3 ft. of surface.	Not significant
Industrial	1—5%	1—10 Acres	Within 3 ft. of surface.	Significant on occasion
Recreational	Varies	¼—100 + Acres	Varies	Very desirable

*Minimum water depth should be 5 feet and minimum water area, while variable, should be 2 acres or more.

Water areas, which are commonly a consequence of the operation, provide definite amenities for recreational, residential, and in some areas industrial uses. The important conditions to consider are whether or not the water area is large enough, deep enough, or in the right location and whether or not there is sufficient buildable land along the shoreline.

Large level sites, which are not uncommon results of mining, are of special value for industrial use. However, in preparing the land to accommodate this type of development the operator must also consider drainage and access. Access with a minimum slope is required. Normally any slope over 5 percent is too steep for industrial use. Similarly, any slope of less than 1 percent is too level for adequate surface drainage. Another problem is how to handle surface water in pits with no outlets. Figure 22 illustrates one solution to this problem. It simply involves the construction of a catchment area large enough and deep enough to handle whatever surface water that will collect in the pit under the wettest possible conditions.

Development of Wayside Pits

With few exceptions the wayside pit is different from the mine pit. It is not as large, nor as deep, as the mine pit. It is mined out in a very short period of time. And, according to past and present practices, the wayside pit is more exposed to the public.

In the development and shaping of wayside pits many of the techniques for rehabilitating mine pits apply. Also, there are several special considerations to be made.

Screening the wayside pit is not usually a practical consideration, primarily because of the short duration of the extractive activity. However, when visual exposure is a factor, available natural screens such as hills and trees should be considered in selecting the site of the pit.

Another factor to consider in selecting the site of a wayside pit is that of blending the excavated area into the natural terrain. Figure 23 illustrates how this objective can be accomplished. As a result, the impact of the disturbed area can be minimized. The obvious "hole-in-the-ground" can be avoided.

Overburden stripped from the wayside pit has several uses insofar as improving the usefulness and appearance of the pit is concerned. First of all a minimum of 6 inches of topsoil and subsoil should be spread over disturbed areas for re-establishing an appropriate ground cover. Second, the overburden can be used to shape the banks and edges of the pit. Third, the overburden can be used to fill areas where drainage conditions and access should be improved.

Re-establishing a cover crop on the disturbed areas of the wayside pit should be the primary objective in a planting program. Additional consideration should be given to blending the pit area into the surrounding landscape with appropriate vegetation.

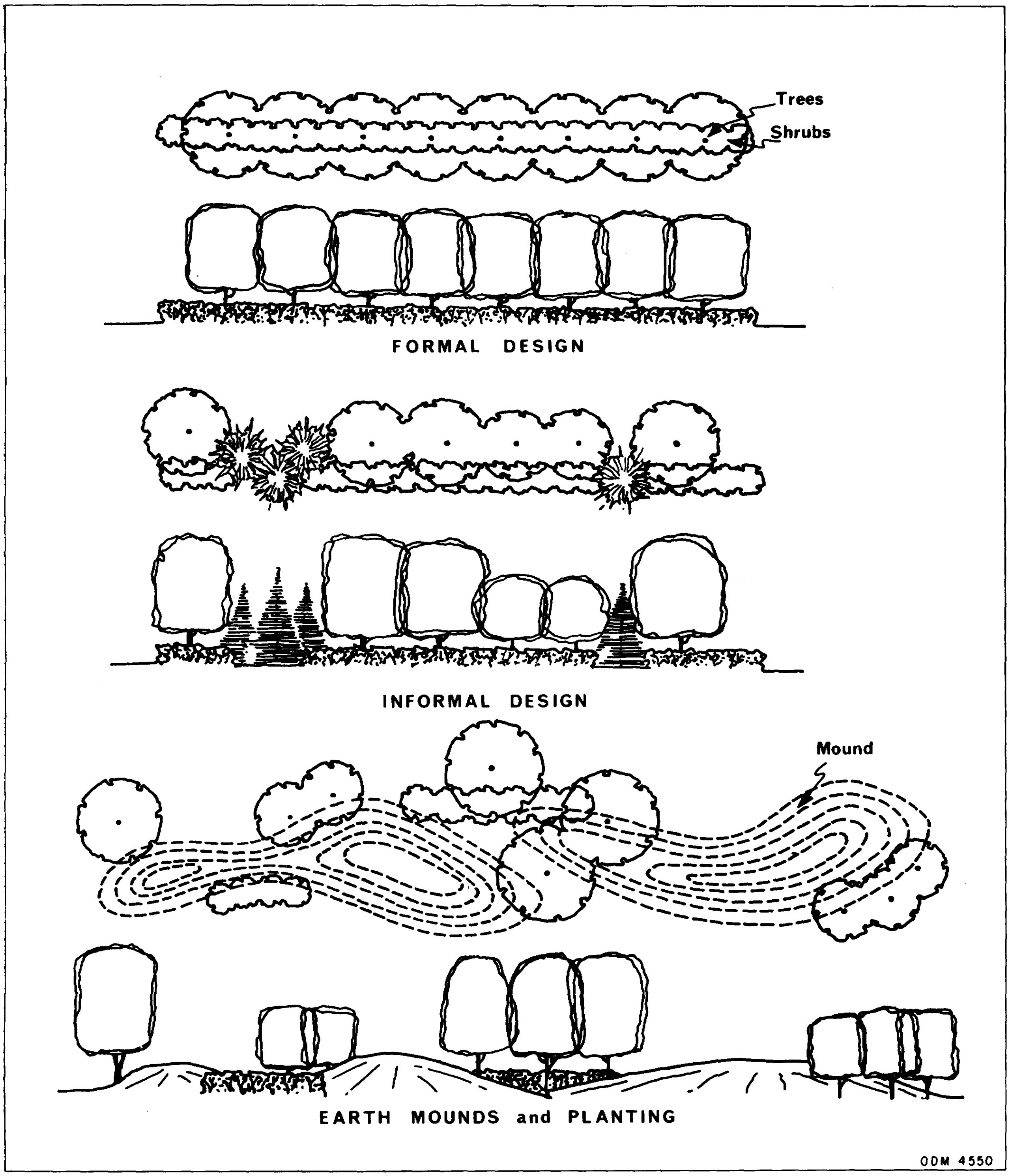


Figure 16 — PLANTING DESIGN

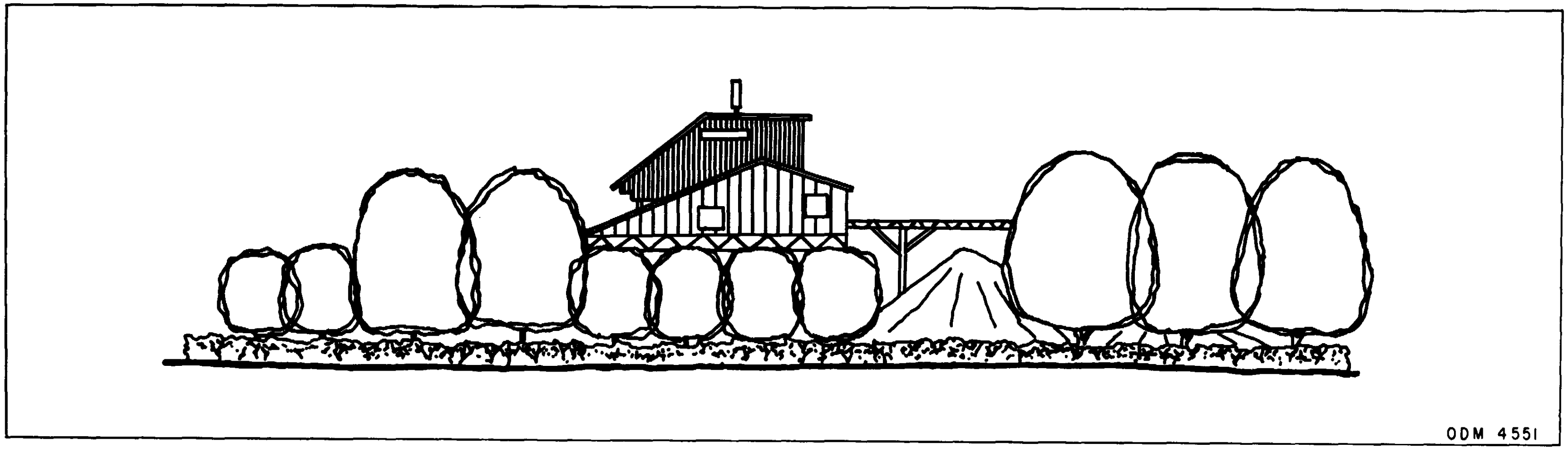
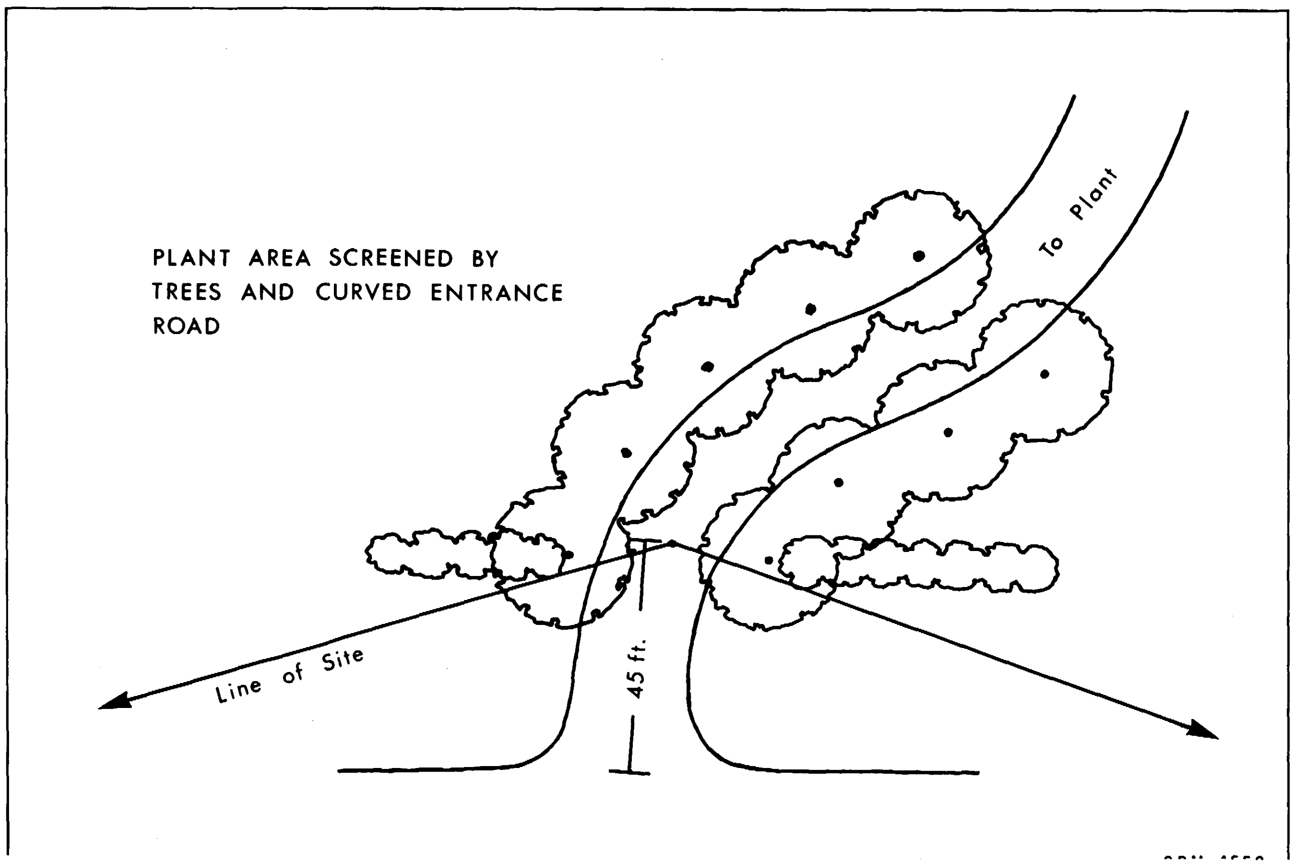


