

PHYSICAL PLANNING OF AN INDUSTRIAL PARK:
A GUIDE FOR PLANNERS AND DEVELOPERS IN THAILAND

by

PRAJIM KRAIRUSSAMEE

B.S., Kasetsart University, Bangkok, Thailand, 1968

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

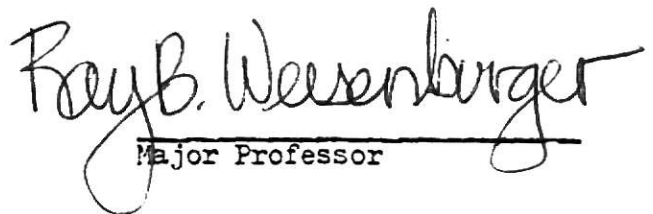
MASTER OF REGIONAL AND COMMUNITY PLANNING

Department of Regional and Community Planning

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1981

Approved by:


Major Professor

SPEC
COLL
LD
2668
.R4
1981
K72
C.2

TABLE OF CONTENTS

	Page
INTRODUCTION.....	1
CHAPTER	
1. LOCATION CONSIDERATIONS.....	10
Raw Material Sources.....	12
Labor Supply.....	13
Transportation.....	16
Power and Fuel Supply.....	20
Water Resources.....	21
Market.....	23
Climatic Condition.....	23
Site Suitability.....	24
Community Factors.....	25
River Sites Location, Waste Disposal and Treatment.....	25
2. PLANNING AND DEVELOPMENT OF INDUSTRIAL SITE.....	27
Pre-Planning Survey and Evaluation.....	27
Criteria for Site Selection.....	31
Development Criteria.....	32
Restrictions and Controls.....	33
3. INDUSTRIAL PARK LAYOUT CONSIDERATIONS AND DESIGN.....	37
Street Layout and Design.....	38
Railways.....	42
Airport.....	43
Grading and Drainage.....	43

	Page
Utilities, Layout and Design.....	45
Design Considerations.....	48
Landscaping and Erosion Controls.....	57
CONCLUSIONS.....	60
BIBLIOGRAPHY.....	61
APPENDIX A MATERIAL, SUPPLIES, SERVICES.....	63
APPENDIX B LABOR SUPPLY.....	66
APPENDIX C TRANSPORTATION.....	69
APPENDIX D POWER AND FUEL SUPPLY.....	74
APPENDIX E WATER RESOURCES.....	78
APPENDIX F MARKET.....	81
APPENDIX G CLIMATIC CONDITION.....	83
APPENDIX H SITE SUITABILITY.....	85
APPENDIX I COMMUNITY FACTORS.....	88
APPENDIX J WASTE DISPOSAL AND TREATMENT.....	99

INTRODUCTION

Thailand is a medium-size, torridly-hot, monsoon-beset, agriculturally-fertile, developing country in Southeast Asia. Thailand's 800 kilometer extension down the narrow Malay Peninsula provides a "handle" for bulk of the country, which covers an area roughly 650 by 800 kilometers bounded by Burma on the west, Laos on the northeast, Cambodia on the east, and Malaysia and the Gulf of Thailand on the south.

The most populous part of the nation is flat, alluvial, central plain, which suffers from near-intolerable heat and humidity for most of the year, influencing architectural styles, daily work and school schedules, cooking practices, and many other culture phenomena. In contrast to the nearly totally farmed and settled rice paddies of the Central Region, the teak-forested uplands of the North are relatively sparsely settled and often remote of access. The Northeast, a seasonably-arid plateau, is a fairly dense farming area suffering from lower levels of living than the rest of the country. The South, a mountainous sliver, is incompletely integrated with the other regions and also is the least productive of agricultural and manufactured products- although it does lead in rubber and tin.

Thailand has three seasons: hot and dry, from March to June; rainy and somewhat less hot, from June to October; and tropically cool, from October through February. The net result, although not particularly beneficial for the comfort of human beings, is a long and highly productive agricultural growing season.

The Thai People: The word "Thai" means "free", and the Thai people have justified its use in naming their country by so arranging their political and military history that Thailand remains the only nation in Southeast Asia that has never been ruled by a European colonial power. The king and the queen are universally revered, for the royal family embodies, to an ordinary citizen, the history and present unity of Thailand.

Income Levels: Like any other predominantly-agricultural nation, Thailand has a low level of income, by any measure. Although income is now increasing at about 4 percent a year, most Thai farm families still earn much less than \$ 1,000 U.S. annually.

Education of Population: Like most people in most countries, Thais generally go to school for the primary purpose of getting a good job. But in Thailand, most work is agricultural and therefore provides little stimulus toward educational attainment. There are four levels of education in Thailand: (1) Pre-school education; (2) Elementary education; (3) Secondary education; (4) Higher education.

Pre-school education aims at preparing children for elementary education.

Elementary education aims at developing children, by giving them basic education, through knowledge and towards better use of knowledge.

Secondary education, the continuation of the primary education, aims at exploring and developing interests and aptitude of children. According to the National Scheme of Education, secondary education is divided into two streams. The first, the General Stream, has its curriculum oriented toward general education with very little emphasis in occupational skills. The other, the Vocational Stream prepares children

with knowledge and skill needs for specific occupations.

Higher education, deals with the study of, and research in the higher academic, professional and technical subjects, at the universities or similar institutions.

Natural Resources: The natural resources of Thailand are now much better known than they were some 20 years ago, especially the mineral resources and energy resources. Thailand has been known as one of the main tin producers for a past few years, and has ranked the third biggest producer of the world. In addition to tin, there are antimony, asbestos, barite, copper, coal, columbium and tantalum, chromite, gold, diatomite, fluorite, feldspar, gemstones, gypsum, praphite, iron, kaolin, lead, manganese, monazite, molybdenum, marble, marl, zinc, petroleum, phosphate, platinum, rock salt, silica sand, soapstone, talc, oil shale, titanium and tungsten.

Transportations:

Highways: Highways system in Thailand can be divided into three categories:

(1) Primary highways, the total length of which throughout the country is 5311.463 kilometers.

(2) Secondary highways, the total length of which throughout the country is 5665.571 kilometers.

(3) Feeder roads, the total length of which throughout the country is 6127.814 kilometers.

Railways: The existing railways lines compose of 3764.529 route kilometers in distance with 2175.713 kilometers on the east bank of the Chao Phya River and 1588.816 kilometers on the west bank. Among those

there is one section of double tracks, that is on the east bank of the river with the distance of 90.350 kilometers from Bangkok to Ban Phachi Junction.

Railway lines connected with neighboring countries are: (1) Thai-Malaysian Connection; (2) Thai-Cambodian Connection.

Civil Aviation: The public air transport service of Thailand was first introduced in 1922 on a 363 kilometers rout in the northeastern provinces by the Royal Thai Air Force. Subsequently it developed considerably until the time of its temporary suspension as a result of World War II. Reorganization of the air transport operations was effected in 1947 through the establishment of the Government-owned Air Navigation Company Limited. The company was amalgamated in 1951 with the Pacific Overseas Airlines (Siam) Ltd., created by joint investments of the Thai Government and foreign companies, and become known as the Thai Airways Company Limited (T.A.C.). This company has been authorized to carry out air transport internally as well as internationally, providing connections with some principal cities in neighboring countries.

Waterways: The total length of waterways is about 2,000 kilometers during the wet season, and 1,100 kilometers during the dry season. No less than 27 provinces can be communicated through these waterways. Among those provinces, the communication and transportation to and from Bangkok, the capital of Thailand, and its twin city, Thonburi are the most important.

Market: (a) Foreign Trade: The world market of the products from Thailand are:

1. Japan

2. The Netherland
3. Singapore
4. U.S.A.
5. Hong Kong
6. Malaysia
7. Indonesia
8. West Germany
9. Saudi Arabia
10. England

Most of the products to those countries are the agricultural products, minerals, rubber, tin, furniture, electrical machinery, glass and glass ware, ceramic products, stone, cement, plastic, articles, foot-ware, cotton, wood, paper, silk, sugar, fish, coffee, tea, and spice, etc.

(b) Internal Trade: The market in the country mostly the regional market. The product was shipped from the factories to the market by highways, railways, and waterways.

Industrial areas of Bangkok-Thonburi Twin City: The existing industrial structure of Bangkok and Thonburi, Bangkok's twin city on the opposite bank of the Chao Phya River, can be divided into two groups:

(1) numerous small and medium-sized establishments operating mainly in shophouse particularly in the Sampeng district and other densely populated areas;

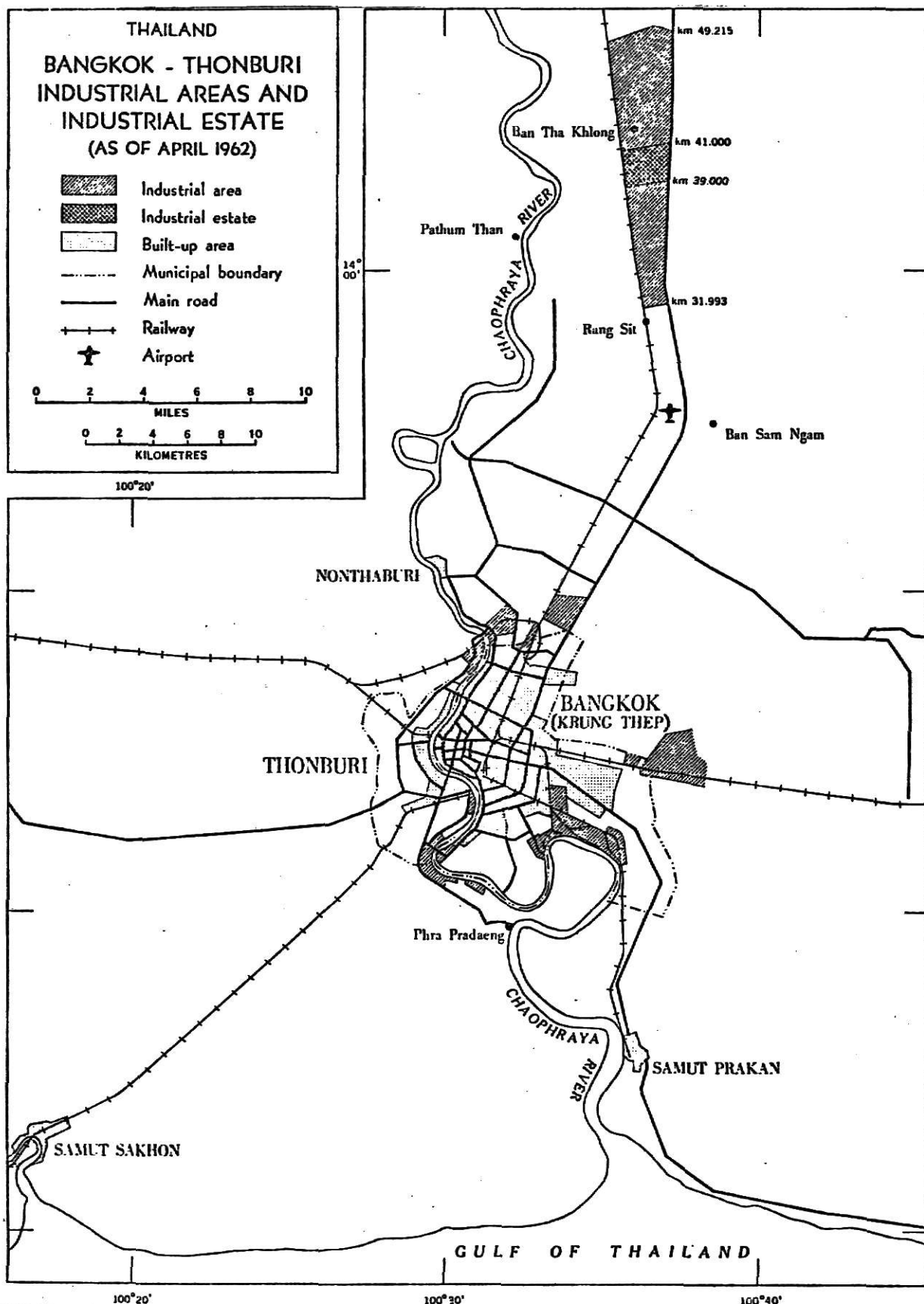
(2) a few large manufacturing establishments located in various outlying areas of the city.