Figure 17 — PLANTING DESIGN—PROCESSING PLANT AREA

Figure 18 — ENTRANCE ROAD DESIGN



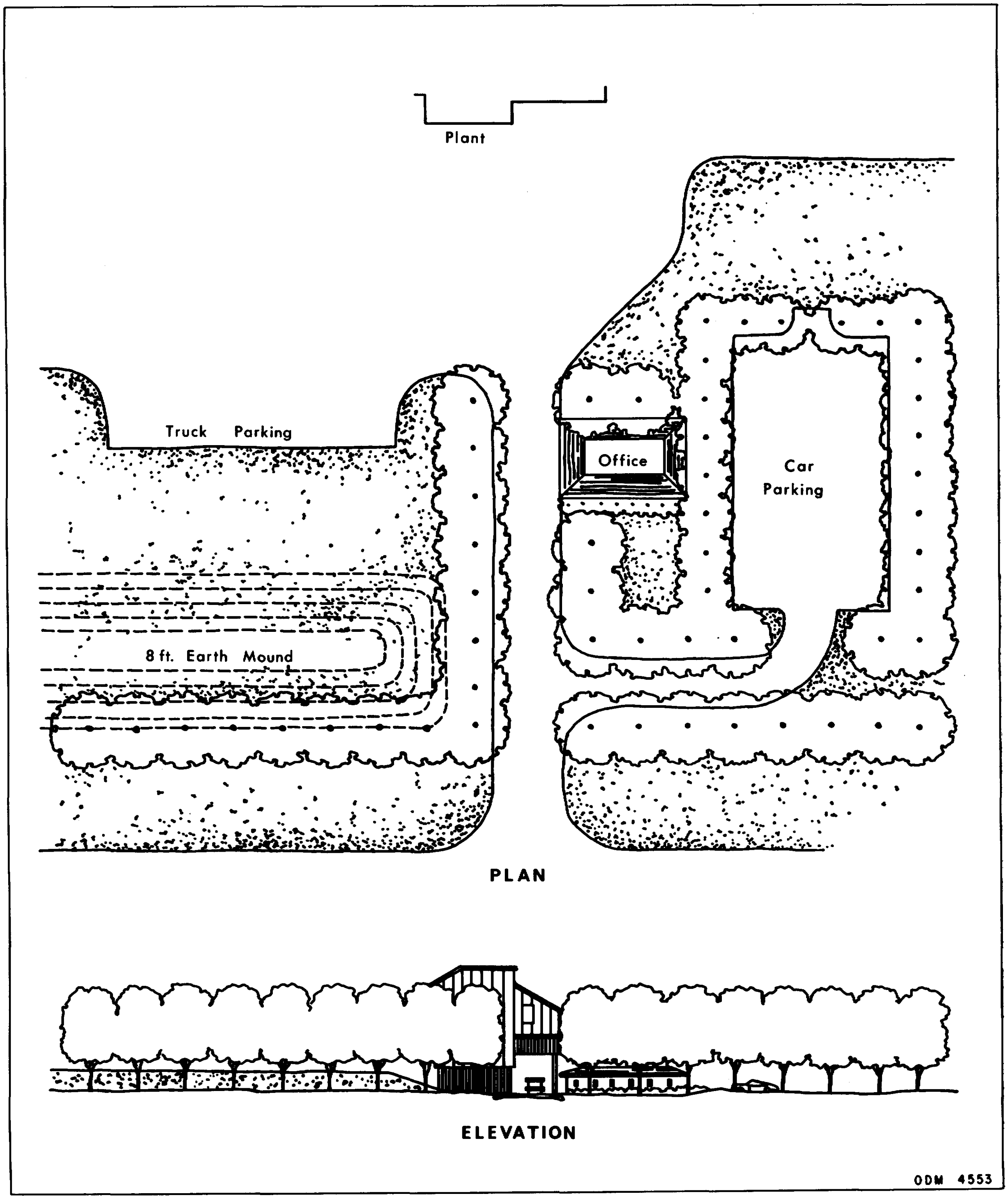


Figure 19 — ENTRANCE AREA DESIGN

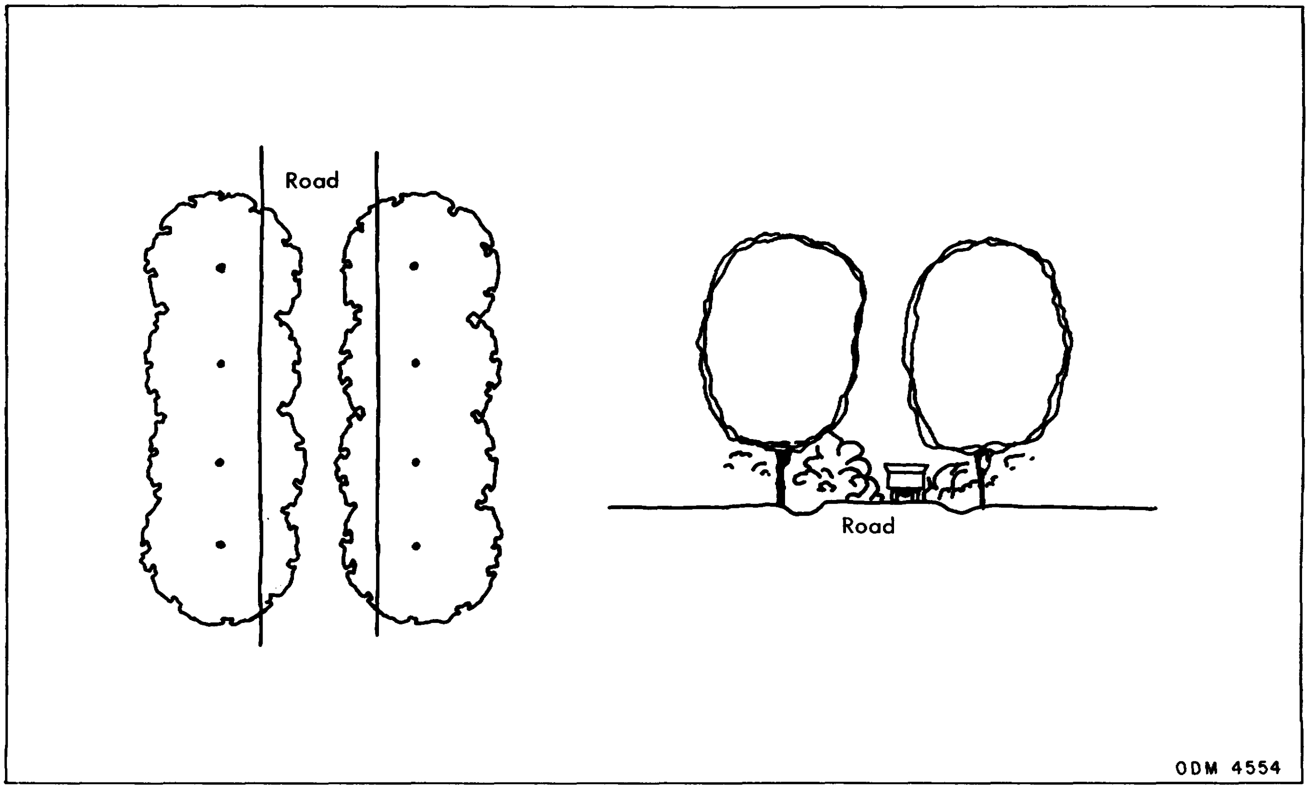


Figure 20 — DUST CONTROL

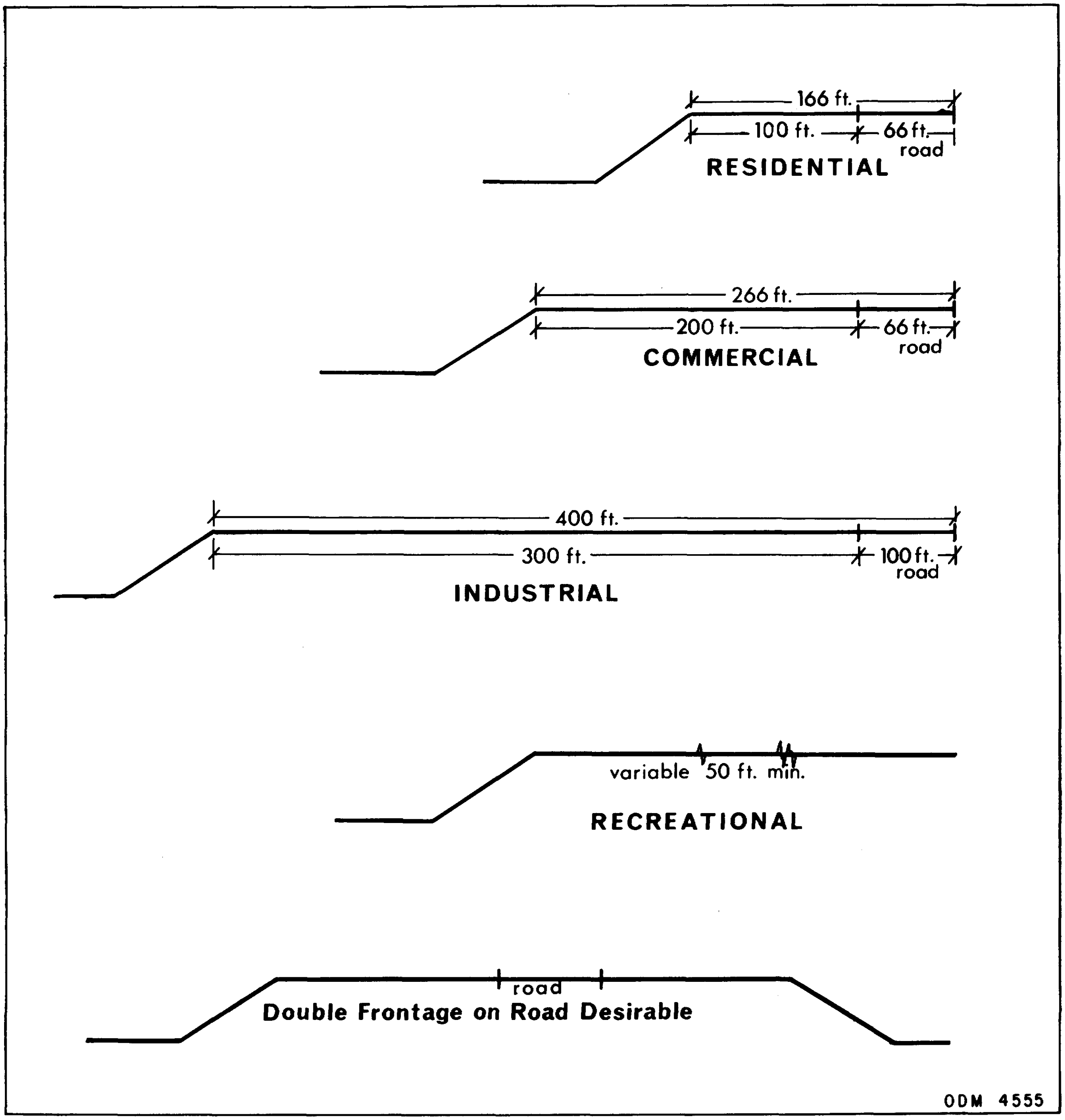


Figure 21 — DESIRABLE LOT WIDTHS

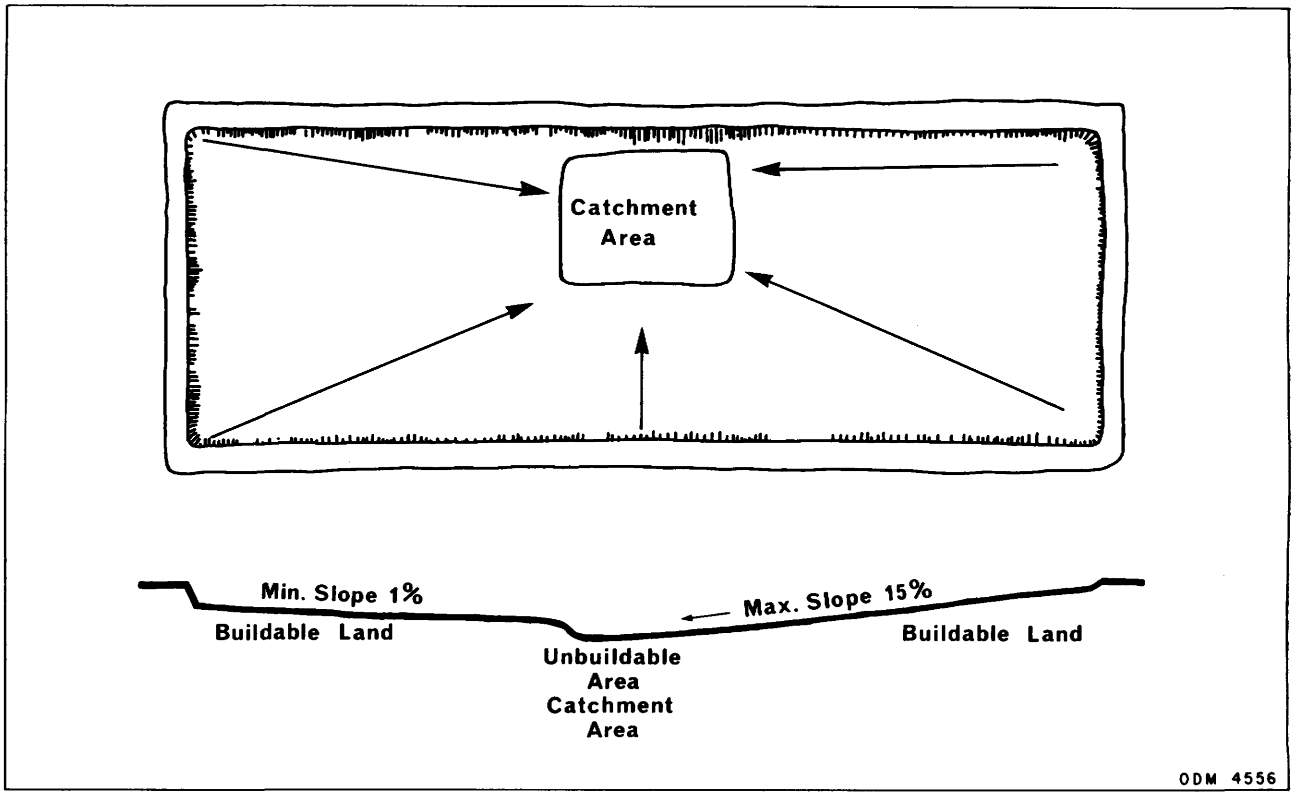


Figure 22 — DRAINAGE WITHIN PIT

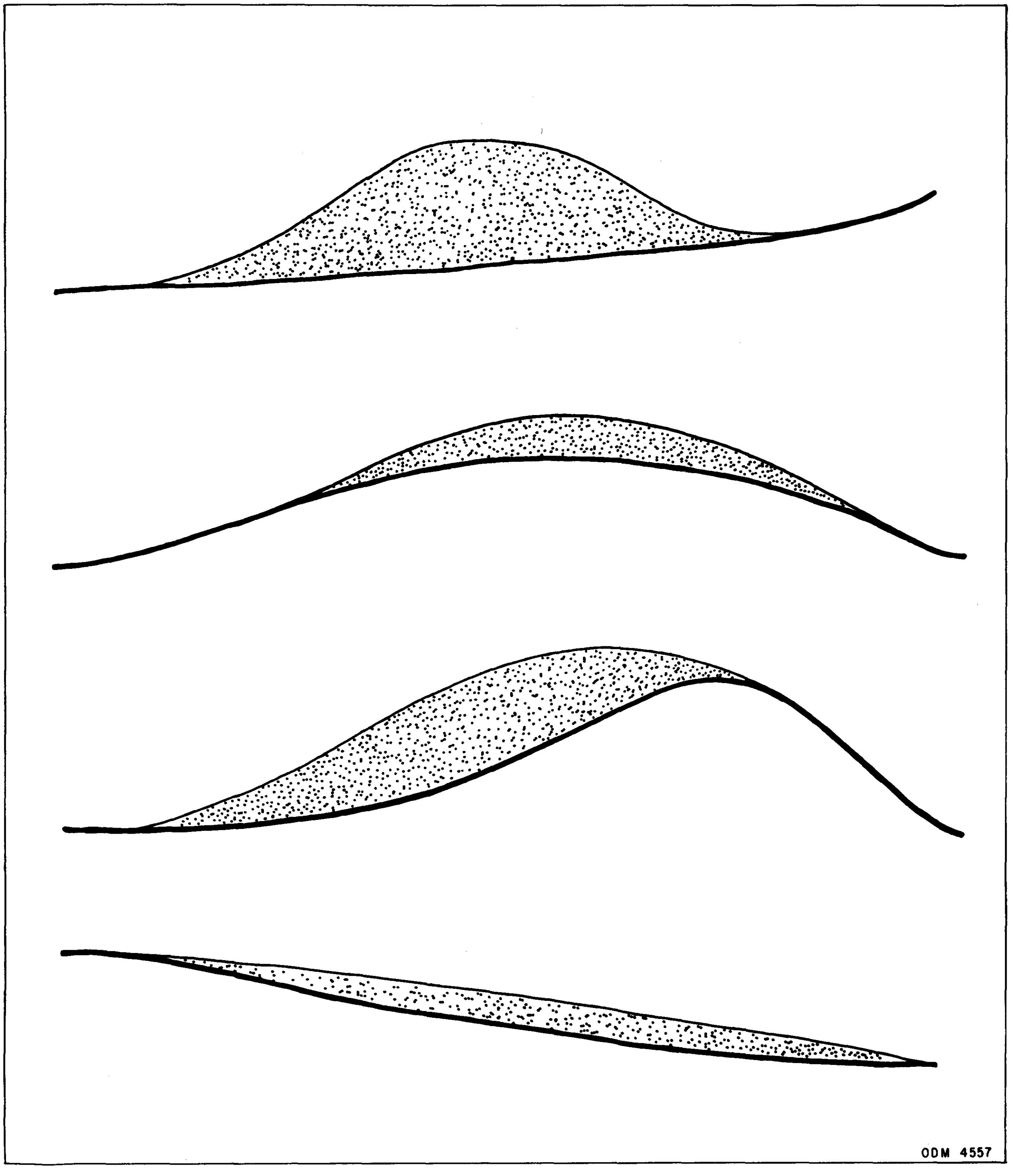


Figure 23 — BLENDING WAYSIDE PITS INTO TERRAIN

CHAPTER III

LIMITATIONS OF UNPLANNED REHABILITATION

Many fine examples of reclaimed pits and quarries that have been completed are illustrated in Chapter IV. They indicate that the "hole-in-the-ground" can be, in one form or another, an attractive and useful asset to the community. However, there are few *planned* rehabilitation projects in existence. That is, rehabilitation that was an integral part of the mining operation. What is the difference between planned and unplanned rehabilitation?

Unplanned Rehabilitation

Unplanned rehabilitation, in the simplest of terms, is fixing up an undesirable situation to the best of one's ability; that is, the repair of mined-out and scarred land. Commonly it means, in terms of creating usable land, maximum effort with minimum results. It means that mining operations proceed with little or no recognition of essential land development criteria, thereby creating whatever land characteristics that may occur from efficient mining activities. Unplanned mining, more often than not, results in: the misplacement of overburden and waste materials useful in building and shaping land; excavation of shallow water areas; shaping of narrow, fragmented and other irregularly shaped unusable land.

In the use of overburden, for example, the consequences of misplacing overburden include:

1. Stockpiling the material too far from desirable land areas where more usable land can be created with less earth material.
2. Concentrating overburden stockpiles in a single area rather than dispersing the stockpiles according to land forming needs.
3. Depositing the overburden in areas where minimum land forming benefits can be attained, such as in or near deep water areas.

Planned Rehabilitation

Planned rehabilitation involves taking stock or investigating the characteristics of both the natural resources and the mining operation to determine the most efficient way to develop the maximum potential of the mine site. Areas requiring fill material are identified. Areas where the greatest amount of usable land can be shaped with the least effort or with available fill material are noted. Potential drainage problems are indicated and resolved during the course of the mining operation; and, suitable access to the site is determined and maintained throughout the mining operation. Figures 24 and 25 compare the results of the two approaches to rehabilitation of a mine site using the same site in both examples. In Figure 25, as a result of planning the distribution of overburden, 33 acres of buildable land are created as compared to the 19 acres of land re-shaped in the unplanned operation.

In the publication, *Shaping the Land* (Schellie and Bauer 1968), four advantages of planned excavation and rehabilitation are noted. They are:

1. Earth moving equipment and personnel are used more efficiently. . . .
2. The movement of material is minimized. . . .
3. Available fill material is used to the maximum advantage. . . .
4. Ultimate land values will increase. . . .

In some areas initial land shaping activities will increase the cost of handling overburden and waste material. But this extra cost needs to be viewed in terms of end results, that is, buildable land. On the one hand buildable land is created by chance, on the other it is predetermined. In the first example earth and equipment is handled a second time to shape usable land, in the second example the equipment places the earth in the appropriate spot during the stripping operation. In planned rehabilitation the characteristics of the mining operation, the equipment, and the deposit features are co-ordinated and exploited to the fullest extent in developing the most usable land possible in the mined-out site.

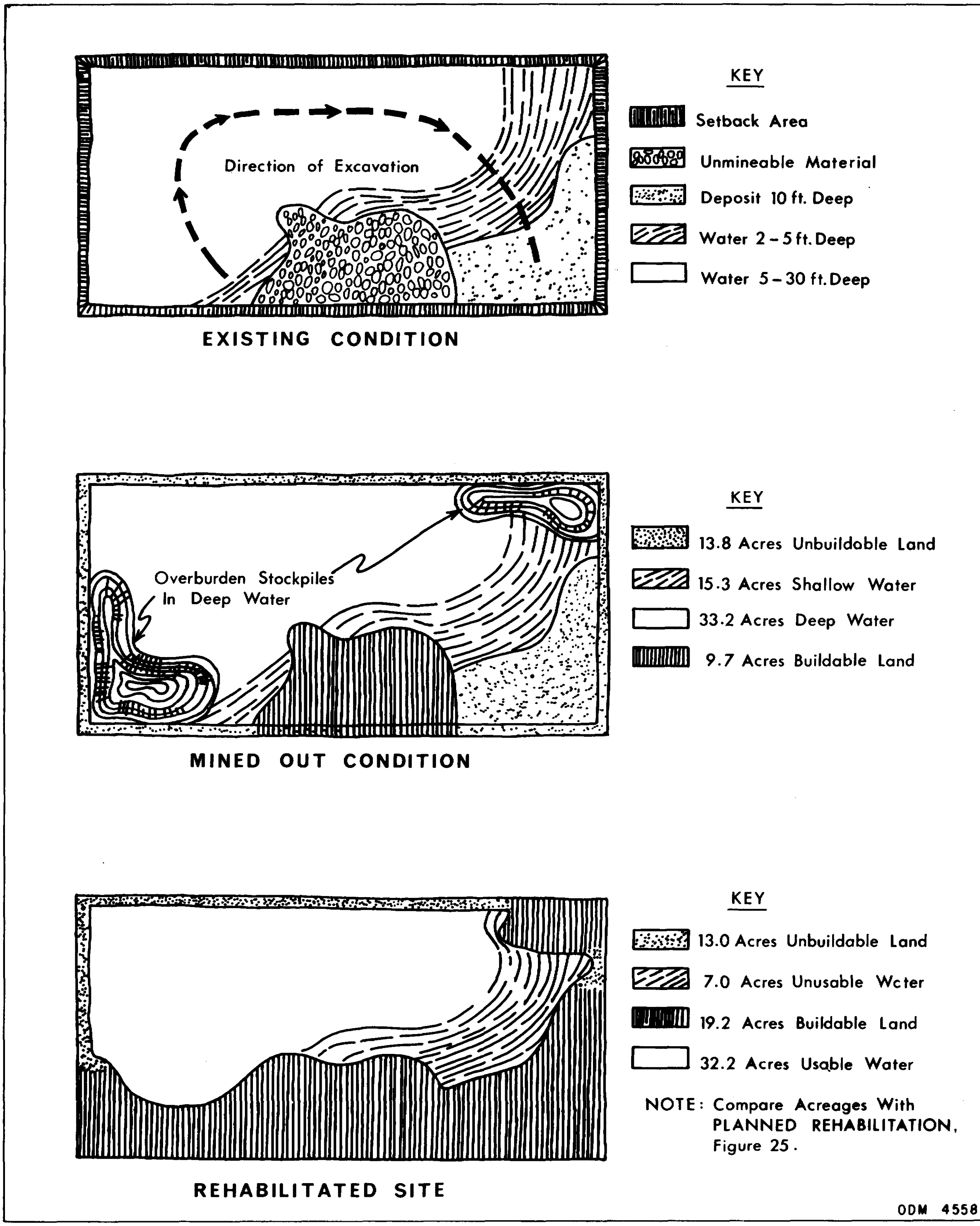


Figure 24 — UNPLANNED REHABILITATION

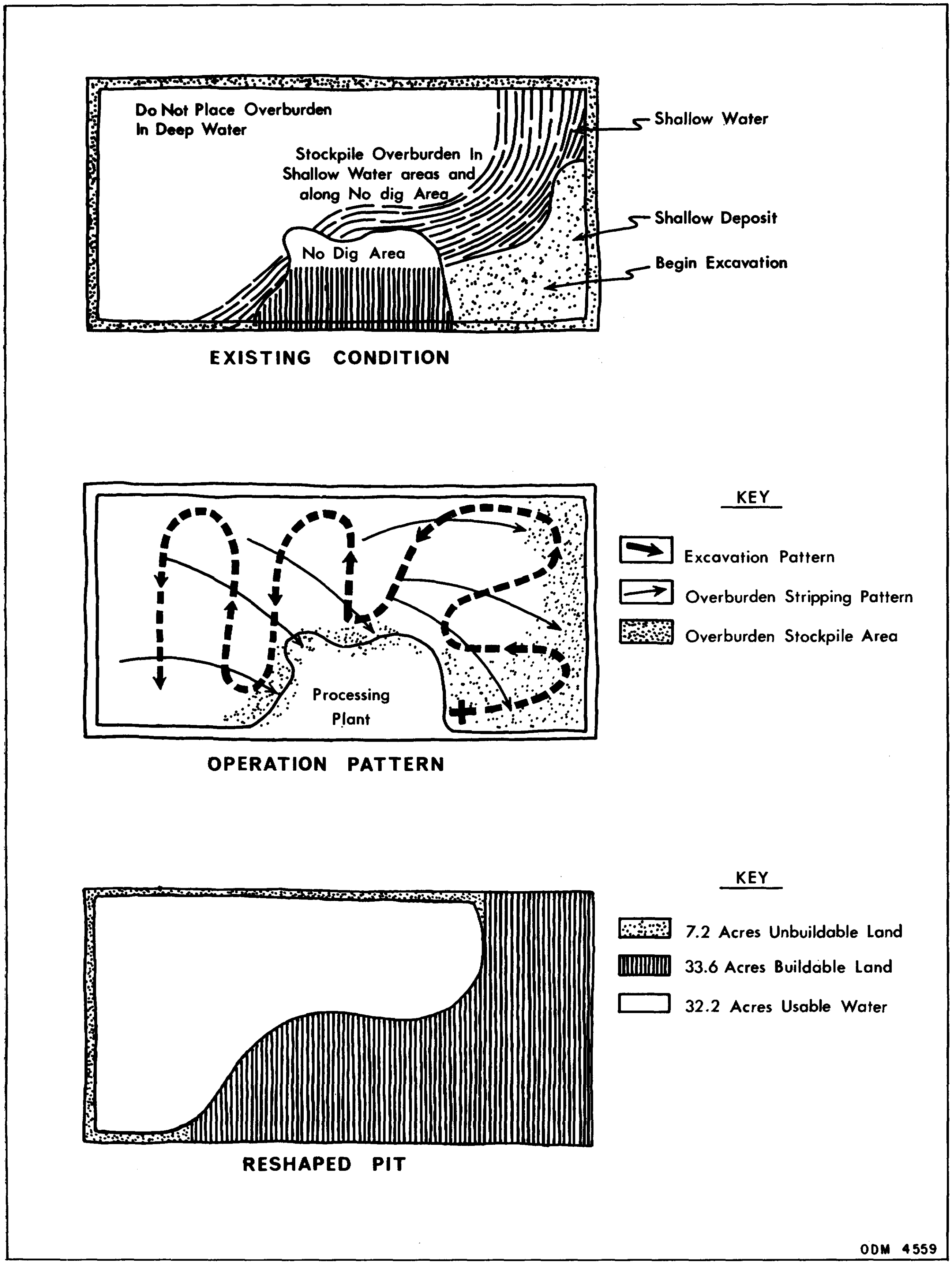


Figure 25 — PLANNED REHABILITATION

CHAPTER IV

AFTER-USE OF MINED-OUT SITES

No use should be ruled out in the development of mined-out land. Residential, industrial, commercial, and recreational types of land uses have been developed successfully in pits and quarries. In many existing rehabilitated sites the mining activity enhanced the development potential of the land. For example, steep and rugged hill sites have been made more accessible and usable as a result of lowering and levelling the contour. In other cases lakes were excavated in low floodable land and high usable land constructed along the shoreline with overburden and waste material from the mining operation. In several instances the value of the mined and re-shaped land exceeded the value of adjacent lands.

Types of Land Uses

Mined-out lands offer many unique development opportunities ranging from sanitary land fills to college campuses. The pits may be developed as amphitheatres, sports fields, parade fields, race tracks, or any similar spectator facilities, with the banks of the pit shaped for the seating area. The pits or quarries can be developed into equipment storage areas, marshalling yards for trucks or rail cars, lumber yards, or general storage areas for a variety of materials with the big advantage of being screened from adjacent lands.

In some areas a pit may be developed by the community as a waste treatment facility or water storage area.

The recreation use potential is unlimited. Many regional, city, and local parks have been developed in conjunction with or entirely within a pit or quarry. The photos in this chapter show just a few examples of this type of use. With available banks, in pits or quarries, rifle and archery ranges can be considered. Also golf driving ranges are appropriate. In some places there may be an opportunity to develop a unique golf course within the confines of the pit or quarry. With water there are many possibilities such as: fishing, boating, swimming, and interesting scenic areas.