The industrial areas of the Bangkok-Thonburi have been classified into four groups:

- (1) obnoxious industries which require isolation from residential areas;
- (2) manufacturing or assembly industries which do not require complete isolation from residential areas;
- (3) light manufacturing or assembly industries which may be located in fairly close proximity to residential areas; and
- (4) light industries which may be located anywhere subject to conformance to special condition covering site size, location of buildings on site, and methods of operation.

Small industrial establishments will for many years contribute significantly to the industrial base of Bangkok-Thonburi. Their relative importance will decrease in the future, but care should be taken to insure their continued contribution to the economy. These establishments, located in shophouse and small houses, provide substantial employment which does not require a daily journey to work, and does not tax the inadequate public transportation facilities.

It is evident that investors in the industrial sector will be confronted with increasing difficulties of finding suitable premises at a reasonable price. There have been cases of prospective investors to whom promotional privileges had been promised who had to withdraw from the venture because of failure to obtain suitable land. The pressing need for land area and worksheds is one of the reasons for which the Government of Thailand adopted a program of establishment of industrial parks. An industrial park will be created near Bangkok with all the basic facilities such as water and power supply as well as social overheads such as housing, schools and hospitals.



The industrial areas, industrial park, built-up areas of the Bangkok-Thonburi are shown on the map next page.

In addition, the Economic Development Project for the north-east of Thailand provides for the establishment of an industrial parks in the province of Khon Khaen, where a hydroelectric scheme is to be set up under the Development Project. The park designed for existing small industries, in particular, jutebaling factories and a certain number of prospective industries whose establishment will be made possible by the availability of power.

Although the concept of the industrial park originated about eighty years ago- the first park was established in 1896 in the United Kingdom, at Trafford Park, Manchester, by a private group, and in United States, the Clearing Industrial District, near Chicago began to operate in 1899. Progress in this field has been slow and halting until the 1950's and largely confined to these two countries. Since the 1950's however, there has been a very rapid growth of industrial parks all over the world. There is a sustained and growing interest in industrial park both in the industrial countries which still account for the largest number of parks, and in developing countries, where they are considered as a major industrialization tool.

In developing countries, industrial parks have received attention as one of the important devices in programs for the development of small-scale industries. This interest is stimulated by the fact that most of the small factories in developing countries are scattered in the commercial districts or the residential areas of urban centers, and that, as industry develops, the very location of small enterprises in these areas

becomes an obstacle to their performance and development. Moreover, increasing difficulties are encountered in finding suitable sites for factories and their establishment often gives rise to public nuisances.

In developing countries, the objective in promoting industrial parks is to help small business to improve its productivity and operation by encouraging it to move in groups to certain sites fit for factories, and located far from the established city areas. This contribution not only to its modernization but also to the dispersion of factories and development of underdeveloped region.

In this report, the term "industrial Park" is used as the generic concept to designate a planned clustering of industrial enterprises, offering developed sites, pre- built factory accommodation and provision of services and facilities to the occupants.

The purpose of this report is to provide guideline in locating, planning, laying out of industrial parks, especially those for small-scale industries. The report is divided into three phases. The first phase of the report will concentrate on theoretical considerations governing industrial park location decision. The second phase is the planning and development of industrial site. In this report, an attempt is made to set out all elements of possible importance in planning an industrial park, by setting the planners' terms of reference, and for the planner, by providing him or her with a checklist which may be refined or corrected by his own knowledge and experience. This phase will include pre-planning survey and design considerations, criteria for site selection, development criteria, and restrictions and controls. The third phase is the lay out considerations and design. The lay out of the industrial park depends on the planning and development of the industrial site and can

be broken down into seven components:

- A. Street layout and design.
- B. Railways.
- C. Airport.
- D. Grading and drainage.
- E. Utilities layout and design.
- F. Design Considerations.
- G. Landscaping and erosion control.

Chapter 1

LOCATION CONSIDERATIONS

The experience of developing countries shows that economic activity, especially industrial activity, tends to be concentrated in one or a few urban areas with many economic advantages. This creates a problem of regional disparities, which must be progressively reduced as a legitimate and necessary objective of development. The goal of regional policy, however, cannot be to develop industrially all regions equally but to develop each region to its maximum potential. Regional development policy should follow the criterion of "selective dispersal", choosing growth points within the less developed areas of the country.

The problem of industrial park location receives more attention. The conditions that can lead to the problem of the industrial park location are:¹ (1) expansion, (2) decentralization, and (3) economic factors, such as a shift of the market or an inadequate labor supply.

In general, three types of locations for industrial parks may be considered: (1) near large urban centers, (2) near smaller towns, and (3) in rural areas.²

Location near the big urban centers will most probably satisfy all the essential requirements. Entrepreneurs will normally favor such locations as they can easily get their skilled labor and arrange for the

¹James M. Moore, Plant Layout and Design (The Macmillan Company, New York, 1962) p.33

²United Nations, Industrial Estates in Asia and the Far East (New York, 1962) p.176

purchase of raw materials and the marketing of finished goods. Another advantage is that provided the industrial park and slum clearance programs are properly coordinated, the industries in slum areas of the city could be shifted to better surroundings. However, there is a serious drawback that such locations will add to the concentration of population and might aggravate slums and blighted areas.

Location near smaller towns seems to be quite promising as most of the advantages accruing from location near large urban centers can also be obtained smaller towns without adding to congestion and concentration of population. Land near smaller towns is comparatively cheaper than the big city location and the towns may be capable of absorbing the additional population attracted by the establishment of the industrial parks.

Location in rural areas appears at first sight to be a promising means of promoting industrial development in regions which are industrially backward. However, success depends on a number of factors which are not often found present together in a rural area, such as adequate supplies of raw materials, skilled labor, electricity, water and communications. Rural industrial parks should therefore be set up on an experimental basis and be further developed only if these difficulties can be reasonably overcome.

The factors which are regarded as essential for location considerations for a particular plant are numerous, depending upon the type of industry. In general, the main factors taken into consideration in the general evaluation of the industrial park location are the following:

1. Raw material sources.

2. Labor supply.
3. Transportation.
4. Power and fuel supply.
5. Water resources.
6. Market.
7. Climatic condition.
8. Site suitability.
9. Community factors.
10. River sites location, Waste disposal and treatment.

Raw Material Sources

The location of raw materials is influential in the location problem of the industrial parks. Some industries by the nature of their manufacturing process are forced to locate near raw material sources. Industries which require frequent or high volume importing or exporting of materials or finished products will find it more economical to operate near the port.

With respect to the influence of raw materials on choice of industrial park location, the following considerations are fundamental:

- (a) The source of raw materials is likely to be the controlling factor when the materials are bulky and of relatively low unit price.
- (b) Factors other than the source of raw materials are influential when the materials are small in bulk and high in unit price.
- (c) When the raw materials are greatly reduced in bulk by the

³
 United Nations, Industrial Location and Regional Development
 (New York, 1971) pp. 668-669

manufacturing process, the plant is usually sited near the source of supply.

(d) When the raw materials are perishable and manufacture makes them less so, the manufacturing plant is usually at the source of supply.

Yaseen suggests that raw materials be treated in three classes;⁴

1. Pure materials which are included in the manufactured article without loss of weight.

2. Weight-losing materials, only a part of whose weight is represented in the weight of the finished article.

3. Ubiquities, or materials found virtually everywhere.

Also, the following generation regarding the effect of raw materials on industrial parks location may be made:

1. When a single raw material is used, without loss of weight, locate the industrial park at the raw material source, at the market, or at any point in between.

2. When a weight-losing raw material is demanded, locate the industrial park at the raw material source.

3. When a ubiquity is used, locate close to the market area, since the material is universally available.

In Thailand, raw materials for industry are often found in abundance in the rural areas. The planner should determine all forms of transport, particularly road and railway.

Labor Supply

Labor is an important consideration in the industrial park site

⁴
Leonard C. Yaseen, Plant Location (New York, American Research Council, 1956) p.29

location. Labor's significance as a factor in location consideration has been somewhat overshadowed in recent years by environmental and energy considerations. But labor has been gaining in importance as a location factor and can be expected to remain a major consideration in the future. Freed, an industrial labor specialist mentioned that:⁵

"A heavy equipment manufacturer invested \$2 million in a facility with future expansion in mind. But a subsequent labor availability study showed that it would be very difficult to meet short-term manpower needs and almost impossible to meet long-term needs. Thus, the original plans had to be abandoned with the consequent loss of the money originally invested.

"This is only one of the many manufacturers that pour money into a venture without first conducting a labor availability study. Other companies may make a study but its often not thorough enough-too many important ingredients are missing."

"Not long ago, in the United States, things were different. You could locate or expand a plant almost anywhere with little concern for attracting the labor force needed. But the situation has changed drastically. This change is reflected in a recent pool of companies that built new plants. It shows that getting the right type of labor is now considered the most important site selection factor."

Another aspect of the labor which is important to industril park location is the difficulty of effecting changes in the labor pool characteristics. Factors are absenteeism, work quality, productivity, trainability, stability and loyalty vary from geographic location to location

⁵ Shervin Freed, "Plant Site; How to Study Local Labor Availability," Factory, Feb. 1972, pp.

and to a large extent must be accepted as inherent qualities of a particular labor pool. Of course, a company can, over a period of time, upgrade the quality of its labor force through effort and community participation. Caution is urged, however, in that it is easy to underestimate the time, effort, and resources such changes will require.

The community factors also have an important effect on the labor quality and quantity. If the community is a desirable place to live, such as good schools, recreational opportunities, hospitals, churches and a variety of entertainment opportunities, workers will relate well to it and will come to accept the community as home. This will have a effect on all aspects of the labor quality. On the other hand, if the community is a bleak "company town" with poor amenities, few people will consider it as their "permanent" home. Out-migration will become the problem, general unrest and "gripping" will be prevalent, and the quality of labor will be poor.

The industrial climate of the community is also an important labor factor. Have there been many strike ? What were the issues ? What was the reaction of local law enforcement agencies ? Have existing industries been treated fairly with regard to zoning, utility, and tax considerations ? Is new industry encouraged, or are there undercurrents of resentment to industry that do not appear on the surface ?

The analysis of the labor aspects of industrial park location is of sufficient importance to justify careful study by a team of competent professionals for a variety of disciplines. Ideally, the team should be made up of individuals who have a detailed knowledge of the company needs, as well as individuals who have a similar knowledge of what the prospective community has to offer.

It was generally agreed that one of the main problems faced by developing countries is that large-scale employment opportunities usually exist only in a few urban centers. This situation imposes the alternatives of either inducing migration to the growing points in the country or of providing employment locally.⁶

In Thailand, a drift of population from agricultural areas to urban centers also creates employment needs. Stimulation of industrial growth in smaller towns within the area from which people are moving is often resorted to in an attempt to check such migration. Industrial land should be reasonably accessible to an adequate pool of labor. Unless existing residential areas are close, or connected to the industries by convenient public transit, provision of housing for workers must be considered. Since 1970s, Thailand lose thousands of skill labors to the Middle East countries. Skills available in the areas will be indicated by the study of existing factories and workshops. Examination of existing technical schools, of their output and ability to increase output, will also be needed. Information on where students go at present on completion of courses, both from technical and primary schools, will be valuable in the assessment of labor supply.

Transportation.