Housing developments of all types have been successfully developed in mined-out sites. If the site has an advantage of a sizable water area these housing units will be at a premium.

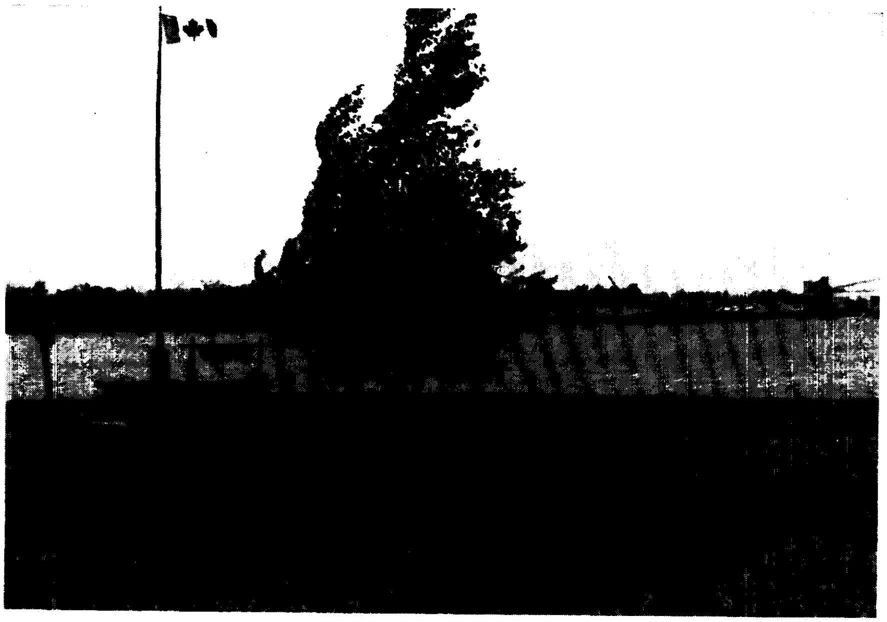
There is no reason not to consider a variety of commercial or office type uses in a mine site. For example, it would be possible to develop a very attractive office park on a series of terraces surrounding a water-filled pit or quarry. In another example, a large shopping centre may be sited above the pit or into the pit bank with the parking lot located within the pit. Access to what may be designed as a three or more level shopping centre may be through several levels.

If the mining operation is located in an industrial area pit forms and shapes can be graded during the mining operation to meet the access, area, and slope requirements of various industrial uses. There may also be the added advantages of screening by the pit slopes and a private supply of water from an excavated lake for industrial use.

In the final analysis, there is no limit to the *type* of uses that can be developed in a pit or quarry, but, there are limits as to the development potential of the pit or quarry such as the number of residential lots that can be developed on the site or the amount of buildable acreage that is available for industrial use. The factors that limit the development potential have been discussed in previous chapters. In effect, it is the rehabilitation program that will determine the capacity of a pit or quarry to accommodate one or a series of land uses.

After-Use of Wet Pits and Quarries

Gravel pits and quarries that are worked below the water table will be water-filled on abandonment. Such sites frequently made excellent recreation areas for the community.



ODM 8297

Photo 7—Waterford Ponds, Big Creek Region Conservation Authority. Photo courtesy of Consolidated Sand and Gravel Company. The Waterford Ponds are the former sites of gravel pits at Waterford, Ontario. These are now small lakes with sandy beaches that have been developed as a public park by the Big Creek Region Conservation Authority. Approximately 100,000 people use this park in an average season.

ODM 8298

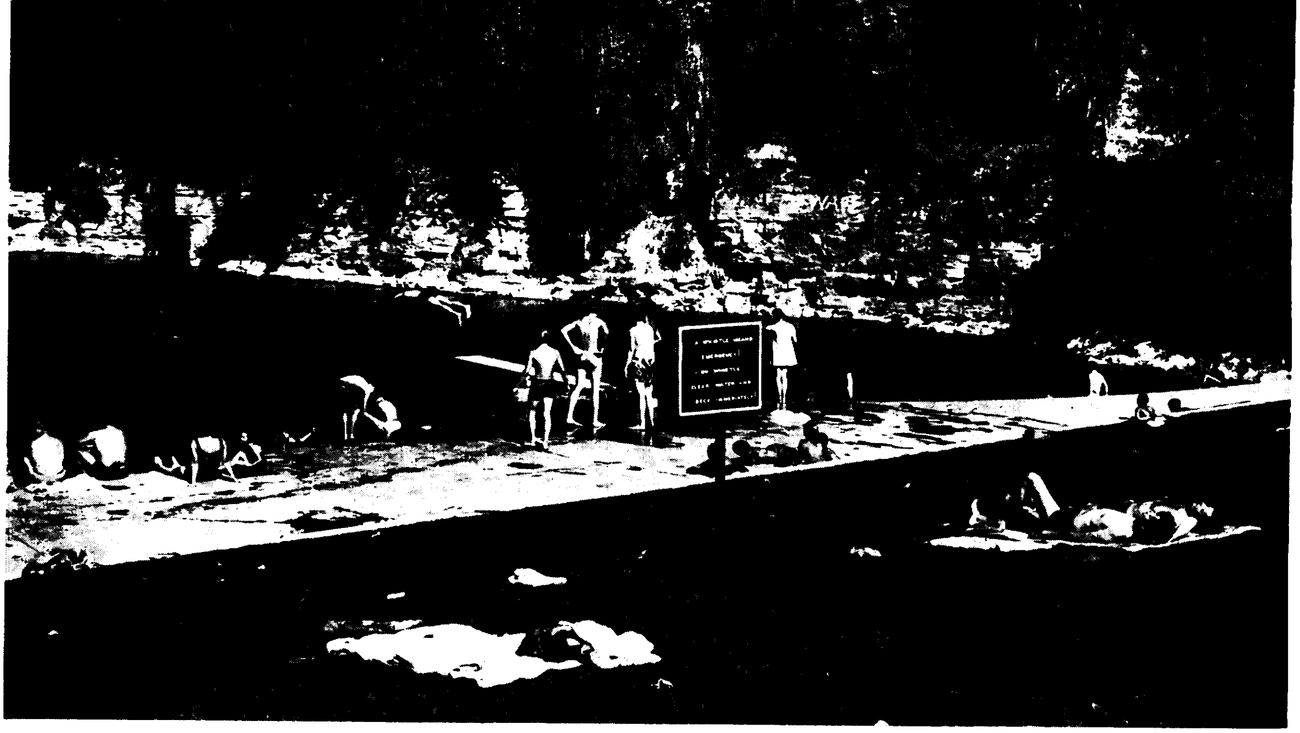
Photo 8—Waterford Ponds, Big Creek Region Conservation Authority. Photo courtesy of Consolidated Sand and Gravel Company.

ODM 8299

Photo 9—Waterford Ponds, Big Creek Region Conservation Authority. Photo courtesy of Consolidated Sand and Gravel Company

Photo 10—Crystal Springs Park about 7 miles southwest of Brantford, Ontario, has been developed at the site of a former gravel pit. The edges of the pit are now wooded. Photo courtesy of W. R. Cowan.

ODM 8300



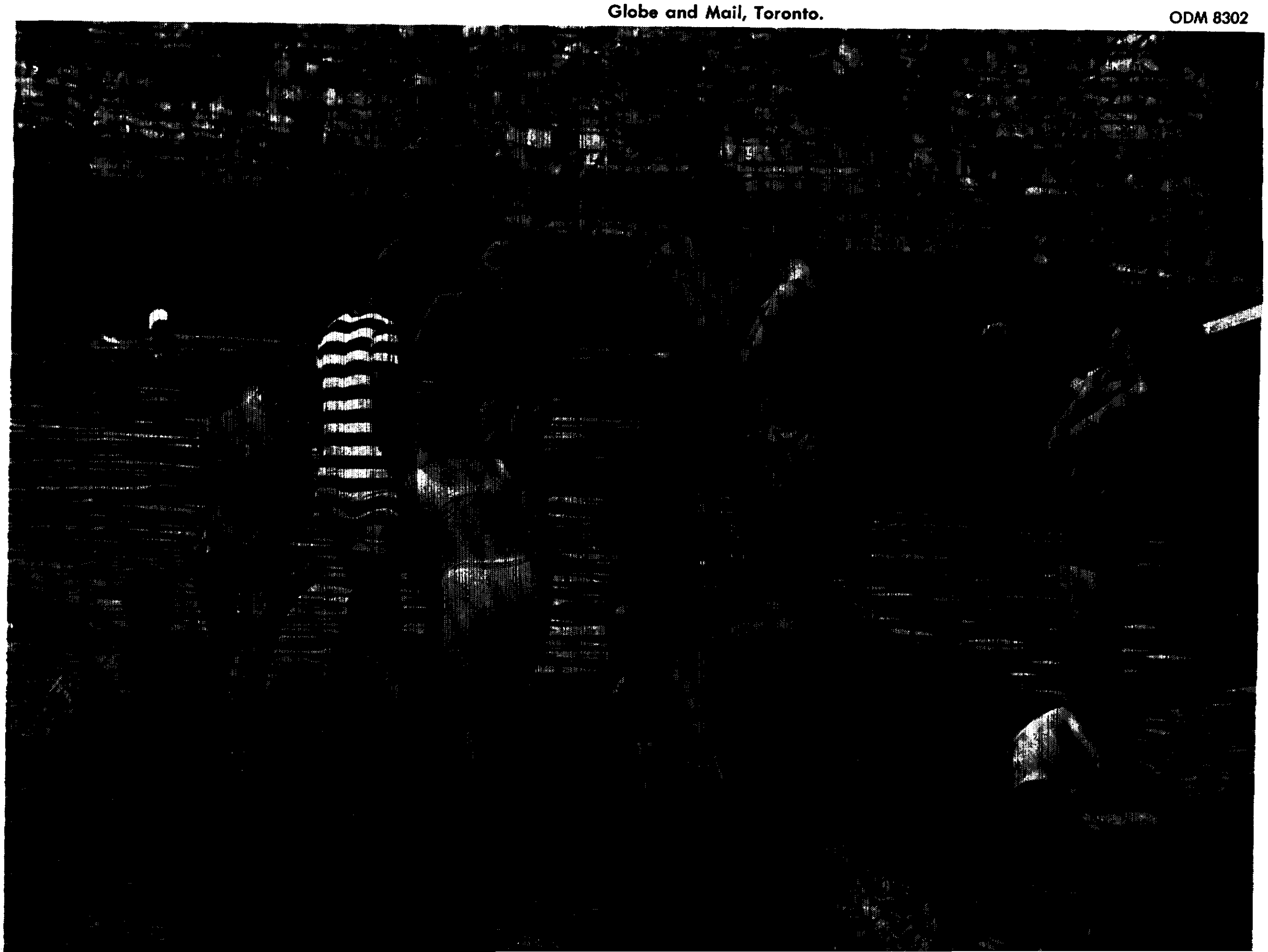
ODM 8301

Photo 11—The swimming pool, at St. Mary's, Ontario, has been developed on the site of a former quarry. Photo courtesy of M. A. Vos.

Photo 12—Another view of the quarry swimming pool at St. Mary's.

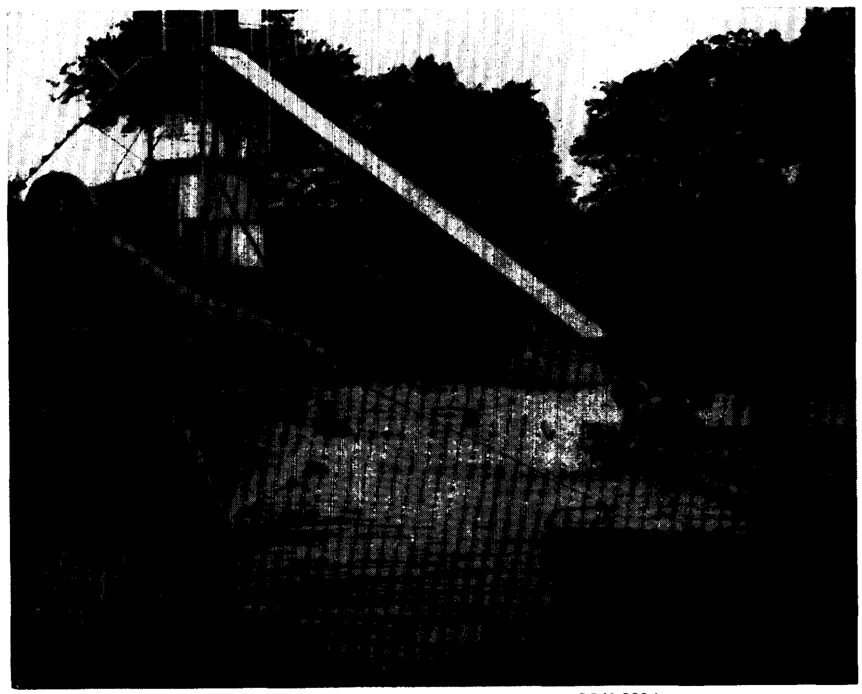
Globe and Mail, Toronto.

ODM 8302



ODM 8303

Photo 13—A former quarry near Sherkston has been developed as a recreation area. Photo courtesy of the Ontario Mining Association.



ODM 8304

Photo 14—Former quarry near Sherkston, Ontario. Photo courtesy of Ontario Mining Association.