Although specific needs vary from industry to industry, all industrial parks require transportation services to ship raw material to the plant and to ship the finished product to the market. Trans-

⁶ United Nations, Report of the Interregional Seminar on Industrial Location and Regional Development (New York, 1969), p. 30

portation is and will continue to be a crucial factor in industrial park location. The availability of adequate transportation is of prime importance for an industrial park. Usually the industrial parks are located near railroads, good highways, harbors or waterways, and more recently, near airports. The major modes of transportation for industrial parks services may be classified as;

(a) Trucks. Road transportation has gained the lead previously held by the railroads. Truck transportation may be sufficient, if raw materials or finished products are not bulky and if the highways are suitable for heavy truck usage. Trucking has the advantage of providing flexibility with respect both to destination and timing, and in addition planning and control on progress are easy. Most industrial parks are dependent on trucking as their main transportation, the importance of adequate direct highways from the industrial park to the main center must be underlined. The experience of developing countries indicates that the development of a highway system should precede the location of the industrial parks, if these parks are to have the optimum chance for success.

(b) Railroads. Generally, only heavy industries and larger firms require rail transportation and, where access to such facilities exist on an industrial park, it should be reserved in the main for these industries. In countries where highway facilities are insufficient, the railroad may be greater and should be anticipated. Industrial parks requiring railroad facilities can be directly connected to the main line and the tracks can be laid out to keep the number of level crossings and bridges to a minimum, since these are costly and can be dangerous; they can also

create traffic problems. The master plan of development for the park should be drawn up in co-operation with the railroad, and should determine in advance the pattern of the rail installation to conserve the land, avoid congestion, and preserve the appearance of the industrial park.

(c) Water. Water transportation is usually the cheapest way of shipping large tonnages. The inherent advantage of barge transportation lies in its ability to handle bulk products at low cost. Consequently, choice of location on major water transportation routes are usually at a premium. The presence of a water transportation can greatly benefit certain types of industries where the direct flow of raw materials and fuel by water transportation from their source to the manufacturing plant is still a major consideration. Water transportation can often make it possible to develop the location which otherwise would have some disadvantages. Generally, the service is slow compared to other modes of transportation. And it is necessary to maintain larger inventories at the terminal facilities because of floods or low-water conditions.

(d) Air. Air transportation is vital to those industrial plants which produce high-grade products and need expedited shipping service. There is some evidence that more industrial parks are being located near airports, because modern smokeless industrial plants, with low-profile, one storey construction, no longer constitute a hazard to aviation.

With the increasing use of air freight, proximity to air facilities becomes a consideration for certain types of industries. In Thailand, the industrial park was located near airport for serving as the shipment point (see the location in the map of Thailand). However, there are some factories which are located in the vicinity of the

general aviation area. These factories have the advantage of being close to the area where the aircraft will be stored and maintained. This location keeps ground taxi time at a minimum.

Selection of Mode of Transportation. The foregoing discussion of the general modes of transportation is of necessity general. In the analysis of specific industrial park location, however, it is necessary to be quite specific and analytical. The first step in such an analysis is to make a detailed review of all of the services available to the various sites under consideration. Each transportation mode has its unique advantages and limitations. In selecting the proper transportation media or mix medias, consideration should be given to the following:⁷

1. The relative cost of the service.
2. The reliability and continuity of the service.
3. The urgency of the shipment.
4. The demand for special services.
5. The physical facilities available at the points of origin and destination.

After each transportation mode has been determined, it is possible to determine the employee communication. In Thailand, it has been recognized that, as new industries are established and additional industrial parks are developed, bus services for workers will become a necessity, because most workers will travel by bus. The industrial park management should determine in advance the available services and the possible need for expansion.

⁷Frank L. Cross and John L. Simons, Industrial Plant Siting (Technomic Publishing Co., Inc., 1975) p. 51

Power and Fuel Supply.

All industries today require electric power of some sort. Over the past decade, particularly in developing countries, there has been a continuous increase in the part played by electricity in the total industrial consumption of energy. In general, most industries prefer to purchase rather than manufacture their own power, because the typical public utility can supply electric power at lower cost than the usual company can produce it.

One of the source suggests the following checklist when examining the power situation in a given area:⁸

- a. Type of service.
 1. Hydroelectric.
 2. Steam.
 3. Other.
- b. Reliability of service; history of stopages.
- c. Adequacy of supply; seasonal restrictions.
- d. Kind.
 1. Phase.
 2. Cycle.
 3. Voltage.
- e. Rates.
- f. Availability of off-peak contracts.
- g. Fuel adjustment.

⁸ Leonard C. Yaseen, Plant Location (New York, American Research Council, 1956) p. 81

h. Lighting allowances.

i. Discounts and penalties.

Hydroelectric power is usually associated with cheap rates, but the original installation of the hydroelectric plant is usually considerably more costly than that for the steam plant.

The Economic Development Project for the north-east of Thailand provides for the establishment of an industrial park in the province of Khon Khaen, where a hydroelectric power is to be set up under the Development Project. The park will be designed for existing small industries, in particular, jute baling factories, and a certain number of prospective industries whose establishment will be made possible by the availability of power.

Fuel, if large quantities of fuel shortage and energy crisis threatens to reshape certain established location patterns of industrial park due to (1) the lack of a necessary and traditional energy resource in a given region, (2) the need to relocate industry in order to obtain more efficiently an alternative energy source, and (3) the need to change production processes to adjust to changing energy supplies with resultant increased costs of operation.

Water Resources.

Water is not a new consideration in the location of industrial park, has been amply demonstrated by the choices that industry has made in the past. The fact that water as a natural resource may be limited as to quantity and quality in any particular location, is becoming ever more evident as the demands of new industries and the expansion of established plants prove in area after area. Water is generally available

from three sources: (1) Surface; that is, water from lakes, streams, etc. (2) ground; that is, springs and wells, and (3) rain water. Surface water varies greatly in its chemical analysis, and microscopic organisms and vegetation may add taste and color harmful to specific manufacturing processes. Hard water can damage steam boilers, pumps and circulating system, engines and other water-jacketed equipment. The pH factor, which is a measure of hydrogen-ion concentration of water and is an expression of its acidity or alkalinity, should be checked if hardness will affect the manufacturing process.⁹

The general water supply pattern of possible areas should be examined first in terms of canals, rivers, reservoirs and main pipe-lines. The nearer the site is to a main supply, the better. Water will be required for industrial uses such as process (32%), cooling (54%), boiler feed (9%), sanitary and service (6%), and other purposes-fire protection needs, landscape maintenance (4%).¹⁰ There are two general situations where industrial park-owned sources of water are desirable or feasible. First, their own sources of water are preferable for large industrial park, where the location usually is along a surface stream. Second in areas of ready and abundant ground water supplies, industrial park may find it cheaper to develop its water supply from wells than a surface source or sometimes a municipal source. Further, the ready accessibility to water through wells permits much greater latitude in the selection of

⁹John D. Hem, Study and Interpretation of the Chemical Characteristics of Natural Water (Geological Survey Water-Supply Paper 1473, Washington, 1970), pp. 333-338

¹⁰_____, Water For Industry: "A Review Of Water Resources Affecting Industrial Location" Urban Land (Technical Bulletin No. 17, 1951) pp. 15-20

the site, inasmuch as choice is not restricted to areas served by public water system.

Market.

The market is a factor to be considered in industrial park location. Depending upon the product, market may be concentrated or widely dispersed. When the market is concentrated, the market factor would tend to influence the planner to locate close to this concentration. For a production servicing a dispersed market the influence of the market, which is a statistical device helpful in approximation that point which will provide the lowest cost for distribution. The center of the market can be used only as a guide for industrial park location.

Climatic Condition.

The climate greatly influences human efficiency and behavior. In general the climate of a given area will be suitable for industrial development if people are already working there successfully. It may be necessary to remember this, particularly if the location of industrial park is being determined by someone from a more temperate area. Hotter climates, particularly with architectural advances in the insulation and cooling of buildings, should be equally suitable for industry. Records of wind velocities and of earthquakes may be important not only in relation to location selection but in relation to building design. Wind velocities and direction can also influence industrial park location; these become very important factors when the possibility of radioactive fall out resulting from an attack upon a distant city is considered.

In addition to fuel costs, climate can influence the selection of location of industrial park because of the amount of precipitation or air pollution.

Site Suitability.

Physical characteristics of the land exert a strong influence on industrial park location, especially as they relate to grading, drainage, building foundations, extension of rail and utilities, visibility to and from adjacent major highways, and site layouts. The industrial park location must be topographically suitable, however, this does not necessarily mean that the land surface must always be flat or near flat, because there are industries and situations that will permit use of quite rugged terrain and, actually hillside site. In general, a slope not exceeding five degrees is desirable for the development of the industrial park.¹¹ Tracts suitable for industrial park by the reason of location often can be economically adapted by site preparation in spite of heavy grading requirements. The rolling land with compatible surrounding uses is preferable to perfectly flat hard-to-drain tracts.

Subsurface conditions must be determined in order to properly estimate the capacity of the underlying materials to support plant buildings as well as the possibility of drainage and grading. In any event, test borings should be taken to determine the load-bearing quality of underlying strata. Where footings must be "floated" it is essential to know the exact boundaries of the "soft" area. Otherwise,

¹¹Dick Howard, Guide to Industrial Development (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1972) p. 13

Buildings may be constructed partially over soft ground and partially over solid ground, resulting in uneven structural settlement.

Community Factors.

The community factors are growing importance to industrial park location. In the past, industrial parks were desired and welcomed by almost every community. Today, most of the communities are selective in the types of industry they seek, and an increasing number of them have adopted a controlled-growth or a no-growth policy. While special inducements, such as favored tax treatment or the provision of water and sewage service at a discount, are still common in some communities, a number of other communities have adopted or are considering the imposition of impact fees. Where the emphasis was once on the economic benefits to be derived from the company payrolls more and more attention is now being to the impact the park will have on the environment and on the services of the community. Community amenities such as physical appearance, cultural and recreational opportunities, police and fire protection, schools and hospitals, civic organizations, and government are important factors in industrial park location.

In Thailand almost every community wellcomes all kinds of industries. As is widely known, Thailand is faced with a serious problem of urban unemployment and rural under-employment. Several of the communities selected as sites for the industrial areas are at present severely suffering from conjection and slum conditions.

River Sites Location, Waste Disposal and Treatment.

The special site is the so-called "river" or "water" site where the industrial park operation requires location along the river or other stream in order to obtain processing water in substantial volume and/or to obtain the advantage of water shipping. Both size and topography of the site are of major importance since, in many cases, the problem of waste disposal can be solved most feasibly "by storage in shallow basins which may serve both as equalization tanks and oxidation lagoons, or by storage in reservoirs which provide a substantial amount of impoundment with release controlled in proportion to the ability of the stream to assimilate pollution."¹²

Today, good river sites, under any condition, are difficult to find, and those that can be satisfactorily developed within existing pollution controls deserve protection and reservation for future industrial use. Industrial park may have to be sited at some distance from their water source. For example, a river with wide flood plain may necessitate location of the industrial park on a terrace or other upland area that would be above flood level.

¹²

Truman H. Safford, "Waste Disposal- A Factor in Site Selection," Industrial Water & Wastes, November-December, 1961

Chapter 2

PLANNING AND DEVELOPMENT OF INDUSTRIAL SITE

This phase provides the developer with insight to engineering and site design considerations which are vital to industrial land development. The intent of this phase is to provide the developer with a checklist- rather than specific design methods or criteria- which can be applied to a parcel of land under consideration of development.

A. PRE-PLANNING SURVEY AND EVALUATION.

The project survey for evaluation begins early in the planning and development of the industrial site under consideration. By such procedure, physical site characteristics can be studied and evaluated. The pre-planning survey usually can not be expected to determine and evaluate all problems, because of limited time and budget. However, major problems such as topography, soils and foundation conditions, availability of utilities, transportation and, landscaping and preservation of existing vegetation should be evaluated during this phase of the work.

a. Topographic Survey: The topographic survey is basic to site evaluation. The survey data are displayed on a map form which shows the ground surface contours of the site under considerations. Contours of perimeter property should be shown also, if available- particularly if they relate to watershed areas. The base map is used for terrain analysis studies which indicate such characteristics as ground slope and surface drainage patterns which provide important clues to the presence of sinkholes in limestone terrain, fault lines in earthquake prone areas,

and susceptibility to flooding. There are two kinds of topographic surveys: (1) Field Instrument Survey; (2) Aerial Survey.

Field Instrument Survey.