ODM 8305

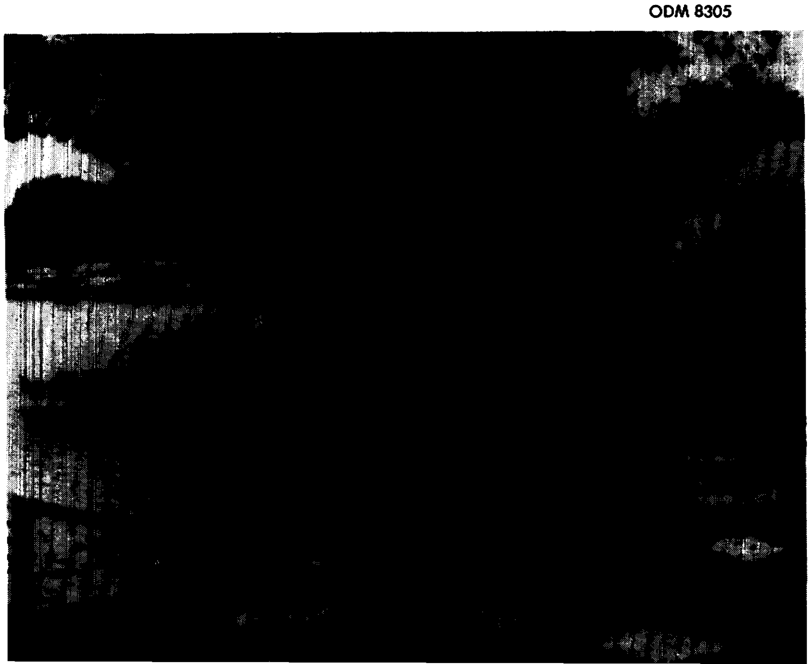


Photo 15—Homes now mark the shore of this beautiful lake, once a quarry, near Ridgeway, Ontario. Photo courtesy of the Ontario Mining Association.

After-Use of Dry Pits and Quarries

The sites of dry pits and quarries are used for a multitude of purposes, some of which are illustrated in the following series of photographs.

ODM 8306

Photo 16—The old Dundas quarry, of Canada Crushed Stone at Dundas, Ontario, has been reforested and returned to its natural state. Part of the area has been taken over by the Hamilton Region Conservation Authority. Photo courtesy of D. F. Hewitt.

Photo 17—A gravel pit was formerly operated about 2 miles south of Greenwood in Pickering Township by Highland Creek Sand and Gravel Company Limited. The company has rehabilitated the area by sloping the sides of the pit, replacing the topsoil and seeding the slopes and floor. The land will become part of the Greenwood Conservation Area. Photo courtesy of D. F. Hewitt.

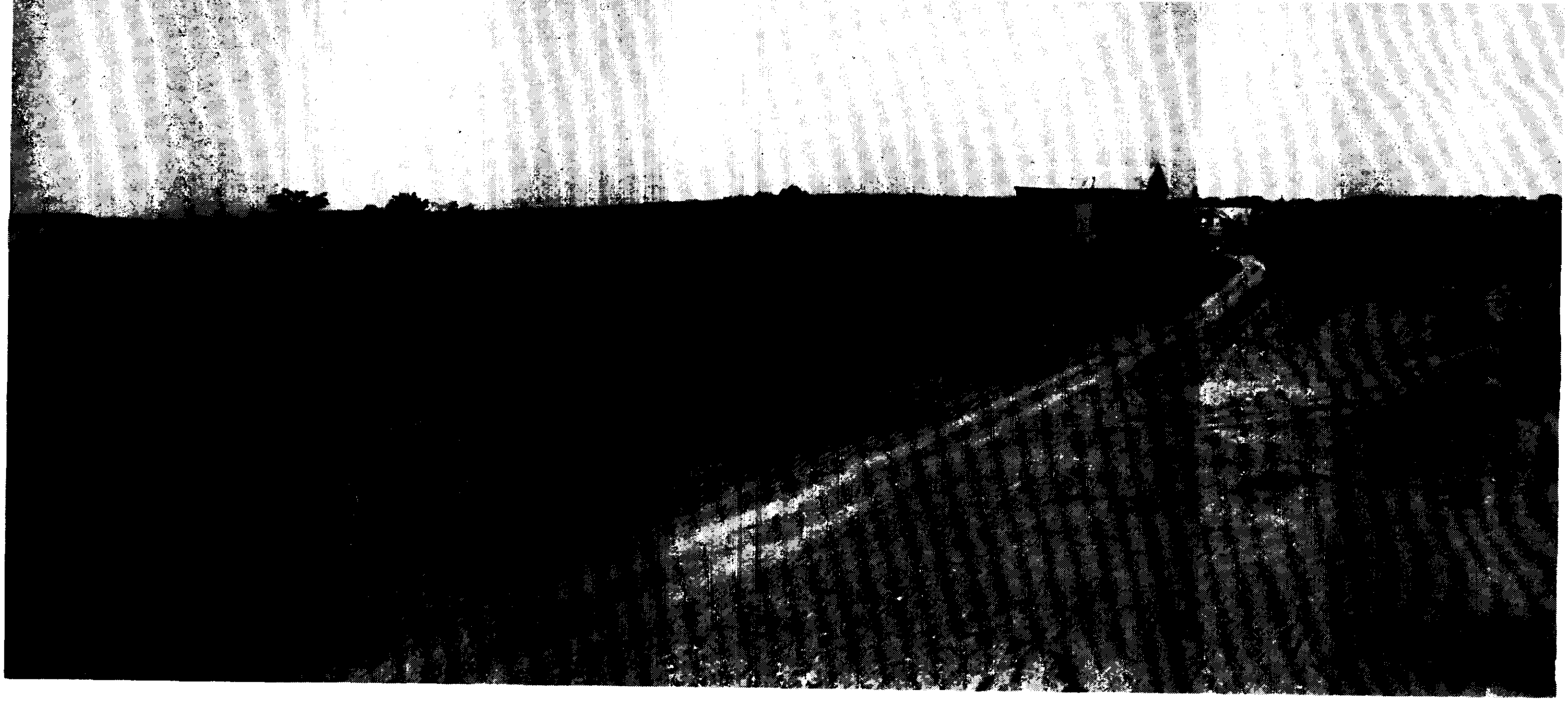
ODM 8307

ODM 8308

Photo 18—Rock Garden of the Royal Botanical Gardens, Hamilton, Ontario. The Hamilton rock garden of the Royal Botanical Gardens is located on the site of an abandoned gravel pit. Photo courtesy of L. Laking, Royal Botanical Gardens.

Photo 19—Rock Garden of the Royal Botanical Gardens, Hamilton, Ontario. Photo courtesy of L. Laking, Royal Botanical Gardens.

ODM 8309



ODM 8310

Photo 20—A gravel pit has been rehabilitated by sloping the sides, smoothing the floor, and replacing the topsoil. Mrs. Reeve-Newson farm, Clarksburg, Ontario. Photo courtesy of L. J. Chapman.

Photo 21—This playground between Elm and Devon Streets in Brantford has been developed on the site of a former sand pit. Photo courtesy of W. R. Cowan.

ODM 8311

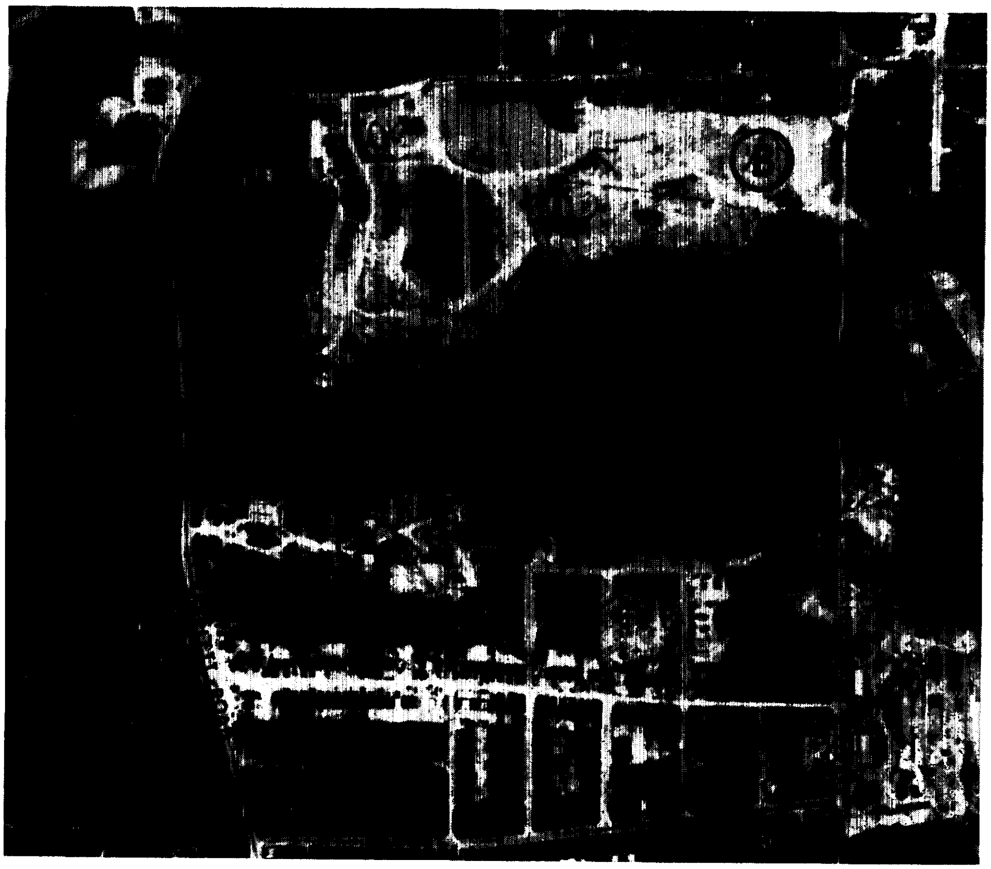
ODM 8312

Photo 22—East Park golf course on Hamilton Road East in London, Ontario is the site of a former gravel pit. Photo courtesy of W. R. Cowan.

Photo 23—A playground and park at Cheapside and Wellington Streets in London, Ontario, has been developed on the site of a former gravel pit. Photo courtesy of W. R. Cowan.

ODM 8313

About sixty gravel and clay pits were once operated in the Metropolitan Toronto area. These have been rehabilitated and put to other uses as shown in the following series of photographs.



ODM 8314

Photo 24—This aerial photo, taken in 1946, shows the location of gravel pits east of Scarlett Road in Toronto. Photo courtesy of Ontario Department of Lands and Forests.

ODM 8315

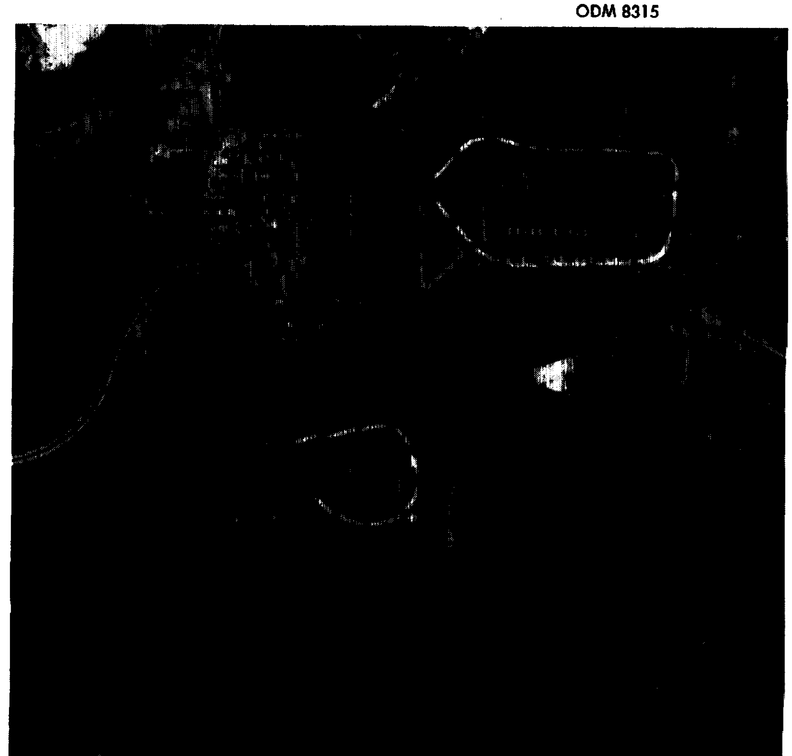


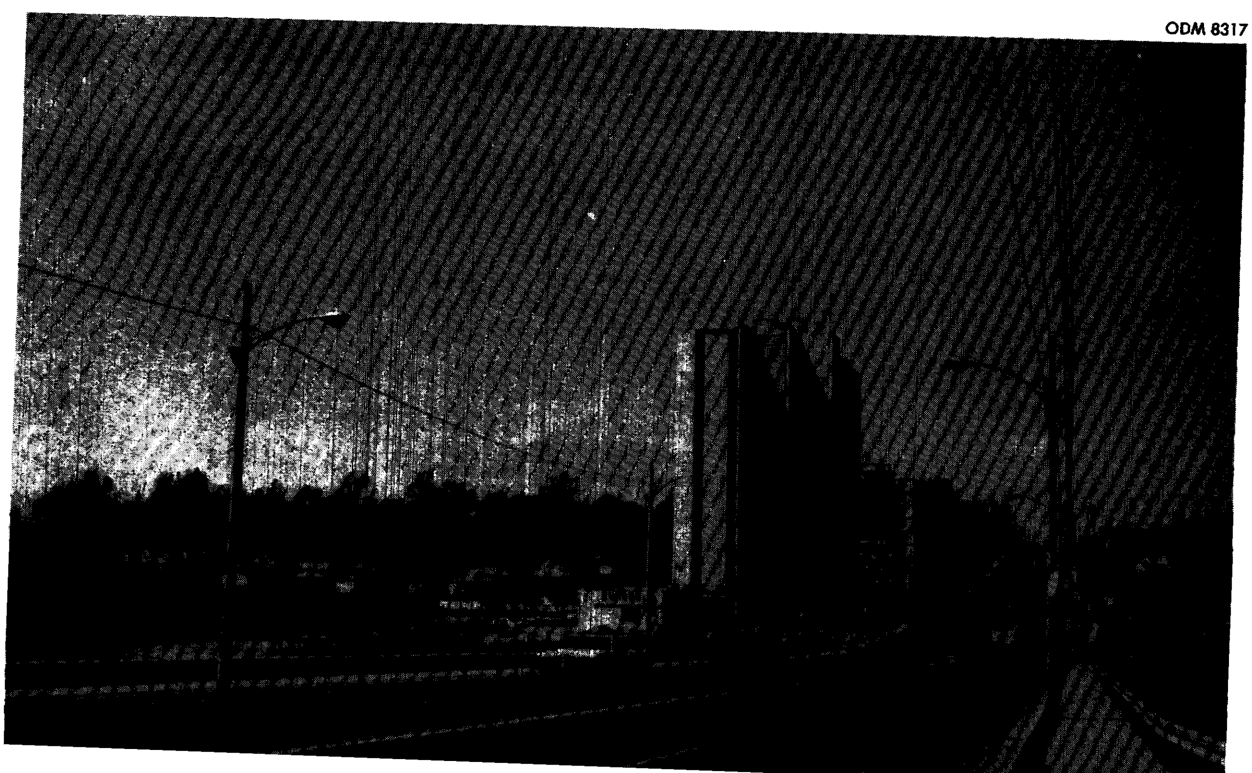
Photo 25—This aerial photo, taken in 1962, shows the same area now occupied by residential subdivisions. The former locations of the gravel pits are outlined in white in this photo. Photo courtesy of Ontario Department of Lands and Forests.

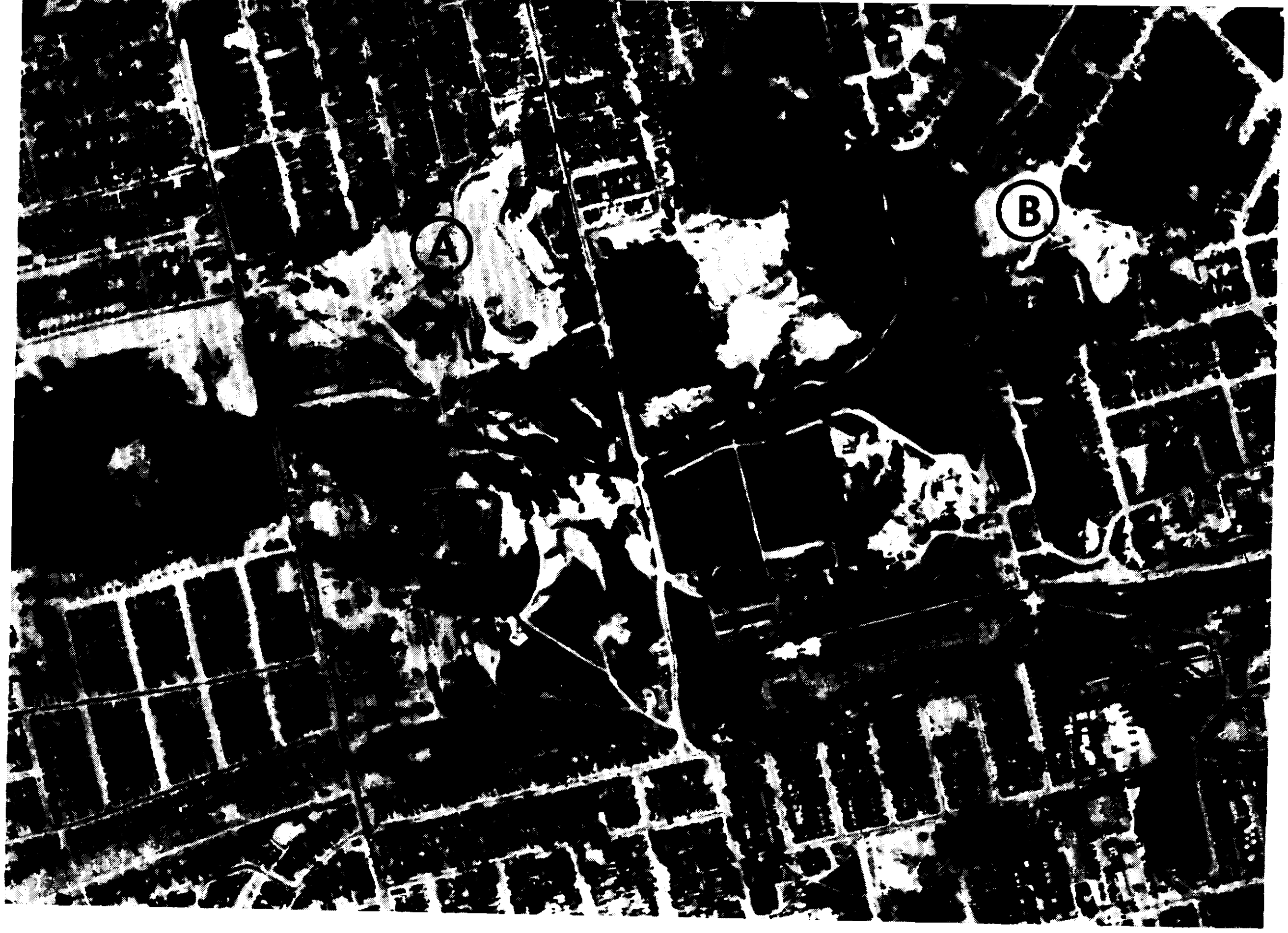
ODM 8316

Photo 26—This photo shows residences on Edinborough Court, east of Scarlett Road, on the site of a former gravel pit operation shown in Photo 24 at location A. Photo courtesy of D. F. Hewitt.

Photo 27—This photo is taken looking north on Jane Street at former gravel pit area B on Photo 24. The area is now occupied by residences and high rise apartments. Photo courtesy of D. F. Hewitt.

ODM 8317



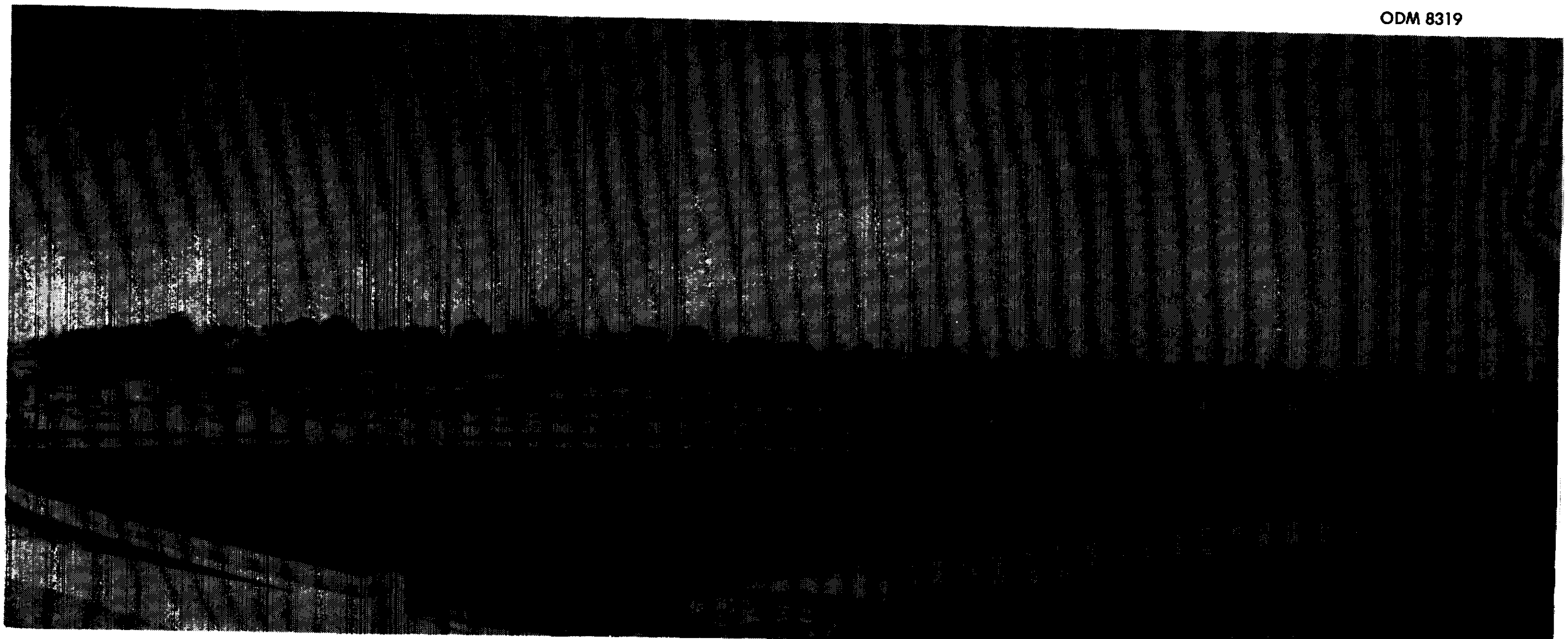


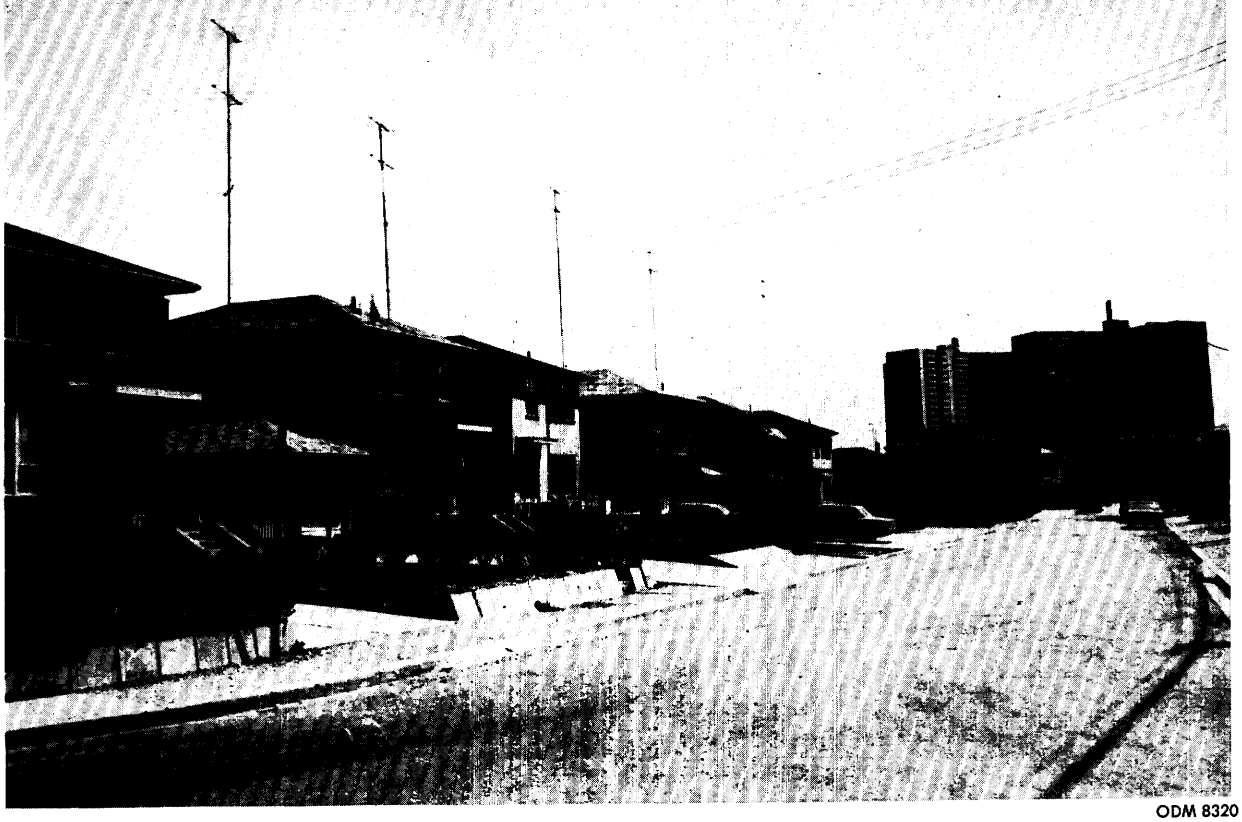
ODM 8318

Photo 28—This aerial photo, taken in 1954, shows gravel pit areas east of Jane Street in the vicinity of Black Creek. *Alliance Avenue now passes through area A.* Photo courtesy of Ontario Department of Lands and Forests.

Photo 29—This photo was taken in 1969 looking north toward the corner of Jane Street and Alliance Avenue. Jane Park Plaza and a residential area *now occupies the gravel pit, area A,* in Photo 28. Photo courtesy of D. F. Hewitt.

ODM 8319





ODM 8320

Photo 30–A view of the residential area on Dalrymple Road, north of Alliance Avenue, on the site of the former gravel pit in location A, Photo 28. Photo courtesy of D. F. Hewitt.

Photo 31–Another residential area on Cameo Crescent, north of Alliance Avenue, on the site of the former gravel pit in location A, Photo 28. Photo courtesy of D. F. Hewitt.

ODM 8321

ODM 8322

Photo 32–This is a view looking west toward the Borough of York Stadium and high rise apartments in the Porter Avenue area. This occupies gravel pit, area B, in Photo 28. Photo courtesy of D. F. Hewitt.