Field Instrument Surveys usually run on a certified plat of the property to be developed. In this survey, the property is laid out and staked in a grid pattern using a transit and chain. Elevations are determined at the location of the stakes and at other locations in between where there are abrupt changes in elevation. Topographic maps prepared from this kind of survey are generally limited to relatively small developments.

Aerial Surveys.

Aerial Surveys are usually used where developments of considerable size are contemplated. Topographic maps prepared by this kind of survey can be produced quickly, and accurately, with the modern equipment currently available. Aerial surveys are more economical than Ground Instrument Surveys especially in step terrain.

b. Soil and Foundation Conditions: Preliminary evaluation of the soils and foundations at the proposed site should be made at the earliest time by a competent soils or geological engineer. Early survey and analysis often can determine potentially difficult conditions such as soils of low bearing capacity, and swelling or shrinking soils which can affect floor slabs and pavements. The presence of shallow depth to bedrock can increase the cost of excavation, pinnacled bedrock can interfere with grading operations, and sinkholes in terrain underlain by limestone may require expensive stabilization. High groundwater levels requiring special subdrainage systems around foundation and basement walls. Many

of these problems can be determined by the preliminary study of soils and foundation evaluation. "A preliminary study of soil characteristics will determine suitability for industrial development. Most important will be identification of site areas where soil characteristics render the land economically unsuitable for building or other surface or sub-surface improvements. The presence of significant amounts of land with these impediments must be ascertained as early in the site analysis as possible because this condition will affect the developer's feasibility analysis."

c. Availability of Utilities: The early survey to determine availability and capacity, should be made of all utility services which are normally required by industrial users. These include sanitary sewers and treatment facilities, water supply, treatment and distribution facilities, and natural gas, electric, and telephone service. An industrial park in a suburban area frequently requires extension of utility services. In rural or suburban areas, sewer and water services may have to be provided by the developer.

Water Service: An important consideration is the extent of expansion of the existing water distribution system which may be required to provide adequate flows to the industrial park to meet fire protection requirements. Preliminary determination of flow and pressure of the public main can be obtained from the utility for planning purposes. While the extension of an existing public main may be adequate for initial phases of development, industrial parks of several hundred acres in outlying areas will often require additional sources of distribution from other parts of the existing system as the area grows.

Sanitary Sewer service: Usually, sewer service is provided by a public agency. The planner or developer should meet with the authorities to determine; (1) the capacity of the existing sewer system to accept estimated flows from the proposed developments; (2) the capacity of the sewage treatment plant to accept the estimated flows; (3) whether discharge by the gravity is possible or pumping is required; (4) the policy of the sewer authority on sewer extension to pick up the proposed development; (5) who pays for the sewer extension; (6) the charge for connecting the park sewer to the authority sewer; (7) the periodic service charge for use of the sewers and sewage treatment facility; (8) quality restrictions on sewage effluents.

Electricity, Telephone, Gas Service: Other local utility authorities should be contacted during this survey to determine the availability of services. Utility rate structures may include either partial or total cost of placing overhead electrical and telephone service, and of placing gas mains underground. Due to environmental and aesthetic consideration, it is becoming more common to bury electrical and telephone lines.

d. Transportation: Field surveys will reveal whether or not the access streets or highways are sufficiently wide and of a paving grade strong enough to handle heavy truck traffic. It is especially important to check width and load capacity of any bridges that would have to be crossed in reaching the site. Also to be evaluated is the ability of these routes to handle the increased traffic volume an industrial park would generate. If the site can be reached only by considerable travel from a major thoroughfare over a local road, it is essential that local

road be able to accommodate the anticipated traffic demands.

e. Landscaping and Preservation of Existing Vegetation. Preliminary evaluation of the site should be made to determine whether desirable tree stands, ponds, or rock outcrops, or other existing features worthy of preservation, can be included in the master plan of industrial park. Landscaping should always be used to give industrial developments a coordinated throughout the development by the introduction of parkways, or median planting along the streets. Frequently, street intersections may be landscaped as part of the theme. The covenants of an industrial park may be a convenient place to specify landscaping requirements so that suitable plantings may occur on each lot.

B. CRITERIA FOR SITE SELECTION.

There are numerous industrial park location checklists available in various sources. A checklist from "Site Selection Handbook / 1979" is included to provide;¹³

(1) a comprehensive listing of factors that must be considered in selecting any industrial site and

(2) a simple but effective evaluation plan to highlight the factors that are most important in a given situation.

Of course, no checklist will solve an industrial location problem by itself. Such charts can only aid the planner in his research. See the checklist on the criteria for site selection on Appendix A-J.

¹³Site Selection Handbook'79, pp. 18-28

C. DEVELOPMENT CRITERIA.

As soon as a specific parcel of land has been selected, a firm plan of development of the entire project must be prepared. In development, therefore the planner or developer considers the conditions under which the sites are to be made available, and then proceeds to create the environment to fulfil those plan conditions.

1. Size and Shape of Lots: The size and shape of lots are limited by the terrain, the availability of utilities, and the location of transportation facilities. One major determination to be made by planner or developer is the layout of the lots. This should be based on the requirements of industrial firms likely to be attracted to the park. Maximum flexibility in design will allow for custom plotting for individual customers and provide room for expansion.

2. Facilities to be Installed: The utilities, streets, and other improvements to be installed depend on the requirements of potential users, and on the present availability of facilities in the area. Moreover, the plan must include specific determinations of "how much" as well as "what". The facilities must meet the standards of potential users. These standards will vary from one geographic area to another. Finally, in determining what facilities are to be offered, the planner or developer must decide what level of service is to be provided.

3. Staging: Staging is a major factor in the success of land development because it helps to conserve cash and reduces the developer's risk. Staging is done by:

a. Having preliminary engineering and design plans as subdivision plans, and therefore make it unnecessary to put all plot plans in advance.

Good planning layout and engineering design provide the basis for estimating the location and size requirements of utilities and roads.

b. Providing timetable for the plan so that spending money can be avoided before it is necessary.

c. Conserving major frontage for the later sale will provide.

1. greater benefits when it becomes more valuable as the park progress successfully,

2. flexibility in planning, platting and subsequent development.

D. RESTRICTIONS AND CONTROLS.

The planner or developer of an industrial park must provide the means of protecting the environment he has created. This protection is provided through deed restrictions, covenants in leases, and park standards relating to land use. These are in addition to any zoning regulations or other land use controls in effect in the community.

1. Type of Controls. The kinds of controls and protective covenants recommended are not merely prohibitions and limitations of land and building use. Workable industrial park controls emphasize function and performance standards. They are specifically geared to the needs and requirements of the kind of industry that the planner or developer is seeking to attract to the park. "District development standards have evolved to accommodate the expanded space needs of the modern industry, and contemporary protective covenants take cognizance of the increasing

attention being given to aesthetics and community compatibility".

Performance standards establish the type of limitations on use and occupancy that are employed. Whatever the form of controls, they must be binding on all occupants of the park in perpetuity, or at least for the same long-term period. The flexibility in planning and design of the industrial park is an important virtue for development purposes, flexibility in the application of restrictive covenants is not. Minimum standards and their universal application to all occupants are essential to the preservation of property values in the industrial park.

2. Provisions of Restrictions. The specific contents of district-wide standards, and the specific covenants included in individual leases or deeds will vary with the circumstances of the individual park and the objectives of its planner or developer. And they will vary by geographic region. The important provisions are list below:

a. Control of Nuisance: Since the element of flexibility is a development essential, the greatest latitude must be given to the controlling of nuisances. The approach to restrictions should be permissive rather than restrictive. This approach follows contemporary trends of creating specific performance standards based on measurable external nuisances. Such standards would be in a range in which all industries could operate without adversely affecting adjacent operations or neighboring land uses.

¹⁴Robert E. Boley, Industrial Districts Restudied- An Analysis of Characteristic (Urban Land Institute-Technical Bulletin No. 41, 1969) p. 6

¹⁵Robert E. Boley, Industrial Districts: Principle in Practice (Urban Land Institute Technical Bulletin No. 44, 1970) pp. 20-23

b. Site Coverage: In order to prevent over-building on individual sites, to insure adequate parking and service areas, and to maintain an attractive open "park-like" appearance certain provisions specifying maximum percent of land coverage by building area are necessary. Usually this percent ranges from 25-50%. The decision to utilize either site coverage and/or other restrictions will depend on a number of factors, namely, the types of firms the park is designed to accommodate, the function of individual buildings and their resultant site needs and again, the adequacy of other related development restrictions.

c. Building Lines: As a general guideline, minimum setback lines for buildings fronting on district streets range from 25-60 feet; setback from side and rear property lines range from 10-30 feet. Where buildings front on major highways, setbacks vary from 50-200 feet or more to avoid interference with highway traffic.

d. Landscaping: A basic landscaping scheme will insure the creation of an attractive appearance within a planned industrial park. It is general practice to require undeveloped portions of industrial sites to be tastefully landscaped. A suitable list of plantings and other landscaping materials should be devised to insure consistency in site landscaping.

e. Outdoor Storage: In conjunction with landscaping, most industrial parks require that outdoor storage of materials and equipment be enclosed by proper screening and/or landscaping. Where unenclosed storage is necessary to the plant's operation, limitations should be imposed on location, appearance and amount of property devoted to such use.

f. Sign Control: In order to preserve the "park-like" appearance of a planned industrial park it is essential that obstrusive signs be controlled. Limitation should standardize the location, size and construction of signs identifying buildings within a park. A sign lettering and material vocabulary should be devised to insure consistency in sign appearance.

g. Off-Street Parking and Loading: It is contemporary practice to require that all parking and truck service areas be located to the rear or side of buildings. Such areas should be hard-surface. Parking on park streets should be prohibited and strictly enforced as it interferes with truck circulation and other vehicle movements. Truck loading areas should be provided with a depth of 120 feet far off street maneuvering and truck positioning at loading docks. Width of docking spaces should be 14 feet.

Chapter 3

INDUSTRIAL PARK LAYOUT CONSIDERATIONS AND DESIGN

The layout plan for industrial park is developed in terms of the objectives of the planner and developer, the physical and other constructions involved, and the use controls and restriction decided upon by planner and developer. Having identified the market they are attempting to attract, the planner and developer should proceed to subdivided the land under considerations to meet the anticipated requirements of those users. Advance consideration should be given to designing the layout of the industrial park as a whole and it should also be designed in context with adjacent land uses and with the structure of the city, so that the best use of the site will be achieved and the requirements of the park met as fully as possible. The layout plan of the industrial park is essentially the physical portion of the park development plan. It indicates the location of the major facilities that are to be provided by the planner and developer, and sets the general shape pattern of the blocks of the sites. The layout of the industrial park should provide for as much adjustment and adaptation to the topography of the land as possible to take full advantage of gravity drainage and flows. Within this general framework, the industrial park layout plan will normally include:

- A. Street layout and Design
- B. Railways
- C. Airport
- D. Grading and Drainage

- E. Utilities layout and design
- F. Design Considerations
- G. Landscaping and Erosion Control

A. STREET LAYOUT AND DESIGN.

Industrial street have design requirements that are different than residential and commercial streets. All too frequently, however, local requirements treat all streets as being the same to the detriment of good engineering and planning design.¹⁶

The location of streets within the industrial development is frequently secondary to other layout features and concepts for the site. Factors influencing the location of streets include the location of existing facilities, future expansion, grading and alignment relating to topography, rail service, soils, drainage, geological conditions, ground cover, maintenance conditions, desired lot depths, and local jurisdictional controls. Street should be located on stable, well-drained soil of high bearing capacity. Surface and subsurface water may affect alignment, earthwork, and drainage features, as well as maintenance. Geological conditions may affect the excavation and stability of slopes. Excavation of rock formation is costly and should be avoided. Clearing and grubbing requirements, and the preservation of trees, are also considered in selecting the location of streets. The main considerations in the street layout and design are:¹⁷

¹⁶ULI-Urban Land Institute, ASCE-The American Society of Civil Engineers, NAHB-The National Association of Homebuilders, Residential Streets, 1974, p. 47

¹⁷U.N. Industrial Estates in Europe and Middle East. New York, 1968, pp. 215-216

-Streets should be adequate for estimate traffic flow and provide against congestion between the main highway and any point on the park where goods or personnel will be loaded or unloaded.

-Streets should give economy in development and not occupy an undue proportion of the park area.

-Streets should not contain traffic hazards such as acute-angled junctions, multiple junctions, concealed junctions, mixtures of pedestrian, bicycle and vehicular traffic, or steep hills. Traffic should ideally be one-way. Vehicles should be able to be parked safely without relying on the brakes.

-Streets design should provide for the installation and easy maintenance of utilities including water, power and sewage mains on verges.

-Streets should not be congested by vehicle loading or unloading, or by car-parking. These should be completely separated from the street or in clearly-defined docks with limited access to the traffic carrying street.

-During the first phase of development some streets may be paved only on part of their ultimate widths; but it is necessary to allow sufficient right-of-way from the beginning, with utilities so sited that they will not be covered by road-widening.

These considerations indicate a rectangular road pattern in so far as the shape of the site allows. Cul-de-sacs restrict movement and are undesirable where inter-communication between factories and access to central services are important, but may be necessary to open up isolate sites. They also have advantages in eliminating through traffic and in reducing street and utility costs.

Rights-Of-Way and Pavement width: The widths of rights-of way for major streets in industrial parks usually range from 60 to 120 feet with pavements of 40 to 80 feet. Secondary street rights-of way are usually range from 50 to 80 feet with pavements of 30 to 60 feet in width depending to a considerable on the size of the industrial park and the anticipated traffic flow.¹⁸ In the small to medium size of industrial parks 33 to 40 feet pavements on 60 feet rights-of-way are the most popular. Pavement widths must be related to the widths and capacities of the streets and highways to which they are connected. At least 10 feet of right-of way on either side of the surfaced street is reserved for side-walks and utility strips.

Paving Materials: Reinforced concrete pavement built to withstand heavy truck traffic is prevalent in many industrial parks. Recently, an increasing number of industrial parks are using asphaltic concrete pavement with satisfactory results and considerable savings in construction costs.

Curves and Sidewalks: Streets in the industrial parks are usually provided with curbs and gutters. This is particularly true of industrial parks within the limits of larger cities. Although many of the older developments (those in central city area where public transportation was a major means of commuting) included sidewalks in their industrial park plans, many industrial parks developers now believe such provision is often unnecessary in contemporary suburban industrial parks. Where sidewalks are constructed, the usual practice is to locate them

¹⁸Robert E. Boley, Industrial Districts: Principle in Practice, ULI-Technical Bulletin No. 44, 1970, p. 14

adjacent to the roadway. The widths of the sidewalks vary from 3 to 10 feet, with 4 to 6 feet most common.

Street Grades and Intersections: Street grades in the industrial park should be below five per cent. To the extent that it is possible, access streets are generally laid out parallel to finished contours, thereby eliminating unnecessary grades, and permitting parked trucks to stand on level ground. Sites are usually graded to drain the water to the street, and where storm sewers are not installed on secondary streets, the curbs are built up to channel the flow of storm water to major streets where city storm sewers intercept it.¹⁹

in designing district street layouts, acute angles at intersections should be avoided to assure safer and more efficient traffic movement and to avoid the creation of oddly shaped lots which may prove difficult to market. Intersection corners should be rounded sufficiently to permit tractor-trailer rigs to negotiate turns without utilizing extra traffic lanes.

Other design considerations should include:²⁰

-Safety, ranks with economy in importance in street design. For example, the removal of roadside hazards and the utilization of recovery zones along major streets are being implemented more frequently.

-Proper Drainage, is essential for operational performance and for protection of the roadway.

-Earthwork Grading, design is essential for establishing economical

¹⁹Robert E. Boley, Industrial Districts; Principle in Practice, ULI-Technical Bulletin No. 44, 1970, p.16

²⁰ULI-The Urban Land Institute, Industrial Development Handbook, Washington, D.C., 1975, p. 116

gradelines consistent with good design practice.

Maximum earth slopes for roadways in cut or fill sections range from $\frac{1}{1\frac{1}{2}}$: 1 to 4 : 1 depending upon the height of fill or generally speaking, slopes steeper than 3 : 1 should avoided since they can not be maintained easily with moving equipment.

-Aesthetic Factors, cannot be overlooked in good design practice. The alignment should complement existing physical features and blend into the terrain. Visual or physical obstruction near the roadway should be minimal. Beautification is an important design consideration, particularly within the development. Landscape design should be incorporated into the street plans.

B. RAILWAYS

Where an industrial park is served by a railway, the railway authority will normally be responsible for designing and constructing the stations, sidings, and connexions to the factories. It is usual to run rail along the rear of factory lots, and it is desirable to sink spure tracks so that waggon floors will be level with factory floors. Level crossing should be eliminate or kept to an absolute minimum so as to reduce accidents.²¹

Rail-access facilities as well as highway-access facilities or water-access facilities should be planned with respect to the long-run rather than to meet short-run needs. Railways frequently use cars ranging up to 80 feet in length. When a plant anticipates the use of

²¹U.N. Industrial Estates in Europe and Middle East. New York, 1968, p. 218

large cars, the plant layout must make provisions for such lengths. The layout must also specify width clearances as well as height clearances surrounding the rail facilities.

C. AIRPORT.

Airports are becoming increasingly attractive as the industrial location. There is some evidence that more industrial parks are being located near airports. Modern smokeless industrial plants, with low-profile, one story construction, no longer constitute a hazard to aviation. Industries considering location on an airport park may not be experienced in air transportation and it will be highly desirable to have available expert advice to help in assessing the transport economics related to their product. This can be supplied by airline cargo representatives; by qualified commercial shipping agencies; or by the employment of a specialist. The applicability of air transport will extend to a growing number of products and many items now shipped by surface will certainly move by air in the future.

D. GRADING AND DRAINAGE.

Grading: Industrial developments are usually sited in flat terrain to minimize grading costs. Consequently, the general philosophy for grading will be established by the requirements for drainage. The amount of grading will be dictated by two factors, and these must be balanced to arrive at the most economical development;²²

1. The number of lots obtained.
2. The amount of earth to be moved.

²² National Association of Home Builders, Land Development Manual, Washington, D.C., 1974, pp. 129-141

In making a grading analysis of a particular piece of land for industrial park development, a topographical map of the existing contours is necessary. Using this map, a number of trails runs should be made to determine the final contours that will provide the most economical balance between cuts and fills.

In order to minimize the volume of earth to be moved, preliminary flowline and channel sections should be determined for stormwater runoff. Hydraulic gradients for the design storm along these channels should be determined. With design stormwater surface elevations determined, the adequacy of the elevation of the existing topography across the site can be determined. The areas with unsuitable low elevations can be brought up to minimum practicable elevation by filling with earth excavated at least in part from proposed stormwater channels or stormwater retention basins. Where practicable, grades should be established for roads which allow lot frontage to slope toward the street. The street gutter will then become a collector for stormwater runoff directing flows to the roadway inlet system. Grades for the remainder of the site should direct runoff to side and rear lot lines in open channel drainage systems. Such practice generally the most economical site plan.²³

In evaluating the suitability of the proposed grading plan, it should be recognized that the lowest area of the site will be the truck loading area or depressed rail track serving an industrial building or warehouse.

Grading cost estimate should be developed including costs

²³ ULI-Urban Land Institute, Industrial Development Handbook, Washington, D.C., 1975, pp. 117-118

for clearing roots, and for building foundation excavations, as well as for stripping vegetation and topsoil. The planner should refer to soils reports during preparation of the land plan and grading plans so areas of deep organic or otherwise unsuitable or difficult soils, such as highly plastic clays, may be anticipated and properly evaluated in terms of removal or treatment to achieve adequate density in fills. In cases where areas may be too costly to improve due to poor soil and drainage conditions, the land may be planned for open space or stormwater retention.

Drainage: One of the principal costs of industrial development is construction of storm drainage facilities. For this reason, a detailed analysis of storm drainage alternatives should be made during the planning process. Detention Ponds method has gained popularity over the years. The demand for more economical methods of handling stormwater runoff, and the trend in planning to provide a more attractive work environment through use of lakes and ponds, has led to increased use of water bodies in modern industrial park.

In an areas where drainage problems exist, the planner can minimize the area of land devoted to lake or channel ponding by establishing a set of selective ponding priorities. A specific area may be established as a permanent lake with perimeter areas set at selectively higher levels. The normal lake surface would be the lowest elevation, followed by landscaped areas, followed by parking areas and private drives, and in turn by public streets.

E. UTILITIES, LAYOUT, AND DESIGN.

Four basic factors should be considered in layout and design

of the utilities.²⁴

1. Adequacy
2. Efficiency
3. Flexibility
4. Economy

It must be borne in mind that utilities and facilities within an industrial park must be larger than those in other types of developments. Consequently, the cost of such extensives is comparatively high and planners strive to keep utility lines to a minimum length and place them so that service is available to buildings on both sides of extended lines.

Water Supply.

Industrial development require water for domestic uses, manufacturing processes, and fire protection. This supply may be provided either by public or private utility. Water requirements for individual industries range from a few hundred to many thousand gallons per acre per day. As a rule, the heavy water consuming industries also require very large plant sites and do not ordinarily locate in industrial parks. So that the waterlines must designed to provide adequate volumes of water at suitable pressures for the types of industry the park is to accommodate. The water system must be designed to meet all the water demands imposed on the system. Peak demand factors which create the variations from average daily and seasonal water usage requirements of the development will vary with the water requirements of industrial occupants. An

²⁴ Robert E. Boley, Industrial Districts: Principle in Practice, ULI-Technical Bulletin No. 44, 1970, p. 18

important water capacity determinant is the fire protection requirement. In laying out the system, the water mains should be looped to provide continuous service to users. When water and sewer lines are located in the planting strip of the street rights-of way, the standard practice has been to place water and gas lines on one side of the street with sanitary and storm sewers on the opposite side.²⁵

Sanitary Sewers.

Industry is divided into two categories- wet and dry. Wet industry uses water for processing; dry industry uses it only for sanitary purposes.²⁶ The number and type of industries a park is designed to house and the capacity of existing disposal facilities are the major factors in determining the size of sanitary sewers to be installed. Sanitary sewers should be designed for gravity flow wherever possible.

If the industrial park cannot be served by an existing public service which is capable of handling the anticipated industrial waste, design must be made for adequate disposal facilities. It is necessary to reserve a location for a sewage treatment plant adjacent to the park if the waste products generated by the industrial occupants are likely to create a nuisance.

Electric Power.

Electric power is the utility which aids economic development most directly and it is therefore given a high priority. In most developing countries, it will be necessary to provide for the future expansion of the power production facilities. This expansion must meet the

²⁵Robert E. Boley, Industrial Districts: Principle in Practice, ULI-Technical Bulletin No. 44, 1970, p. 18

²⁶Ibid.

increased consumption needs of a growing number of industrial parks. Overhead wires for distribution are normally cheaper but underground conduits are preferred from the safety point of view. It has been suggested that the separate lines be permitted by the side of factory units for the transmission lines and transformers. In power-short areas, the same power unit producing industrial steam could presumably electric current.

Steam.

Steam may need to be given to the supply of steam for industrial processes and factory heating from a central boiler house. This may be an economic proposition for a densely-built development, where pipe runs and consequent losses will be small, and where it is possible to estimate closely in advance what total requirements will be. It will be necessary to install or provide boiler capacities for the maximum possible load, which may never be reached. Unless steam is produced in conjunction with the generation of electric power, it is unlikely that a central station will be able to compete with individual oil-fired boilers in factories.

Street Lighting.

The need for street lighting will depend upon the number of shifts operating. In the case of small-scale industries which rarely operate more than one shift, there is little need for street lighting except for security. Lighting can be confined to a minimum consistent with security requirements, but care should be taken to provide adequate peripheral lighting.

F. DESIGN CONSIDERATIONS.

a. Industrial Buildings.