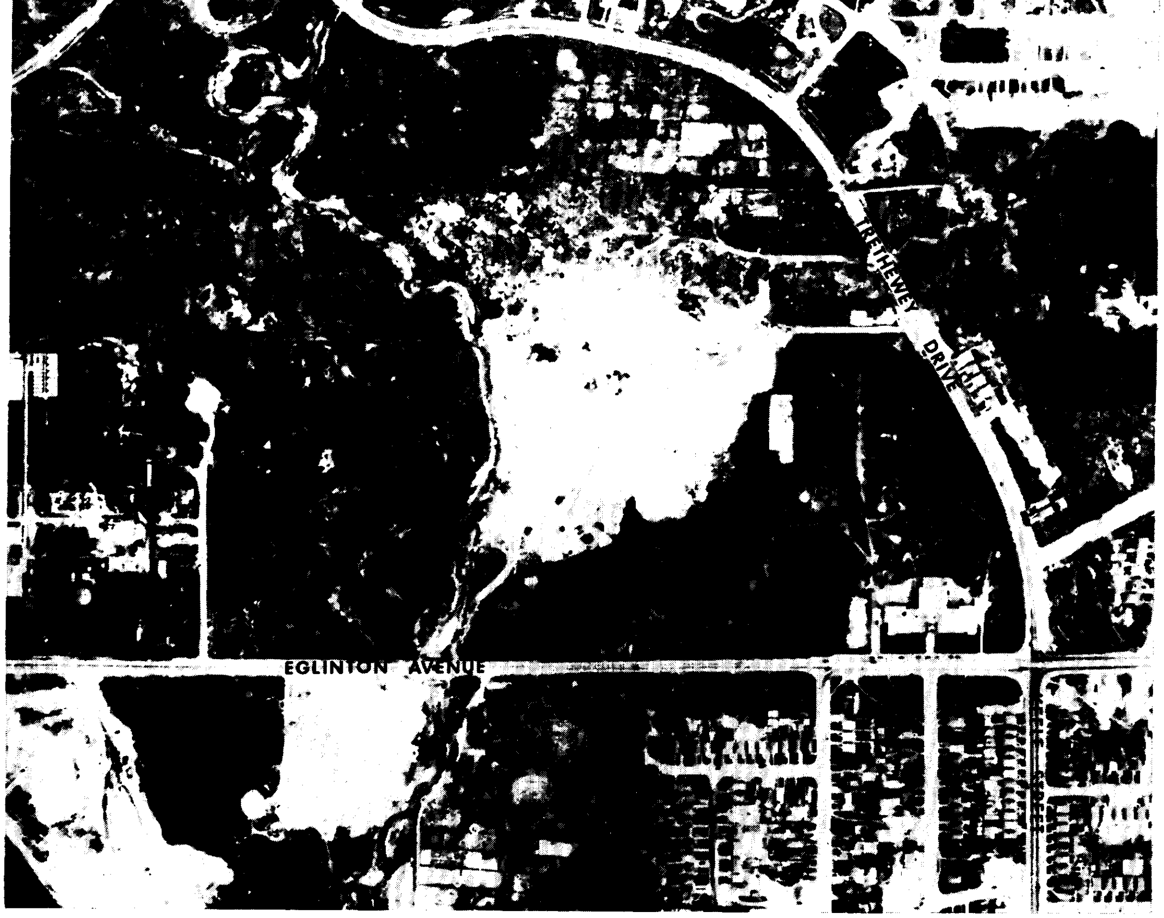
Photo 33–Ramsden Park on Yonge Street, Toronto, *was the former site of a brickyard and clay pit now rehabilitated for* parkland. Photo courtesy of D. F. Hewitt.

ODM 8323

ODM 8324

Photo 34—*This aerial photo, taken in 1948, shows a gravel pit area west of Scarlett Road and south of the Richview Side Road, in Etobicoke. Photo 35 shows the present use of the area on Fontenay Court for residential purposes. Photo 34 courtesy of Ontario Department of Lands and Forests; Photo 35 courtesy of D. F. Hewitt.*

Photo 35 ODM 8325



ODM 8326

Photo 36—This photo shows a gravel pit in 1948 in the Eglinton Avenue-Trethewey Drive area, Borough of York. The site is now occupied by Coronation Park shown in Photo 37. Photo 36 courtesy of Lockwood Surveys Limited; Photo 37 courtesy of D. F. Hewitt.

Photo 37

ODM 8327

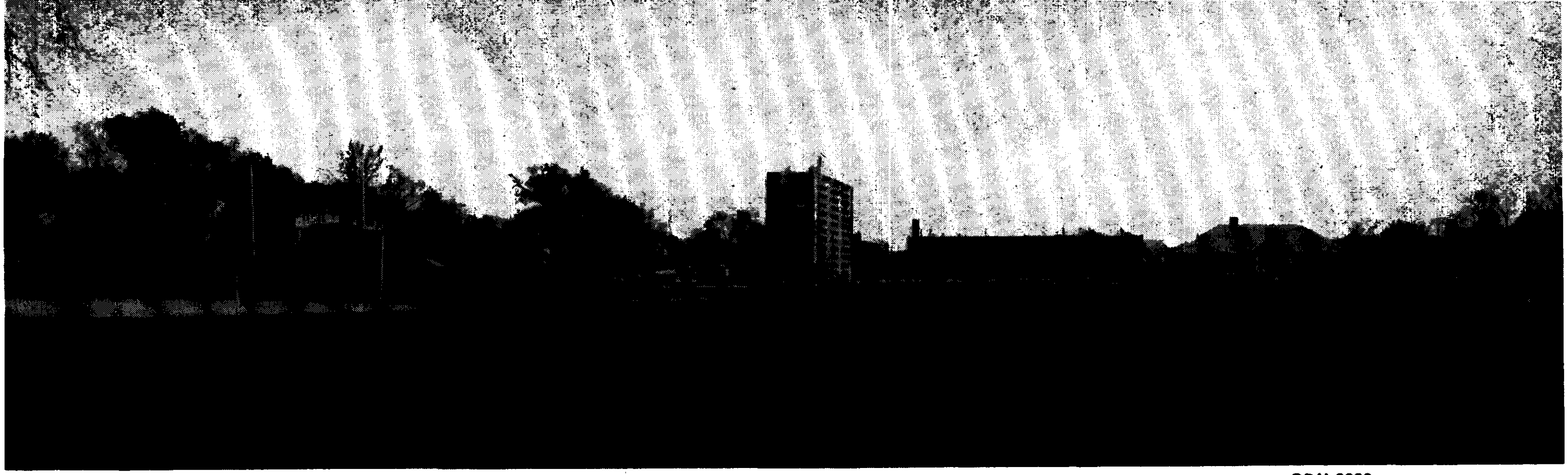


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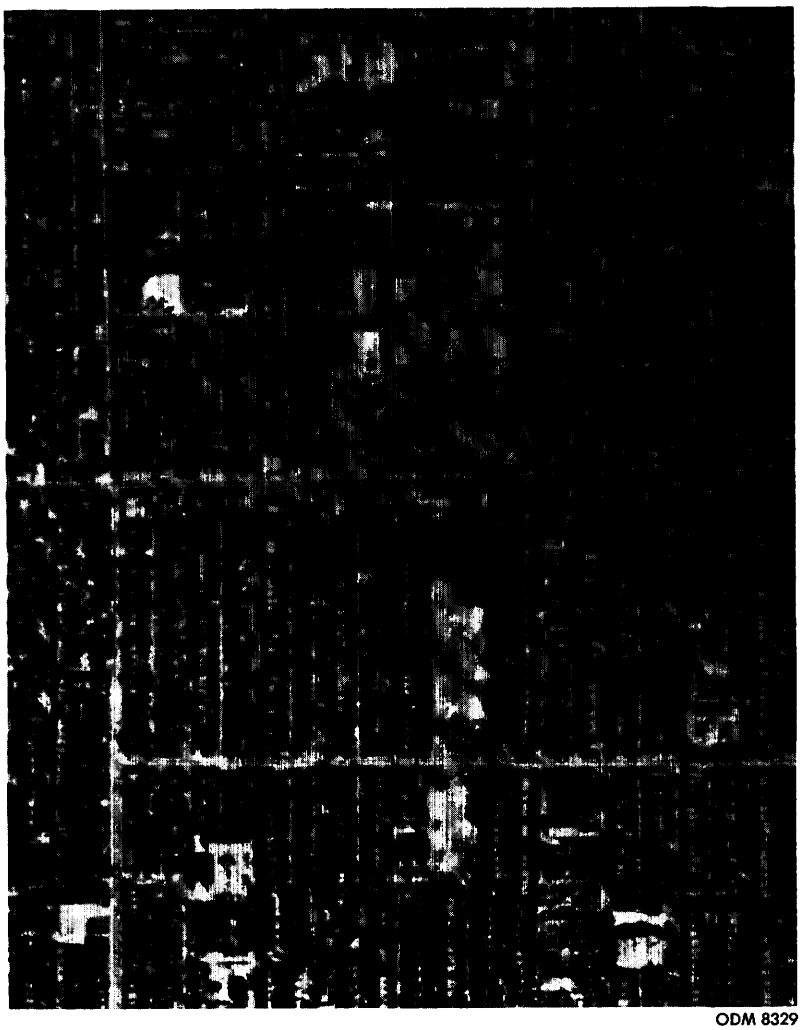
Photo 38—Eglinton Park on Eglinton Avenue at Oriole Parkway in Toronto was the former site of Pears' brickyard and clay pit. Photo courtesy of D. F. Hewitt.



ODM 8329

Photo 39—This is an aerial view of Willowvale Park on Bloor Street at Christie Street. This was the site of a former gravel pit. Bickford High School is on the south side of Bloor Street at this locality in Bickford Park. Photo courtesy of Ontario Department of Lands and Forests.

ODM 8330

Photo 40—A view of Willowvale Park, on Bloor Street at Christie Street. Photo courtesy of John O. Spender.

Photo 41—Bickford High School on the south side of Bloor Street at Christie Street. Photo courtesy of John O. Spender.

ODM 8331

Photo 42—This aerial photo, taken in 1954, shows the clay pits and brickyards on the west side of Dawes Road in Toronto. The site is now occupied by apartment and residential construction as shown in Photo 43. Photo 42 courtesy of Ontario Department of Lands and Forests; Photo 43 courtesy of D. F. Hewitt.

ODM 8332

Photo 43

ODM 8333

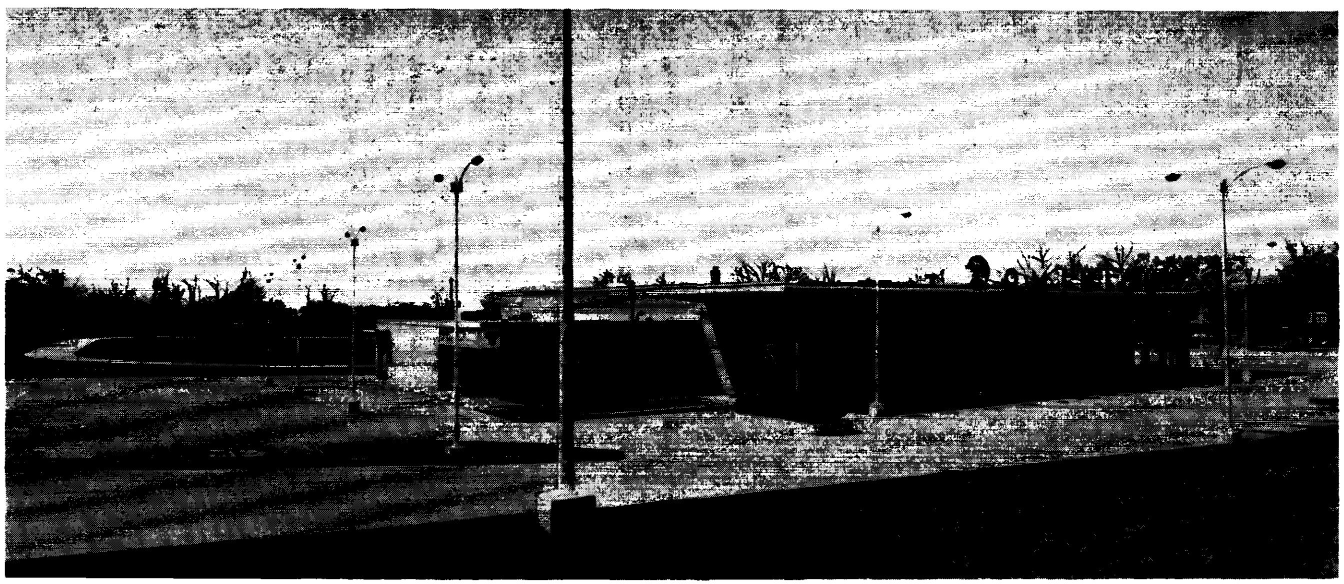
Photo 44 ODM 8334

Photo 44 and 45–These photos show the Greenwood Avenue subway yards, which are located on the site of several brick plants and clay pits. Photos courtesy of John O. Spender.

Photo 45 ODM 8335

ODM 8336

Photo 46–Greenwood Park in Toronto occupies the site of a former pit. Photo courtesy of D. F. Hewitt.



ODM 8337

Photo 47–A park and supermarket occupy the site of a former gravel pit on Kingston Road at Victoria Park Avenue in Scarborough. Photo courtesy of D. F. Hewitt.