Over the years considerable knowledge has been accumulated about planning good industrial buildings. It has been rather recently, though, that planners have come to the realization that the primary function of a building is to provide protection for the plant facilities, it can contribute greatly to the effectiveness of the plant layout it contains. Should the building be built first and the layout planned to fit it? Or should the layout be planned first and the building built around it? Which comes first, the chicken or the egg? This ancient puzzle can be used to illustrate the relationship between the layout and the industrial building.

Seymour Howard mentioned some of the criteria that should be considered when planning the industrial building are:²⁷

1. Environment, the building's relationship to the community and to the natural setting around it. The social isolation of the industrial park is fortunately being broken down by including restaurants, snack bars and motels, which link them peripherally to neighboring towns and airports.

2. Access, how the site is linked to the public lines of circulation around it is an essential functional question, and an esthetic one as well.

3. Entrance, Le Corbusier argued that "an entrance should be like a lighted candle in a dark room". This is essential for newcomers, who should not have to read signs to find the right door. The entrance for employees, of course, can be inconspicuous; they know the building

²⁷Howard Seymour, Small Industrial Buildings: Architectural Record, Feb., 1969, pp. 155-166

and where to go. Truck entrances can generally be recognized by the obvious loading platforms and large doors. The central requirement is that the main road lead directly to them.

4. Plan and Massing, plan result from one of two basic approaches: the subdivision of one space; the accretion of separate forms. For a small company the principal design task will usually be the subdivision of a single space. Esthetically, the problem is usually how to preserve an awareness of the total volume even though subdivided. For large factories, it is more efficient to separate the major function into buildings of different forms, corresponding to the separate needs. The approach is essentially an open-ended one, more easily adapted to change and growth. As exterior composition and mass, the single building solution can gain significant interest from a strong geometric form, from allowing the interior subdivisions to show through on the facade, or from organizing into a formal pattern the mechanical equipment usually scattered haphazardly over the roof space. The different requirements for spans and ceiling heights in offices and in manufacturing or storage spaces can be expressed by establishing a dominant mass, with smaller elements, arranged in a clear geometrical relationship.

5. Interior Space, a place to work should be practical and matter-of-fact. Large spans and exposed structure usually give interest in themselves to interior spaces, especially in manufacturing areas. Care should be taken in the design of trusses to avoid the visual confusion of web members set at varying angles. Equipment or materials stored against the exterior walls usually limit window location. The often-seen solution of a continuous bank of windows just below the roof is very

logical, one of the "good cliches" of modern architecture.

As for day lighting in work areas, in certain countries, there is a school of thought according to which artificial lighting should be preferred to natural daylight. In tropical countries, where there is abundance of sunlight, it should be desirable to take advantage of it and to reduce the recurring cost of artificial lighting.

In industrial structures, day lighting is generally obtained through roof glazing, but in small work areas, lighting from windows would be adequate for most operation. In particular, when building in tropical countries are aligned in the east-west direction with windows on the north and south walls.

Ventilation is a problem allied to lighting. In most countries in the South-east Asia, the air-conditioning of interior cannot be thought of because of the poor economical situation. In hot and humid regions, the windows and permanent openings should be kept as low as possible to ensure through ventilation at the working level. In arid regions, large window areas would lead to discomfort because of dry hot winds in summer and cold winds in winter. This is the case that would be considered in the arid regions in Thailand, especially in the north-east where there is an establishment of the industrial park and hydroelectric scheme under the Development Project. This solution can be done by reducing window areas or having windows just below the roof so that the hot or cold winds could get through above the working areas.

6. Expansion, provision of expansion should be made at the initial stage of site planning, even if the form of the future buildings need not be completely determined. The site plan should be like a good

city plan, with areas and volumes approximated but with freedom for future design.

b. Visual Design.

The planned industrial park should form a recognizable unity visually as well as functionally; it should more than a collection of factory buildings concentrated in a formless way on an advantageous site. The principles employed in designing the overall layout can contribute a great deal towards realizing this objective and, in particular, the planned distribution of non-industrial uses which should play an important part in drawing together the various units into a whole. Standard factories or other industrial buildings should also be arranged as planned units within the overall design. Gordon Logie thinks that successful industrial parks from the visual point of view are those which have not held strictly to a rigid layout or to standardization of frontage elevations, but have concentrated on a compact, informal layout; on the use of suitable colors, facing materials, lettering and signs; and have prohibited advertisement.²⁸

The good visual design is very difficult to achieve because of the varied nature of industrial development. Compactness, coherence and simplicity in general form should be basic objectives in the visual design of industrial parks, particularly where number of small buildings are involved. The use of central avenue as a main feature and the careful placing of open spaces and non-industrial buildings within the industrial parks can play an important part in drawing the development together.

²⁸Gordon Logie, Industry in Towns, London, Allen and Unwin, Ltd., 1952

c. Gas Station Location.

Gas station and auto repair shops are useful additions to the principal industrial occupants. Proper site selection is critical. Prominent and accessible sites at the entrance to the industrial park should be avoided, because these are likely to be the locations selected by oil companies, if given a choice. It is easily accessible to all industrial occupants of the park, in a prominent location, but not at the entrance.

d. Perimeter Sites.

Usually the perimeter sites with high visibility command higher sales prices than interior locations. Many new industrial parks continue to be planned and developed with buildings oriented toward internal streets with the rear of the structure facing the main highways.

The development plan for the industrial park, it should be remembered that lots which are adjacent to major highways are fronting on these streets and highways regardless of building orientation or site access points.

e. Off-Street Parking.

The provision of parking space for cars is less critical in developing countries. Employees are most likely to travel by bus or bicycle or to walk. For wider use of bicycles and motor cycles may be anticipated, however, and adequate provision for this type of transportation should be incorporated in plans now being drawn up. These countries should also consider reserving land for automobile parking even though this may not yet be essential. With rising incomes, increased automobile use is a strong likelihood and the parking problem will become more urgent.

Off-street parking in the industrial park is important for the developing countries in the future because;²⁹

- It promote efficient intermingling of auto and truck traffic;
- It avoids the use of either paved lanes or unpaved right-of-way which is an expensive use of land, not intended for parking;
- It adds to the appearance of the park, and makes the development aesthetically pleasing,

Design of off-street-parking should be given the same attention as other aspects of site development controls. Where parking will be permitted in front yards, appropriate screening requirements should be established which might include landscaping, low walls, earth berms, or depressed surface elevation. Equal concern should be given to relationships between adjoining parcels. Where large parking lots are anticipated, landscaping requirements within the parking areas should be considered to relieve the appearance of a sea of asphalt.

f. Off-Street Loading.

Sufficient land must also be reserved for off-street loading and unloading. In well designed industrial park each plant has its own loading dock with a well-paved road leading into each property. The most restricted industrial parks require the placing of loading docks so that all loading and unloading takes place at the sides and rear of buildings, thus minimizing traffic congestion at the street front. Loading areas are sometimes permitted in the front of buildings if properly screened by landscaping or other appropriate arrangements. Loading areas are

²⁹ ULI-Urban Land Institute, Industrial Development Handbook, Washington, D.C., 1975, p. 140

generally required to be hard-surfaced so as to be mud and dust free.

g. Relationship to Adjacent Residential Development.

Planning the industrial park it is a compatible neighbor to adjacent commercial and residential areas is a matter of critical importance. This can be accomplished in a number of different ways. Perhaps most common is to utilize an arterial street or highway as a buffer zone. The effectiveness of this approach can be enhanced by creating a landscaped median in the right-of-way to enlarge the separation between homes, businesses and industrial activity.

h. Engineering Consideration in Lowlands Development.

Industrial development in lowlands, protected from flooding by levees or floodwalls, is an area of special concern. Such areas have special problems with where improvements are to be constructed and with the land prepared for building construction. These areas characteristically consist of flat-lying alluvial soils of variable texture ranging from coarse sands and gravels to silts and clays. In areas which are former river or creek channels or sloughs, clays of high plasticity may cover many acres, and may create special limitations due to potential settlement or shear failure under structural loading. In addition, problems due to groundwater and stormwater runoff from tributary hillside watersheds, are possible.

Special design features applicable to lowlands development include:³⁰

-Use of water tight joints for sewer construction,

³⁰ ULI Urban Land Institute, Industrial Development Handbook, Washington, D.C., 1975, pp. 135-137

- Use of subdrainage beneath street pavements to drainoff accumulating water and thus improve pavement performance,

- Use of open channels and roadside swales to minimize drainage costs,

- Subdrainage systems around rooms below grade including use of sump pumps to relieve hydrostatic pressures,

- Slope protection along drainage channels with berms as applicable to assure stability during bleedout of groundwater through slopes,

- Use of stormwater retention basins or lakes to accommodate stormwater runoff from hillside areas,

- Use of smooth sewer pipe to reduce friction and thus minimize the number of sewage lift stations required in the development, and

- Anchored provisions for underground storage tanks to prevent flotation.

i. Mass Transit.

Most of the developing countries' mass transit is supplied by motor bus transit. Where the industrial park was beyond walking or cycling distance from housing, this mode of transportation would be needed for the worker. The industrial park management should determine in advance the available services and the possible need for expansion. Usually such services are provided by private enterprise, but the management should take the initiative in negotiating with the bus company and the municipality to ensure adequate service. Such pre-arrangement with the transit company might also make possible a bus route that will circle the industrial park, with a series of demand stops for use during all

but rush hours. For the rush hours there might be a central bus station or shed not more than five minute walk from the factory. Bus congestion can be relieved if tenants co-operate to stagger the hour of arrival and departure. Where possible, and the industrial park is large enough. The management might consider having an internal transport service which can be housed on the industrial park and which will co-ordinate the transportation needs of the industrial park employees.

G. LANDSCAPING AND EROSION CONTROLS.

The industrial park should include a basic landscaping scheme for the entire development. This will help assure prospective district occupants the attractive setting they demanded for their modern, well-designed plants. In addition to aesthetics, landscaping serves various practical functions such as preventing erosion and reducing runoff, screening storage yards and parking lots from view, controlling wind and affording shade from direct sunlight. Landscaping of the strips between the street pavement and the property lines of sites is customary. The planner provides the basic plantings as an encouragement for the landscaping required as part of individual site treatment. Where the planner also supervises or constructs the building, landscaping is included in the site planning. Where purchasers build their own plants, it is customary for the planner to insert specific standards on landscaping in restrictive covenants and to review site and building plans to see that they meet the requirements.

The problem of control of siltation and erosion is strongly affected by drainage characteristics. The control of drainage will almost control siltation and erosion; at least it certainly will have a profound effect upon both. Basic techniques for erosion controls are:

- Diversion Methods
- Temporary Ground Cover
- Protection of Critical Areas
- Control of the Major Drainage
- Debris Basins
- Permanent Vegetation

Diversion Methods

Erosion, by diversion methods, can be controlled by temporarily diverting heavy accumulations of storm water from the construction site. This can be done by several means such as having temporary ditches, dam, channels, and storm drain (by collecting the water and convey it to a safe discharge point).

Temporary Ground Cover

Temporary ground cover is one of the most effective means of controlling erosion for the period of grading operations before the establishment of permanent vegetative cover. What can be used for temporary ground cover are, for example, mulch, sprayed liquid asphalt, fast-germinating annuals such as rye and rye grasses, and the mixture of seeds, fertilizer and a mulch spraying on the site to be seeded. Any grass, plant, flower or tree which can be started from a seed can be used in any combination.

Protection of Critical Areas

The critical areas that cause erosion are on high cuts or fills. Drainage benches are required to correct this condition because they intercept the water flowing (from rainfall) down the slope and conduct

it to some drainage facility. They must be well designed to have sufficient slope for high velocity of water flowing to keep the flow line clean of debris and sedimentation.

Control of the Major Drainage

The control of the major drainage ways is the most effective means of controlling erosion and siltation. There are many factors to be considered during the construction of the permanent drainage facilities such as the control at the outlet end because of the high velocities. The solution could be done by conveying water an additional distance downstream or constructing a large distilling or plunge basin to slow the water.

Debris Basins

The most effective means of trapping the silt and preventing rapid runoff is the construction of a small temporary earth-fill type dam downstream from the development. The debris basins could be built out of logs, old trees, or broken concrete. A permanent debris basin is desirable for a large project.

Permanent Vegetation

The developer has a wide choice of grasses and other plant material for both seeding and sodding. The choices depend on the esthetic requirement, degree of maintenance desired, and initial installation costs. The operation of this method is simple and relatively inexpensive.

CONCLUSIONS.

In this report, an attempt is made to give what is considered to be the basic information necessary in guiding the physical planning of the industrial park. As is the case in any discussion of this sort, many topics have been touched briefly, but none in detail. Though this report is meant as a guide for the planners in Thailand, some principles or rationales mentioned are universal which can be applied to most countries. It is the task of the planners to select the principles. It is the task of the planners to select the principles or rationales that will be useful and appropriate to the environment of the country.

BIBLIOGRAPHY

- Boley, Robert E. Industrial Districts Restudied- An Analysis of Characteristics. Urban Land Institute- Technical Bulletin No. 41, 1969
- Boley, Robert E. Industrial Districts- Principle in Practice, Urban Land Institute- Technical Bulletin No. 44, 1970
- Brown, J.A. "Industrial Estate Development in India," Pacific Viewpoint, 1969
- Cox, G.W. Planned Industrial Parks and Districts, "Urban Land" 1960
- Cox, George W. "The Role of the Railroad in Industrial District Development," Urban Land, 1959
- Cross, Frank L. and Simons, John L. Industrial Plant Siting. Technomic Publishing Co., Inc., 1975
- Dickenson, J.P. "Industrial Estates in Brazil," Geography, 55, 1970
- Freed, Shervin. "Plant Site; how to Study Local Labor Availability," Factory, Feb. 1972
- Hem, John D. Study and Interpretation of the Chemical Characteristics of Natural Water. Geological Survey Water-Supply Paper 1473, Washington, 1970
- Howard, Dick. Guide to Industrial Development. Prentice-Hall, Inc., Englewood Cliffs, N.J., 1972
- Howard, Seymour. "Small Industrial Buildings." Architectural Record, Feb., 1969
- Kinnaird, W.N. Industrial Real Estate, Society of Industrial Realtors, Washington, D.C., 1971
- Logie, Gordon. Industrial in Towns. London, Allen and Unwin, Ltd., 1952
- Moore, James M. Plant Layout and Design. The Macmillan Company, New York, 1962

- National Association of Home Builders. Land Development Manual, Washington, D.C., 1974
- Safford, Truman H. "Waste Disposal- A factor in Site Selection," Industrial Water and Wastes, Nov.-Dec., 1961
- Smith, L.F. "Inner City Industrial Districts," Urban Land, May, 1971
- Sofer, D. "Industrial Estates in Israel," Town and Country Planning, 1975
- United Nation (Department of Economic and Social Affairs). Establishment of Industrial estates in Underdeveloped Countries. New York, 1961
- United Nations. Industrial Estates in Asia and The Far East. New York, 1962
- United Nations. Industrial Location and Regional Development. New York, 1971
- United Nations. Report of the International Seminar on Industrial Location and Regional Development. New York, 1969
- United Nations Industrial Development Organization. Industrial Estates in Europe and The Middle East. United Nations, New York, 1968
- Yaseen, Leonard C. Plant Location. New York, American Research Council, 1959
- Zisman, S.B. "Note on Industrial Site Planning," Journal of American Institute of Planning, 1959
- ULI-Urban Land Institute, Industrial Development Handbook. Washington, D.C., 1975
- ULI, ASCE, NAHB. Residential Streets: Objectives, Principles & Design Considerations. 1974

APPENDIX A

MATERIAL, SUPPLIES, SERVICES

APPENDIX A

A. Each Raw Material

1. Location of suppliers
2. Quantity and quality produced
3. Amount produced available to new customers
4. Delivery time, interruptibility
5. Long-term production outlook
6. Alternate supplies
7. Competition for materials from other companies

B. Each Semi-finished Material

(same as above)

C. Storage Facilities

1. Public warehouses
2. Bulk storage terminals

D. Routine Supplies

1. Mill supplies
2. Building materials
3. Maintenance supplies
4. Office supplies and equipment
5. Distance to warehouse and distributors of above, if not local

E. Technical Services

1. Laboratories product research, testing chemical analysis,
instrumentation
2. Computer service bureaus

3. Consultant-management, engineering
4. Blue print service
5. Industrial photography and X-ray
6. Instrument, machinery repair

APPENDIX B

LABOR SUPPLY

APPENDIX B

A. Area labor Force Inventory

1. Total labor from within feasible commuting radius
2. Number and percent unemployed during last five years
3. Seasonal variations in employment
4. Categories of employment
 - a. Agricultural
 - b. Manufacturing (by type)
 - c. Government
 - d. Other non-agricultural (by type)
 - e. Non-available work force (institutional, military and student)
5. Analysis of potential employables by skills
(skilled, semi-skilled, unskilled, clerical, professional)
6. Skills notably abundant in area, or in short supplies
7. Analysis by age, sex, educational level
8. Management potential
 - a. Your requirement for next five years
 - b. Number of college graduates
 - c. Undergraduate and graduate program of colleges
 - d. Executive development programs in colleges for non-students
 - e. Executive development programs of various associations and organizations

B. Wages and Hours

1. Local wage rates, by occupation
2. Average work week
3. Domination of wage structure by single company or industry

4. Competition for labor force from other companies
5. Cost of living index

C. Benefits Usual in Area

1. Pensions
2. Life insurance
3. Medical insurance
4. Holidays
5. Vacations
6. Coffee breaks, rest periods

D. Vocational Training

1. Facilities and programs available
2. Plans for new programs, facilities

E. Sources for Evaluating the Availability of Labor

1. Government labor office
2. Other employers in the area
3. Development organizations
4. Advertising, sampling
5. Registration program
6. College and trade school placement services
7. Employment agencies

APPENDIX C

TRANSPORTATION

APPENDIX C

A. Rail Transportation

1. Lines serving city
2. Classification territory
3. Daily freight and passenger service
4. Shopping time to particular cities
5. Adequacy of car supply
6. Commodity rates
7. Carload rate-minimum size of carload
8. Less than carload rates
9. Piggy-back and other interchange services
10. Demurrage
11. Railroad offices in area
12. Financial strength of rail system serving area
13. Possibility of branch line abandonment

B. Rail Service at Site

1. Relation of siding to man system
2. Switching frequency
3. Switching limits
4. Probable cost of erecting siding, if none at site
5. Apportionment of cost between plant and railroad
6. Effect of siding on plant design
7. Complications sidings jointly used, public road crossing, etc.

C. Highway Transportation

1. Distance to nearest interchanges on interstate Highway system

existing or proposed routes

2. Access to other major highways and feeder roads
3. Condition, length and width of roads and streets
4. Weight, height and length limitations
5. Capacity vs. current usage and projected demand
6. Bond issues for new roads
7. Toll roads-amount of toll
8. Seasonal restrictions on road use

D. Trucking Service

1. Companies serving are-local, intrastate, interstate
2. Terminals and facilities
3. Overnight service radius
4. Schedules-trips per days
5. Rate structure
6. Specialized equipment (Liquid or dry bulk, heavy hauling, etc.)
7. Express and transfer service
8. Freight consolidating and forwarding service, export service
9. Location of commercial zone

E. Other Motor Transportation

1. Local rapid transit-facilities, schedules proposed extensions
2. Nearest service to plant site
3. Intra-city bus service-terminals schedules
4. Taxi service-rates, adequacy of service, radio equipment
5. Car rental

F. Commercial Air Service

1. Airlines, air taxis and commuter service serving
2. International service
3. Air cargo forwarders
4. Distance and travel time from fplant site to airport
5. Taxi, limousine, car rental

G. Other Air Service

1. Airfield used by executive aircraft
2. Hangar and office facilities
3. Taxiway access to plant sites
4. Air charter and rental
5. Airport facilities
 - a. Terminal
 - b. Runway-length, surfacing, lighting
 - c. Radio and radar
 - d. Instrument approaches
 - e. Availability of gas, jet fuel
 - f. Repair services
 - g. Taxi, car rental

H. Water Transportation

1. Channel width and depth
2. Depth alongside, if on water way
3. Distance to channel, if not adjacent
4. Distance to nearest overseas dock
5. Lines serving area-schedules, rates, commodities handled
6. Port facilities-warehousing, transit shed, storage areas,

stevedoring, container handling capability

7. Port authority, if any
8. Interchange facilities
9. Seasonal limitations
10. Icebreakers
11. Insurance rates

APPENDIX D

POWER AND FUEL SUPPLY

APPENDIX D

A. Power Source

1. Thermal-coal, natural gas, propane, fuel oil, lignite
2. Hydroelectric
3. Other-nuclear, geothermal, solar

B. Electric Power Supply

1. Company or public agency serving area
2. Interconnection with other system
3. Capacity-present and planned
4. Recent record of shortages or interruptions
 - a. Average number of interruptions per year
 - b. Maximum duration
5. Vulnerability to natural disasters
6. Location of nearest electric substations and whether interlocking
7. Voltage, phase and cycle available
8. Size of connection at proposed site
9. Two-way feed
10. Rates based on your demand for services
 - a. Lighting
 - b. Machine operation
 - c. Air conditioning
 - d. Welding
 - e. Furnaces
11. Cost of extending service

12. Typical residential rates
13. Off-peak possibilities
14. Fuel Adjustment provisions

C. Gas Service

1. Suppliers
2. Capacity, present and planned, as compared with peak requirements
3. Allocation for industrial use
4. Type (natural, mixed, manufactured Btu value)
5. Storage facilities
6. Recent record of shortages and interruptions
7. Size of connection at proposed site
8. Two-way feed
9. Industrial and residential rates, including interruptible rate

D. Coal, oil

1. Suppliers
2. Cost of coal delivered, per million Btu's
3. Cost of oil delivered, per million Btu's

E. Potential for On-Site Independent Energy Source

1. Gas well
2. Coal mine
3. Nuclear reactor
4. Other

F. Potential for Location in an Energy Park Complex (which include waste

recovery plant, generating station, etc.)

G. Other Special Energy Plans

1. Alternate fuel plan
2. Cogeneration
3. Back-up system

H. Motor Fuel

1. History of Shortages in area
2. Cost of fuel

APPENDIX E

WATER RESOURCES

APPENDIX E

A. Regional Water Situation

1. Trend of consumption as compared with developed supplies, planned developments
2. Watershed development proposals for export of water to or import from other watersheds

B. Local Water Supply

1. Agency and source of supply
2. Pumping and storage capacity
3. Average and maximum use as compared with present or proposed supply
4. Supply vs. projected demand
5. Pressure at site
6. State health dept. rating of supply
7. Method and extend of treatment, including foundation
8. Industrial and residential rates
9. Chemical analysis
 - a. Hardness
 - b. Alkalinity-acidity
 - c. Solids
 - d. Oxides, chlorides, nitrates, sulfates
10. Cost of extending service
11. Likelihood of restricted use

C. Surface Water-Streams and Lakes

1. Daily, seasonal and long-term flow variations

2. Upstream uses
3. Temperature
4. Chemical analysis (same as above)
5. Distance to site
6. Feasibility of dam or pumping station

D. Ground Water-Wells

1. Recent trend of water table elevation
2. Recharge rate
3. Regulations on use
4. Pumping cost
5. Temperature, chemical analysis

APPENDIX F

MARKET

APPENDIX F

A. Descriptions

Definition of markets in terms of past, present and future trends for your industry as a necessary first step in site evaluation.

B. Location

1. Detailed layout of urban areas-streets, existing and proposed highway, railroads, topography, land use including existing and proposed industrial land, zoning patterns, political subdivisions.
2. Distance and means of access to major metropolitan areas.
3. Area in which city is dominant retail center, dominant wholesale center.

C. Industrial Markets

1. Major economic activities by SIC number
2. Major industrial purchases and output (input-output study of area if available)
3. Trend of industries moving into and out of area- reasons for moves.
4. Growth industries- including announced plants not yet built.
5. Branches of nationally known firms.