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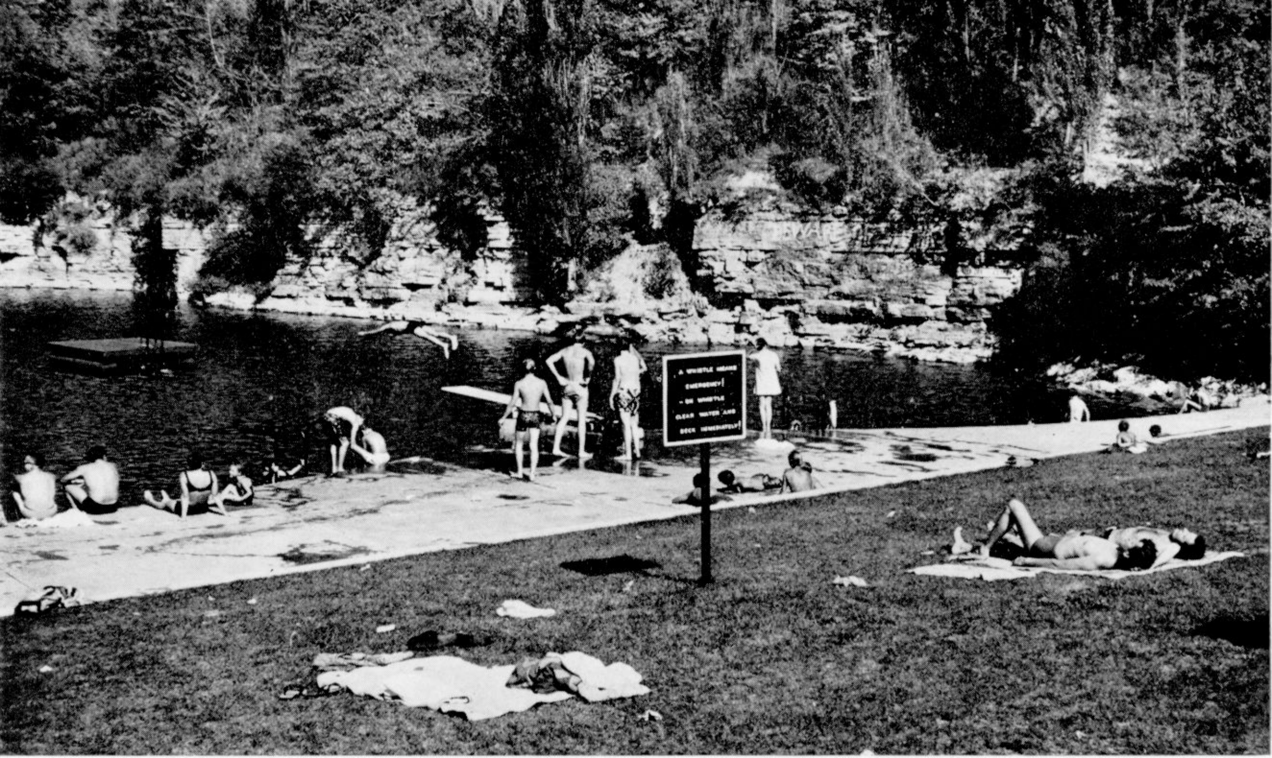
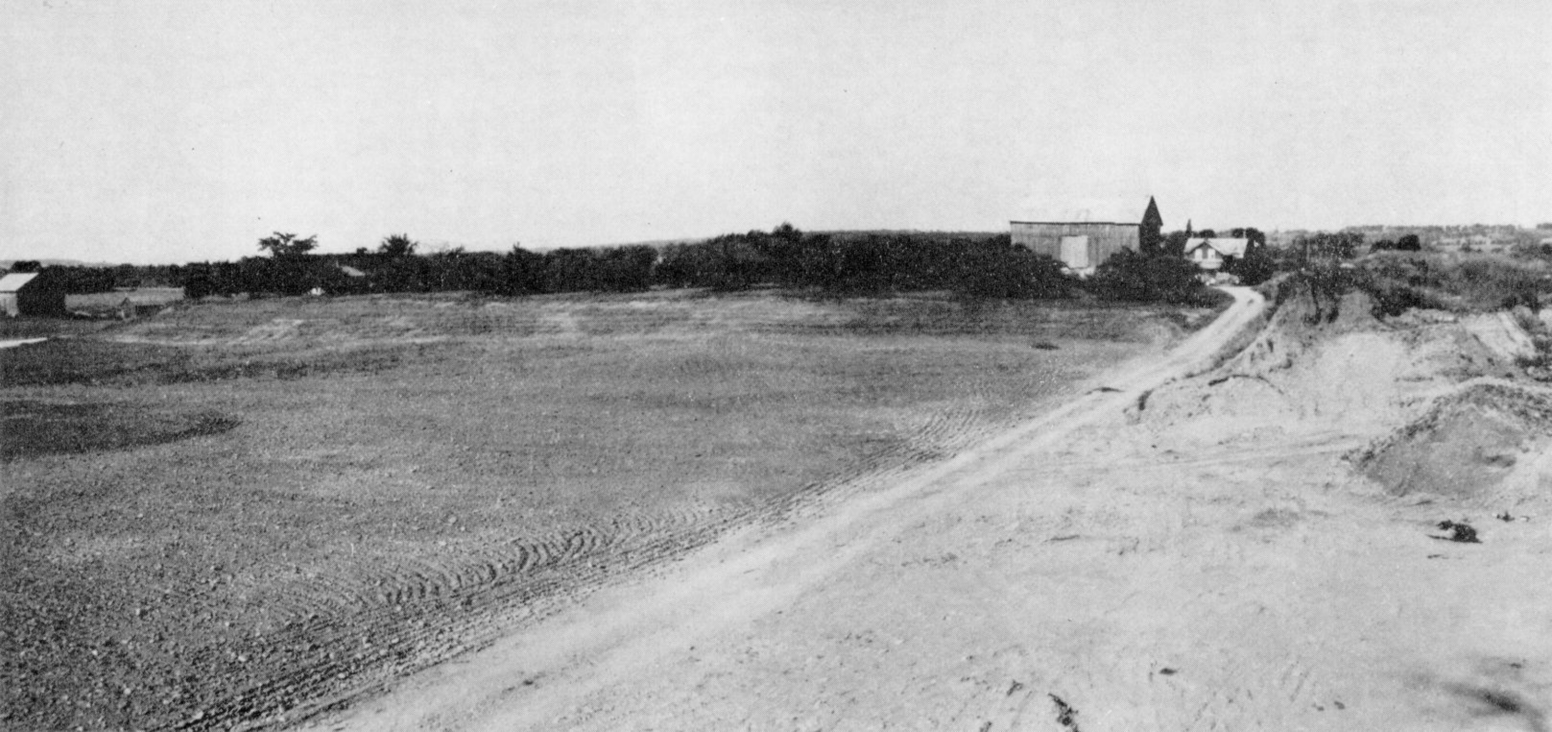
INDEX


NELSON CRUSHED STONE
KING PAVING & MATERIALS LTD.

Figure 1 — SURFACE FEATURES MAP
PROPOSED QUARRY SITE
Parts of Lots 23 and 24, Concessions [illegible]
Norwood Township


THE BIG CREEK REGION
CONSERVATION AUTHORITY
THE GOVERNMENT OF ONTARIO


A WHISTLE MEANS
EMERGENCY!
- ON WHISTLE
CLEAR WATER AND
DECK IMMEDIATELY!



B
A
SCARLETT ROAD
JANE STREET


SCARLETT
ROAD
JANE
STREET


SUNOCO

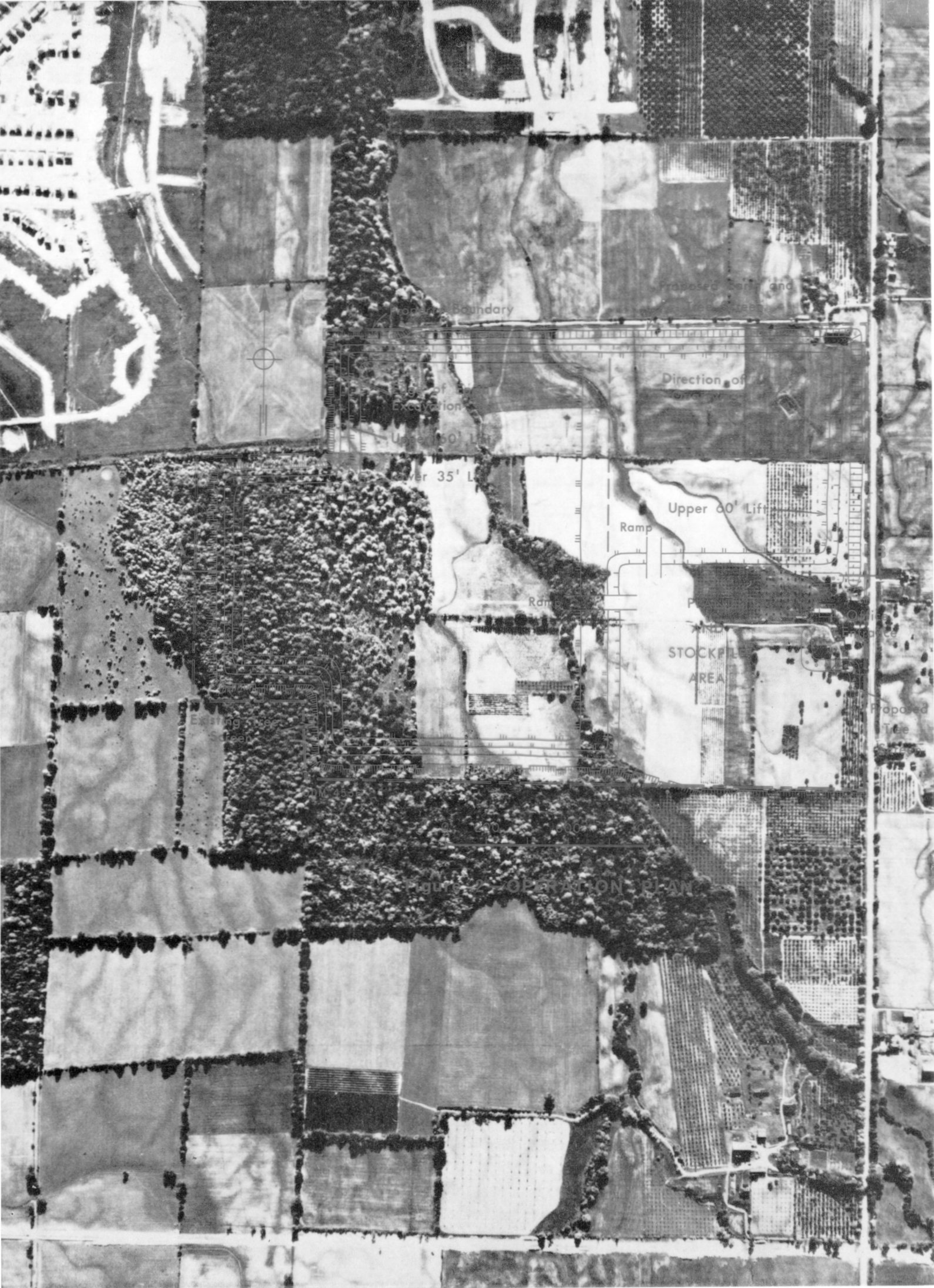


Figure 2 — OPERATION PLAN

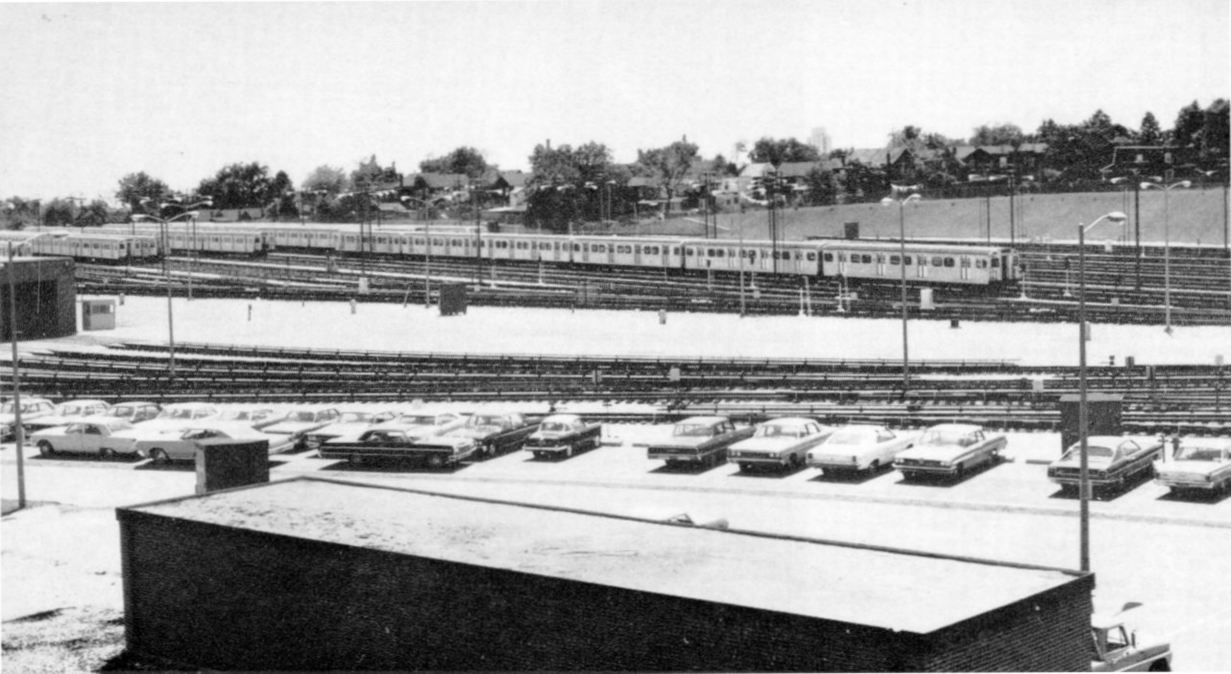

A
B
JANE STREET

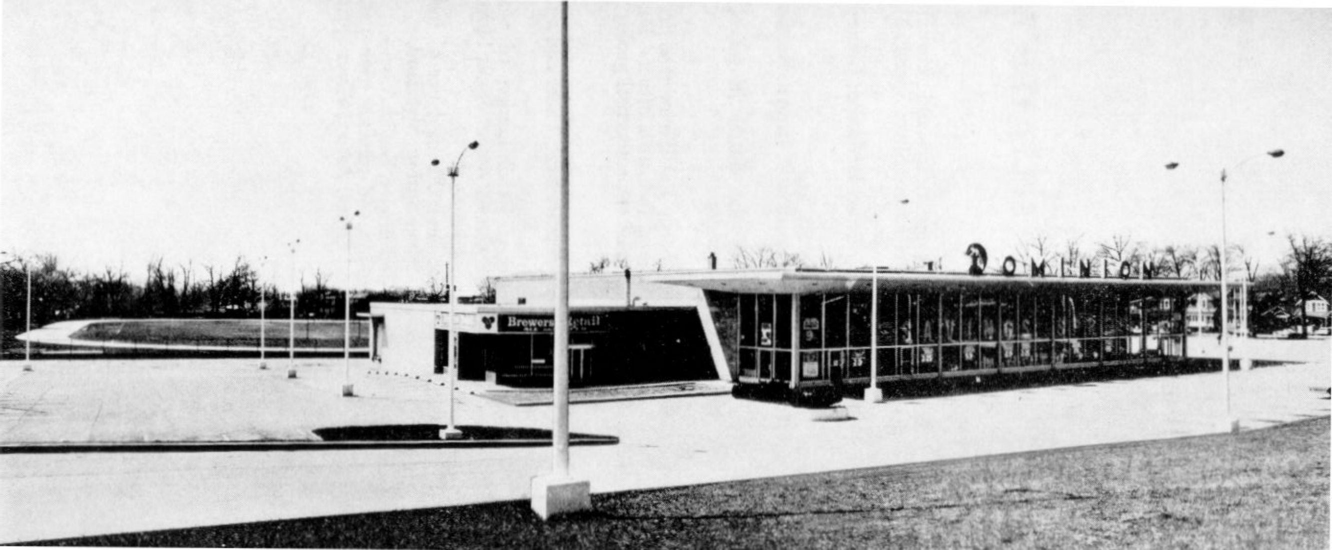

STADIUM


RICHVIEW SIDE ROAD
SCARLETT ROAD


TRETHEWEY DRIVE
EGLINTON AVENUE
KEELE STREET


DAWES ROAD




DOMINION
Brewers Retail
SAVINGS