APPENDIX G

CLIMATIC CONDITION

APPENDIX G

A. Climatic Condition

1. Monthly Average, maximum, minimum and long-term extreme temperatures.
2. Degree days by month.
3. Number of days over 90 degrees and number under 32 degrees.
4. Period between killing frosts.
5. Average monthly rainfall, snowfall.
6. Maximum rainfall, snowfall in 24 hours.
7. 50-year low, high precipitation.
8. Monthly averages of relative humidity.
9. Monthly wind velocity, prevailing wind direction.
10. Number of clear, partly cloudy and cloudy days.
11. Number of days with poor visibility and low ceilings.
12. Special weather hazards-hurricanes, tornadoes, dust or hail storms, droughts, floods, temperature inversions, fog.

B. Climate Effects

1. On building design, construction and maintenance.
2. On cost of heating air conditioning.
3. On transportation to and from plant.
4. On operations within plant, including technical processes.
5. On employee morale and recruiting.

C. Air Pollution Index

D. Mean Annual Inversion Frequency

APPENDIX H
SITE SUITABILITY

APPENDIX H

A. Type of Site

1. Raw land, previously agricultural.
2. Zoned industrial but not in planned industrial park.
3. Planned industrial district.
4. Urban, suburban, rural.
5. Waterfront or airport frontage.
6. Redevelopment area.
7. Drained or reclaimed land.
8. Cleared, graded land.
9. Site in large-scale PUD or new town.
10. Previous land use.
11. Adjacent land use.

B. Topographic Considerations.

1. Slope and grade.
2. Potential aesthetic problems.
3. Legislation restricting construction due to topography.
4. Height above sea level.

C. Geologic Conditions.

1. Depth to solid rock and character or intervening soil strata.
2. Bearing loads as compared with requirements.
3. Soil analysis.
4. Variation in ground water level.
5. Flood risk and flood plains of surface bodies of water

6. Drainage pattern after plant construction.
7. Earthquake risk.

APPENDIX I**COMMUNITY FACTORS**

APPENDIX I

A. General Appearance of Community

1. Natural environment.
2. Appearance of commercial, industrial areas
 - a. Active
 - b. New construction
 - c. Empty buildings

B. Community Features

1. Housing
 - a. Location of in-town, suburban residential areas
 - b. Areas served by all utilities
 - c. Slum areas
 - d. Urban renewal-public and private
 - Progress
 - Method of financing
 - Effect on other areas of city
 - e. Undeveloped acreage in city
 - f. Photographs of typical areas and homes
 - g. Housing available in various price ranges
 - h. Housing built in last five years
 - i. Typical construction- basements, garages, frame, brick, air conditioning, setbacks,
 - j. Lot sizes and costs
 - k. Building costs per square foot for various types of house
 - l. Rental units- size range, rentals, lease, requirements,

terms of lease

m. Apartments- type, rentals, terms of lease

n. Percent of total housing stock in rental units

2. Travel and meeting facilities

a. Hotels and motels

Number of rooms

Maximum and minimum rates

Recognition by national hotel and motel associations

b. Auditorium, arena, exhibit hall

Capacities

Special facilities

c. Restaurants

Number and capacity

Inspection by local health authorities

Banquet and meeting facilities

Noted specialties

3. Shopping facilities

a. Major department stores, including parking provisions

b. Specialty stores

c. Branches of metropolitan stores

d. Shopping centers

4. Adequate construction facilities and services available, such

as architects, engineers, prime contractors, subcontractors,

labor, masons, plasterers, painters, landscape artists and

paving contractors

5. Banks

- a. Number
 - b. Proximity
 - c. Total deposits
6. Legal firms
- a. Type
 - b. Number
 - c. Proximity
7. Communications media
- a. Newspapers-local and major out-of-town
 - Number and time of editions
 - Circulation
 - Editorial philosophy
 - Percent of population subscribing to daily newspapers
 - b. Television
 - Channnels, affiliations
 - Quality of reception
 - Local interest programs of special quality
 - Educational TV
 - CATV
 - c. Radio
 - Call letters and reception
 - Quality of programs
 - d. Other media
 - Trade publications
 - Farm journals

8. Mail and express service

- a. Number, location and hours of local post offices
- b. Frequency of delivery-business areas, residential
- c. Express service-area served, average shipment time to major cities
- d. Messenger service
- e. Location of bulk mail facilities

9. Organizations

- a. Civic, fraternal and social groups
- b. Economic development organizations
- c. Outstanding programs and expenditures per capita
- d. Extent of active participation
- e. United Fund

Results of last three drives

Per capita giving

Agencies included and those conducting separate drives

Participation by local industry-employee contributions by payroll withholding

- f. Professional societies

Membership

Frequency of meeting

Programs conducted

10. Political and social attitudes

- a. Majority of local civic, business and religious leaders with progressive attitude toward business and industry
- b. Proportion of population registered to vote and voting in

national and local elections

c. Business leader participation

Election to local office

Service on planning boards, school boards, tax councils

Local businessmen prominent at state and national levels

d. Economic education programs

e. Ethnic, racial and religious groups prominent in local affairs

f. Reception accorded new residents

g. Restrictions on sale of alcoholic beverages

h. Unusual "blue laws"

11. Amenities and intangibles

a. Points of unusual, historic or scenic interest

b. Prestige factors

C. Health and Welfare

1. Hospitals and clinics

a. Number of hospital beds per 1,000 population

b. Semi-private room rate

c. Special equipment

d. Rating

2. Medical personnel

a. General practitioners

b. Surgeons

c. Specialists

d. Number of physicians, dentists, nurses per 1,000 population

3. Dentists

4. Ambulance service
5. Public health regulations
6. Social services
 - a. Groups assisted
 - b. Number of social workers per 1,000 population
 - c. Source of funds
 - d. Expenditures for social services as percent of total city/county budget
 - e. Percent of total population on welfare
 - f. Adequacy of services for existing population
7. General health of population
 - a. Infant mortality rate
 - b. Death rates from heart disease, cancer
 - c. Tuberculosis rate
8. Average per capita government expenditure or public welfare

D. Police and Fire Protection

1. Law enforcement
 - a. Personnel per 1,000 population
 - b. Annual expenditures for police force
 - c. Equipment
 - d. Surveillance of industrial areas
 - e. Cooperation with county and state police
 - f. Crime and juvenile delinquency rates, major categories
(murder, rape, aggravated assault, burglary)
 - g. Performance during strikes and labor disputes
 - h. Injunctions against illegal strikes or picketing

- i. Traffic regulation during shift change at plants
- j. Municipal courts
- k. Personnel attrition
- l. Training programs
- 2. Civil defense
 - a. Shelters in downtown area
 - b. Trained disaster squads and civil defense units
- 3. Fire protection
 - a. Personnel per 1,000 per population
 - Paid
 - Volunteer
 - b. Fire insurance classification
 - c. Extent of protected area
 - d. Stations-location and time to outer limits of protected area
 - e. Equipment, including that for chemical fires
 - f. Water pressure to fire fighting
 - g. Sprinkler system requirements
 - h. Fire inspection of local industry
 - i. Personnel attrition
 - j. Training programs
- 4. Plant security
 - a. Availability of private security agency protection, if needed
 - b. Other

E. Education

- 1. Number, enrollment, teachers, accreditation

- a. Public schools- elementary, junior high, senior high
- b. Parochial schools- elementary and high
- c. Private schools
- d. Pupil-teacher ratios
2. Cost of education per pupil
3. Investment per pupil and public school debt per capita:
Responsibility for funding: school property tax trends
4. Teacher requirements and salary scales
5. School building expansion program and need for split shifts
6. History of voter rejection of school bond issues
7. Capacity vs. existing demand vs. projected demand
8. Condition and appearance of school building and grounds
9. Special facilities- libraries, laboratory facilities
10. Special programs for exceptional students
11. Average SAT scores
12. Percent of high school graduates who go to college
13. Percent of high school drop-outs
14. Trade and business courses in regular high schools
15. Adult evening classes- vocational and avocational
16. Kindergarts and nursery schools
17. School buses- areas served
18. Status of desegregation
19. History of racial conflict in schools
20. Program to deal with drug abuse, alcoholism
21. Colleges and universities in 50 miles radius
 - a. Enrollment, faculty, accreditation

- b. Degrees granted, graduate programs
- c. Evening courses offered
- d. Extension programs
- e. Special facilities for research
- f. Research undertaken for industry in last five years
- g. Expansion programs

22. Vocational schools

- a. Courses offered
- b. Curricula flexibility
- c. Federal, state or local training programs tailored to specific industry requirements
- d. Training cost reimbursement programs for industry
- e. Median school years completed by those 25 or older
- f. Percent of those applying for military service who fail mental test

F. Cultural Aspects

1. Libraries

- a. Number of volumes
- b. Branches, bookmobiles
- c. Circulation
- d. Budget

2. Legitimate theatre

- a. Traveling shows last five years
- b. Local repertory groups

3. Musical groups

- a. Symphony orchestra

b. Choral and chamber music groups

4. Lecture and concert series

5. Museums and art galleries

6. Discussion groups-forums

G. Recreational Facilities

1. Park- acres per 1,000 population

2. Playgrounds

3. Golf courses

a. Ownership

b. Fees and membership dues

4. Tennis courts

5. Water sports facilities

6. Winter sports facilities

7. Bowling alleys- number of lanes

8. Professional sports

a. Stadium capacity

b. Baseball, football, basketball, etc.

9. Race tracks- racing days per year

10. Team sports facilities

APPENDIX J

WASTE DISPOSAL AND TREATMENT

APPENDIX J

A. Sewage Disposal

1. Local sewage disposal agency, if any
2. Present and proposed capacity, as compared with present and projected load
3. Capacity to handle required quantity, BOD, acidity
4. Seperate or combined sanitary and storm sewers
5. Secondary sewage treatment
6. Ordinances on industrial waste
7. Cost of extending lines
8. Cost of service
9. Space on proposed site for lagoon, if necessary to process wastes
10. Requirements for septic tanks

B. Solid Waste Disposal

1. Agency and nature of collection system- incineration, land-fill or dump, transfer stations, resource recovery
2. Cost, methods and frequency of collection
3. Capacity compared with present and projected load
4. Pollution and aesthetic problems

PHYSICAL PLANNING OF AN INDUSTRIAL PARK;
A GUIDE FOR PLANNERS AND DEVELOPERS IN THAILAND

by

PRAJIM KRAIRUSSAMEE

B.S., Kasetsart University, Bangkok, Thailand, 1968

AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the
requirements for the degree

MASTER OF REGIONAL AND COMMUNITY PLANNING

Department of Regional and Community Planning

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1981

PHYSICAL PLANNING OF AN INDUSTRIAL PARK:
A GUIDE FOR PLANNERS AND DEVELOPERS IN THAILAND

Most of the small factories in Thailand are dispersed in the commercial districts or the residential areas of urban centers. As industry develops, the very location becomes an obstacle to their development; and their establishment often becomes a public nuisance. The establishment of industrial park then is needed because its objective is to help small business to improve its productivity and operation by encouraging it to move in groups to contain sites fit for factories, and located far from the city areas.

The purpose of this report is to provide guidance in locating, planning, and laying out of industrial parks, especially those for small-scale industries.

The report has been divided into three phases: The first phase concentrates on theoretical considerations governing industrial and plant location decisions. The second phase is the planning and development of industrial site. The third phase is the lay out consideration and design which can be broken down into seven components: Street Layout and Design, Railways, Airport, Grading and Drainage, Utilities Layout and Design, Design consideration, and Landscaping and Erosion Control.

In this report, an attempt is made to give what is considered to be the basic information necessary in guiding the physical planning of the industrial park. As is the case in any discussion of this sort, many topics have been touched briefly, but none in detail. Though this report is meant as a guide for the planners in Thailand, some principles

or rationales mentioned are universal which can be applied to most countries. It is the task of the planners to select the principles or rationales that will be useful and appropriate to the environment of the country.